Field research

Scientific papers, abstracts and posters from cooperation activities in Africa – 2021

MEDICI CON L'AFRICA CUAMM
Doctors with Africa

Field research

Scientific papers, abstracts and posters from cooperation activities in Africa – 2021

MEDICI CON L'AFRICA
CUAMM
Doctors with Africa

Doctors with Africa CUAMM
via San Francesco, 126 - 35121
Padua - tel +39 049 8751279
www.mediciconlafrica.org
cuamm@cuamm.org
c/c postale 17101353

Design
Heads Collective

Layout
Publistampa Arti Grafiche

Photography
Nicola Berti

Editorial staff
Chiara Di Benedetto
Giovanni Putoto
Francesca Tognon

Translated in part by
Sara Benjamin

Padua, April 2022

Con il contributo della Fondazione
Cassa di Risparmio di Padova e Rovigo

Fondazione
Cassa di Risparmio
di Padova e Rovigo

«Health workers have both
a professional obligation
and a clear mission “to protect
life and preserve peace”,
which in practical terms means
responding to needs, treating
those who are wounded or ill, and
restoring both services
and dignity to the people
and communities affected».

*«Gli operatori sanitari hanno
un obbligo professionale,
una missione chiara: “tutelare
la vita e preservare la pace”,
che significa concretamente
rispondere ai bisogni, curare
le ferite, ripristinare i servizi,
ridare dignità alle persone
e alle comunità colpite.».*

Giovanni Putoto,
Medici con l’Africa Cuamm

PROTECTING HEALTH, PRESERVING PEACE

War has returned to Europe. The conflict in Ukraine came abruptly, unexpected and shocking – yet another absurd and tragic war, with grim consequences for the country's people, their health and future generations.
And Ukraine is not the only country that is suffering. According to the 2021 yearbook of the Stockholm International Peace Research Institute (SIPRI), 2020 saw armed conflicts in 39 states around the world, twenty of which in sub-Saharan Africa[1]. The dynamics of such conflicts are manifold and often interconnected, including powerful interests in geopolitical supremacy, the exploitation of natural resources, religious and tribal extremism, political violence, widespread corruption and state fragility, inadequate essential services, growing economic and social inequality, and climate disasters.
Spirals of violence become extremely difficult to contain or reverse and violence is also increasingly on health workers and facilities to interrupt basic health care and service provision. So in the long list of tragedies associated with conflict, we find not only injury, incapacitation and death, but also the anguish and suffering brought over time by poverty, social deprivation, psychological distress, the loss of one's home. And in the end, those who pay the heaviest price in terms of health are always the same: civilians, including the most vulnerable among them – children, adolescents, women, the elderly, and sick or disabled individuals[2].
We can and will not remain indifferent to what is going on.
Health workers have both a professional obligation and a clear mission **"to protect life and preserve peace"**[3], which in practical terms means responding to needs, treating those who are wounded or ill, and restoring both services and dignity to the people and communities affected. This is the work Doctors with Africa CUAMM does in countries besieged by less well-known, more "silent" conflicts – the Central African Republic and South Sudan, for example, or Ethiopia's Tigray region and Mozambique's Cabo Delgado province – places where we work to foster safe motherhood, psychological wellbeing, and epidemic monitoring systems, and to tackle malnutrition, gender-based violence and chronic diseases.
Undertaking research in conflict settings might seem a "luxury" given the urgent material needs of the populations affected. Yet the field of humanitarian and emergency assistance needs to unearth much more evidence on critical issues such as the impact of political factors and (in)security on the resilience of health systems, needs assessment, intervention effectiveness, quality and equity, the links between emergency and development[4]. So, despite limitations posed by conflict settings, we are convinced that it is fundamental to conduct operational research while providing humanitarian assistance, in order to generate critical know-how that allows us to better understand what does and does not work in emergency interventions. This, too, is part of our mandate, and something we intend to expand our commitment to ever more over time.

Giovanni Putoto
Head of Operational Programming and Research,
Doctors with Africa CUAMM

TUTELARE LA SALUTE, PRESERVARE LA PACE

La guerra è tornata in Europa. La notizia del conflitto in Ucraina è arrivata inattesa e scioccante. Un'altra guerra, assurda e tragica, per le conseguenze sulla popolazione, sulla salute e sulle generazioni a venire. L'Ucraina non è il solo paese a soffrirne. Secondo il rapporto SIPRI dell'Istituto Internazionale di Ricerca sulla Pace di Stoccolma, i conflitti armati nel 2020 hanno interessato 39 paesi di cui ben 20 in Africa subsahariana[1]. Poderosi interessi di supremazia geopolitica, sfruttamento di risorse naturali, estremismi religiosi e tribali, violenza politica, corruzione diffusa e fragilità dello stato, inadeguatezza dei servizi essenziali, crescenti diseguaglianze economiche e sociali, crisi climatiche sono alla radice dei conflitti armati e generano una spirale incontenibile di violenza che diventa poi difficile da arrestare e invertire.
Questa violenza si abbatte sempre più frequentemente e intenzionalmente sugli operatori e sulle infrastrutture della salute con interruzione dei servizi e dell'assistenza sanitaria di base. Nella lunga scia di drammi che accompagnano i conflitti non ci sono solo la morte, le ferite, le disabilità, ma anche le sofferenze e i tormenti proiettati nel tempo come la povertà, la deprivazione sociale, la sofferenza mentale, l'abbandono della propria abitazione. E a pagare il prezzo più alto in termini di salute sono sempre loro: i civili, i gruppi più vulnerabili come donne, bambini, adolescenti, anziani, disabili, malati[2].
*Non resteremo indifferenti a quanto sta accadendo. Gli operatori sanitari hanno un obbligo professionale, una missione chiara: **"tutelare la vita e preservare la pace"**[3], che significa concretamente rispondere ai bisogni, curare le ferite, ripristinare i servizi, ridare dignità alle persone e alle comunità colpite. È quanto cerchiamo di fare come Medici con l'Africa Cuamm nella Repubblica Centrale Africana, nel Sud Sudan, nel Tigray in Etiopia e a Cabo Delgado nel nord del Mozambico, paesi tormentati da conflitti silenziosi, dimenticati dove ci occupiamo di maternità sicura, malnutrizione,* gender based violence, *salute mentale, malattie croniche e sistemi di monitoraggio delle epidemie.*
Occuparsi di ricerca in situazioni di conflitto potrebbe apparire un lusso, addirittura uno sfregio morale, rispetto ai bisogni materiali della popolazione. Eppure, il settore degli aiuti umanitari e dell'emergenza è tra quelli in cui sono meno forti le evidenze disponibili su questioni cruciali come l'impatto dei fattori politici e di sicurezza sulla resilienza del sistema sanitario, la valutazione dei bisogni, l'efficacia, la qualità e l'equità degli interventi, i nessi tra emergenza e sviluppo[4]. Pensiamo perciò che nonostante le difficoltà gravose poste dal contesto conflittuale la realizzazione di ricerche operative realizzata dentro e accanto all'assistenza umanitaria, possa fornire elementi fondamentali a comprendere meglio cosa funziona e cosa non funziona negli interventi d'emergenza. Anche questo fa parte del nostro mandato e su questo ci impegneremo ulteriormente nel prossimo futuro.

Giovanni Putoto
Responsabile della Programmazione e della Ricerca Operativa, Medici con l'Africa Cuamm

---

[1] https://www.sipri.org/yearbook/2021/02
[2] Levy BS, Sidel VW (eds). War and Public Health. 2nd ed. Oxford University Press.
[3] World Health Organization Department of Emergency and Humanitarian Action, *Conflict and Health Working Paper*, Preventing Violent Conflict: The Search for Political Will, Strategies and Effective Tools, June 2000 seminar. (www.who.int/hac/techguidance/hbp/Conflict.pdf).
[4] Women's and Children's Health in Conflict Settings, Lancet series, 2021.

RESEARCH THAT MATTERS TO COMMUNITIES

CUAMM published 33 studies in 2021, a figure that aligns with our scientific output in recent years and attests to our ongoing commitment to carry out research and analysis in parallel with, and incorporated into, our work in the field.

A quick survey of the papers we published this year provides a clear "map" of CUAMM's areas of intervention not just in Africa but also in Italy: from the effectiveness of maternity waiting homes in reducing perinatal mortality and an analysis of the cultural, economic and social factors underlying inadequate breastfeeding, to the role of health insurance in ensuring access to primary care by the most vulnerable groups and the impact of an emergency system for transporting rural patients to health centers or hospitals. We also undertook research on topics such as measuring access to care by the most vulnerable among the vulnerable – individuals sheltering in places like the Nguenyyiel Refugee Camp in Ethiopia's Gambella Region or the ghettos in Italy's Apulia Region – and tuberculosis, HIV and infectious disease management, with a focus on specific age groups such as adolescents. Other lines of research focused on the Covid-19 pandemic's impact on communities, particularly vis-à-vis the lack of reliable data, a well-known and widespread problem in sub-Saharan Africa.

Also noteworthy was research measuring the impact of the field training that CUAMM makes available to medical residents through its Junior Project Officer program. Also a further line of research was also relaunched in 2021: it addressed nutrition.
The increasingly influential journals and open-access publishers that have featured our research, including BMC, BMJ Global Health, Resuscitation and Frontiers, have positioned our organization as one well-equipped for the peer review selection process and continued collaboration with research centers and institutions.

And the list of CUAMM's research associates in 2021 provides evidence of our ongoing international expansion: leveraging the network we have been able to build up over the years, we conducted studies in partnership with an almost equal number of African, Italian and other European counterparts.

At the same time, the "map" described by this year's publications shows research that is increasingly geographically integrated; for the first time, in fact, in 2021 we published two papers analyzing specific cases in the Central African Republic. This development is making the integration of research components into field interventions more and more typical everywhere CUAMM works. It is a methodology that we have believed in from the start, and that enables us to provide quality health care to the global South.

Chiara Di Benedetto e Francesca Tognon
Implementation Research Unit

LA RICERCA CHE CREA VALORE PER LE COMUNITÀ

Sono 33 le ricerche a firma Cuamm pubblicate nel 2021, in linea con la produzione scientifica degli ultimi anni e a testimonianza di un lavoro di studio e di analisi che continua ad affiancarsi e integrarsi all'attività sul campo.

Se guardiamo infatti ai lavori pubblicati, sembrano tracciare una mappa molto chiara delle aree di lavoro di Cuamm, in Africa ma anche in Italia: dall'efficacia delle case di attesa per contrastare la mortalità neonatale allo studio dei fattori culturali, economici e sociali che ostacolano l'allattamento al seno, dal ruolo delle assicurazioni sanitarie per garantire assistenza primaria fino all'impatto di un sistema di emergenza per trasferire pazienti da zone rurali a centri di salute o ospedali. E ancora: studi che hanno misurato l'accesso alle cure in zone di riparo, come il campo profughi di Gambella in Etiopia ma anche nei ghetti della Puglia, entrambe terre dei più fragili tra i fragili, studi su tubercolosi, HIV e la gestione di malattie infettive, con uno sguardo privilegiato a fasce di età specifiche, come gli adolescenti. Troviamo qualche linea di ricerca che, come atteso, guarda all'impatto della pandemia di Covid-19 sulla popolazione, ponendo l'accento sulla scarsa attendibilità dei dati, problema diffuso e noto nell'Africa sub-sahariana.
Rilevante è l'importanza di ricerche che dopo molti anni di attività misurano l'impatto della formazione sul campo offerta a medici specializzandi e si riapre poi nel 2021 un filone di ricerca che risponde a un tema di cruciale importanza per Cuamm: la nutrizione. Sono cinque i paper dell'ultimo anno che trattano in tre paesi diversi di malnutrizione, della sua gestione e trattamento nella popolazione più giovane: i neonati e i bambini. E riconfermano pertanto il ruolo che rivestono i primi mille giorni di vita nella "costruzione" di una vita adulta in salute, con la consapevolezza che è proprio in età neonatale che bisogna intervenire per contrastare fattori critici.

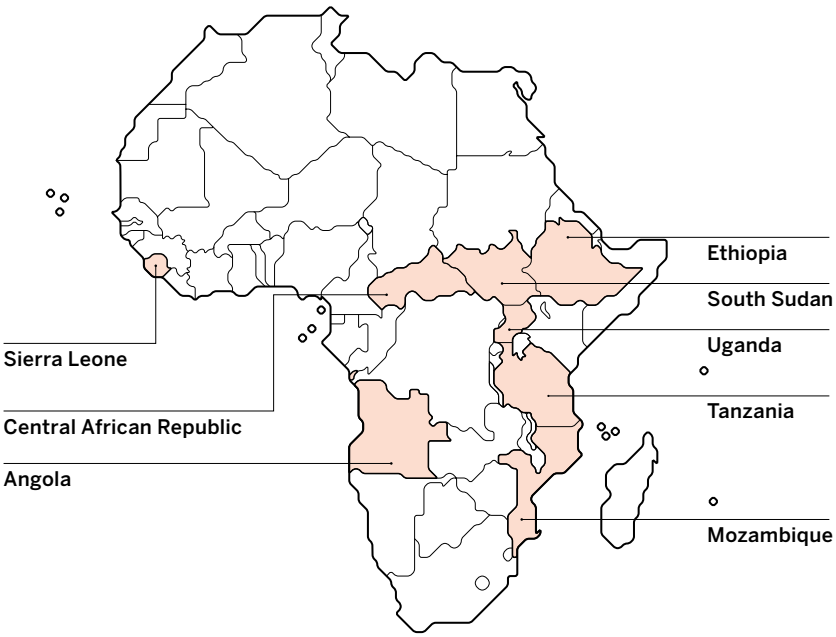
Anche le riviste che hanno ospitato i lavori Cuamm – tra queste BMC, BMJ Global Health, Resuscitation, Frontiers – evidenziano una crescita di autorevolezza, posizionando l'organizzazione come autore di ricerca ormai pronto ad affrontare una selezione peer review.

Sono proprio i partner di questo 2021 che segnalano una ulteriore crescita internazionale: le ricerche sono state condotte collaborando con centri italiani, africani ed europei in misura pressoché simile. E al tempo stesso la mappa geografica descritta dai paper *pubblicati narra un lavoro di ricerca che sempre di più si integra nei paesi, tanto da portare per la prima volta due* paper *che analizzano casi specifici della Repubblica Centrafricana. Un avanzamento questo che avvicina tutti i paesi all'integrazione di componenti di ricerca al programma di azione sul campo: un percorso metodologico in cui crediamo da sempre e che ci consente di continuare a portare una medicina di qualità anche nel sud del mondo.*

Chiara Di Benedetto e Francesca Tognon
Implementation Research Unit

Doctors with Africa CUAMM

Medici con l'Africa Cuamm



Doctors with Africa CUAMM is the largest Italian NGO working to **improve the health of vulnerable communities in Sub-Saharan Africa**. CUAMM carries out **long-term projects in 8 countries** in the region and partners with **universities and research centers** in Italy and abroad to raise awareness about people's right to health care. CUAMM also organizes **courses on global health** for medical students and health professionals and conducts **research** with international partners, convinced that such endeavors are vital to developing **quality international healthcare programs**.

Medici con l'Africa Cuamm è la più grande organizzazione italiana per la ***promozione e la tutela della salute delle popolazioni africane****. Medici con l'Africa Cuamm realizza* ***progetti a lungo termine in 8 paesi*** *dell'Africa Sub-sahariana e collabora con* ***università e centri di ricerca in Italia e in Europa****. Organizza inoltre* ***corsi di Salute Globale*** *per studenti di Medicina e professionisti sanitari e lavora con partner internazionali a* ***progetti di ricerca****, nella convinzione che questi sforzi siano necessari per lo sviluppo di* ***programmi sanitari internazionali di qualità****.*

Doctors with Africa CUAMM currently operates in Angola, Central African Republic, Ethiopia, Mozambique, Sierra Leone, South Sudan, Tanzania and Uganda. / ***Medici con l'Africa Cuamm attualmente lavora in Angola, Etiopia, Mozambico, Repubblica Centrafricana, Sierra Leone, Sud Sudan, Tanzania e Uganda attraverso:***

23
hospitals / *ospedali*

80
districts (for public health activities, mother-child care, the fight against HIV/AIDS, tuberculosis and malaria, training) / *distretti (iniziative per la salute pubblica, assistenza e cure per la salute materna e infantile, lotta contro l'HIV/AID, la tubercolosi e la malaria)*

3
nursing schools / *scuole per infermieri e ostetriche*

1
university (Mozambique) / *università (Mozambico)*

4,581
health workers, including / *collaboratori sanitari, che includono:*

493
from Europe and abroad / *europei e internazionali*

Operational research in 2021
Ricerca operativa nel 2021

33 articles published in international journals, featuring topics ranging from nutrition and the importance of neonatal health research to a focus on infectious diseases and specific categories such as adolescents. CUAMM's operational research in 2021 delved into the areas we tackle in the field every day, and evidences our preferred methodological approach: conducting research in parallel with our interventions to ensure quality interventions. Our partnerships with 212 researchers from 68 research centers in Italy, Africa and elsewhere enabled us to develop new projects and generate important new know-how even in limited-resource countries.

33 ricerche pubblicate su riviste internazionali: dall'importanza della ricerca sulla salute neonatale al tema della nutrizione, dall'attenzione per le malattie infettive allo sguardo privilegiato verso categorie specifiche, come gli adolescenti. Nel 2021 la ricerca operativa Cuamm è entrata nei temi di lavoro sul campo, dimostrando l'approccio metodologico che intendiamo perseguire: una ricerca che si integra all'intervento per garantire qualità. Abbiamo lavorato a fianco di 68 centri di ricerca italiani, africani e internazionali, coinvolgendo 212 ricercatori e ricercatrici che hanno collaborato per costruire nuova conoscenza e sviluppare progetti in Paesi con risorse limitate.

- Maternal and child health
  Salute materna e infantile
- Infectious and tropical diseases
  Malattie infettive e tropicali
- Universal coverage and equity
  Copertura sanitaria universale ed equità
- Nutrition
  Nutrizione
- Chronic diseases
  Malattie croniche

OUR RESEARCH PARTNERS

The 68 research centers, universities and other organizations – in Africa, Europe (including Italy), and other countries around the world – with which Doctors with Africa CUAMM partnered on research 2021.
I 68 centri di ricerca, università e organizzazioni con cui Medici con l'Africa CUAMM ha collaborato per produrre la ricerca nel 2021.

AFRICA

1. Tosamaganga District Designated Hospital, Ethiopia
2. District Medical Office, Iringa District Council, Tanzania
3. Ministry of Health and Sanitation, Government of Sierra Leone, Freetown, Sierra Leone
4. Ngokolo Health Centre, Catholic Diocese of Shinyanga, Shinyanga, Tanzania
5. Bugisi Health Centre, Catholic Diocese of Shinyanga, Tanzania
6. Center for Research in Infectious Diseases, Faculty of Health Sciences, Catholic University of Mozambique, Beira, Mozambique
7. MoHS Sierra Leone, Pujehun District, Sierra Leone
8. Ifakara Health Institute, Dar es Salaam, Tanzania
9. Children's Investment Fund Foundation, Nairobi, Kenya
10. Maternal and Child Wellbeing Unit, African Population and Health Research Center – APHRC, Nairobi, Kenya
11. Simiyu Regional Medical Officer's Office, Tanzania
12. Tanzania Food and Nutrition Centre, Dar es Salaam, Tanzania
13. Makerere University Lung Institute (MLI), Kampala, Uganda
14. National Tuberculosis and Leprosy Control Program (NTLP), Kampala, Uganda
15. Tosamaganga Council Designated Hospital, Iringa, United Republic of Tanzania
16. Saint Luke Hospital, Wolisso, Ethiopia
17. Beira Central Hospital, Beira, Mozambique
18. St. Kizito Hospital, Matany, Uganda
19. Missionary Catholic Hospital of Chiulo, Ombadja Municipality, Angola
20. Federal Ministry of Health, Addis Ababa, Ethiopia
21. Centre Hospitalier Universitaire Pédiatrique de Bangui (CHUPB), Central African Republic
22. Faculté des Sciences de la Santé (FACSS), Université de Bangui, Central African Republic
23. Infectious Disease Institute, Kampala, Uganda
24. Université Marien Ngouabi, Brazzaville, Congo
25. Muhimbili University of Health and Allied Sciences, Department of Obstetrics and Gynecology, es Salaam, Tanzania
26. Clinical Epidemiology Unit, Makerere University College of Health Sciences, Kampala, Uganda
27. Makerere University College of Health Sciences, Kampala, Uganda

ITALY

1. University of Pisa, Department of Internal Medicine
2. Policlinico Umberto 1, Department of Hematology, Oncology and Dermatology, Rome
3. University of Palermo, Department of Health Promotion, Mother and Child Care, Internal Medicine and Medical Specialties
4. CRIMEDIM - Center for Research and Training in Disaster Medicine, Humanitarian Aid, and Global Health, Università degli Studi del Piemonte Orientale, Scuola di Medicina, Novara
5. SUEM 118, Veneto Region
6. University of Padua, Department of Woman's and Child's Health
7. University of Florence, Department of Economics and Management
8. University of Milan, Centre for Multidisciplinary Research in Health Science
9. University of Siena, Department of Physics, Earth and Environmental Sciences
10. University of Bari, Clinic of Infectious Diseases, Bari
11. ANLAIDS Lombarda Section, Milan
12. A.O.U. "Policlinico Riuniti", Infectious Diseases Unit, Department of Clinical and Experimental Medicine, Foggia
13. Italian Society for Infectious and Tropical Diseases (SIMIT), Bari
14. University of Verona, Department of Diagnostics and Public Health
15. Bambino Gesù Children's Hospital IRCCS, Rome
16. University of Padua, Hygiene and Public Health Unit, Department of Cardiac Thoracic and Vascular Sciences and Public Health
17. Istituto Superiore di Sanità, National Center for Global Health, Rome
18. San Camillo-Forlanini Hospital, Rome
19. Italian Medical Students Association (SISM)
20. University of Padua, Department of Statistical Sciences
21. Bruno Kessler Foundation, Center for Health Emergencies, Trento
22. University of Maastricht, Faculty of Health, Medicine, and Life Sciences, Care and Public Health, The Netherlands
23. Bocconi University, Dondena Centre for Research on Social Dynamics and Public Policy, Milan
24. Fondazione IRCCS Ca' Granda Ospedale Maggiore Policlinico, U.O.C. di Medicina Generale, Emostasi e Trombosi, Milan
25. University of Milan Bicocca, Emergency Unit, Milan
26. Bologna Institute for Policy Research

EUROPE

1. King's College London, School of Population Health and Environmental Sciences, London, UK
2. Vrije Universiteit, Research Group on Emergency and Disaster Medicine, Brussel
3. Amsterdam Institute for Global Health and Development, University of Amsterdam, The Netherlands
4. London School of Health and Tropical Medicine, Department of Global Health and Development, London, UK
5. Chelsea and Westminster Hospital, NHS Foundation Trust, London, UK

6. Barcelona Institute for Global Health, University of Barcelona, Spain
7. Department of Global Health, Royal Tropical Institute (KIT), Amsterdam, The Netherlands
8. Athena Institute, VU Amsterdam, The Netherlands
9. European Parliamentary Research Services, European Parliament, Brussels, Belgium
10. Institute of Tropical Medicine, Department of Public Health, Sexual and Reproductive Health Group, Antwerp, Belgium
11. Karolinska Institutet, Stockholm, Sweden

OTHER COUNTRIES

1. Epidemiology and Prevention Group, National Cancer Center, Tokyo, Japan
2. King Abdullah University of Science and Technology (KAUST), Thuwal, Saudi Arabia
3. Indiana University School of Public Health, Department of Epidemiology and Biostatistics, Bloomington, IN, USA
4. Johns Hopkins University, USA

68 Research partners
partner di ricerca

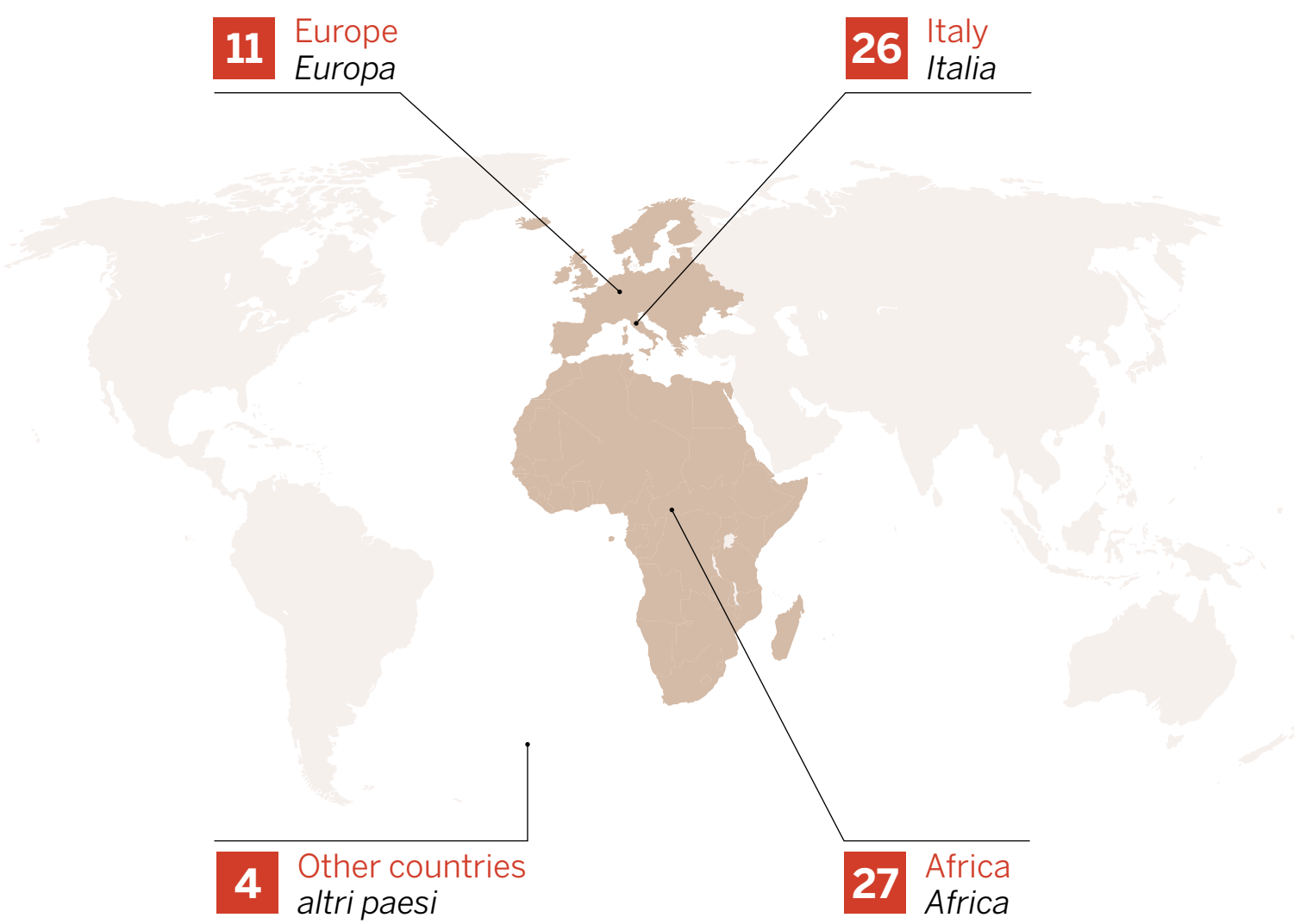


TABLE OF CONTENTS

Maternal and child health

POSTER PRESENTATION

83

01 → Sierra Leone

12th European Congress on Tropical Medicine and International Health (ECTMIH)

Virtual from Bergen, Norway, 28 September – 1 October 2021

- Valente N., *Estimating the impact on obstetric complication care: comparison between Met Need for Emergency Obstetric Care and Unmet Obstetric Need*

84

02 → Sierra Leone

12th European Congress on Tropical Medicine and International Health (ECTMIH)

Virtual from Bergen, Norway, 28 September – 1 October 2021

- Arata M., *The 10 Group Classification System (TGCS) applied in a urban referral hospital in Sierra Leone: an observational study*

Chronic diseases

85

PAPERS

86

01 → Ethiopia

Bregani E.R. et al., **A survey on a rural in-hospital population diagnosed with Atrial Fibrillation in west Shewa region, Ethiopia,** in *Journal of Public Health,* June 2021

87

02 → Tanzania

Miselli M.A. et al., **An Integrated Management System for Noncommunicable Diseases Program Implementation in a Sub-Saharan Setting**, in *International Journal of Environmental Research and Public Health*, November 2021

101

Universal coverage and equity

PAPERS

Universal coverage and equity

190

11 → Multi-countries

Pisani L. et al. **Performance evaluation of a multinational data platform for critical care in Asia. Collaboration for Research, Implementation and Training in Critical Care - Asia Investigators**, in *Wellcome Open Research* Journal, October 2021

POSTER PRESENTATIONS

208

01 → Uganda

12th European Congress on Tropical Medicine and International Health (ECTMIH)

Virtual from Bergen, Norway, 28 September – 1 October 2021

- Tognon F., *Measuring Effective Coverage for institutional deliveries in a rural district in Uganda: the role of Supportive Supervision data*

209

02 → Mozambique

12th European Congress on Tropical Medicine and International Health (ECTMIH)

Virtual from Bergen, Norway, 28 September – 1 October 2021

- Occa E., *Mozambican Adolescents and Youths in COVID-19 Pandemic: knowledge and awareness gaps in the provinces of Sofala and Tete*

ORAL PRESENTATIONS

210

01 → Sierra Leone

12th European Congress on Tropical Medicine and International Health (ECTMIH)

Virtual from Bergen, Norway, 28 September – 1 October 2021

- Caviglia M., *Improving access to healthcare in Sierra Leone: the role of the newly developed National Emergency Medical Service*

211

02 → Multi-countries

IEEE International Humanitarian Technology Conference (IHTC)

Virtual conference, 2-4 December 2021

- Bonaldo S. et al., *Portable Digital Stadiometer for Assessing the Degree of Childhood Malnutrition in Low-Income Countries*

213

Infectious and tropical diseases

PAPERS

Infectious and tropical diseases

POSTER PRESENTATIONS

303

01 → Multi-countries

12th European Congress on Tropical Medicine and International Health (ECTMIH)

Virtual from Bergen, Norway, 28 September – 1 October 2021

- Pellizzer G., *Application of Infection Prevention and Control Assessment Framework (IPCAF) tool in 13 hospitals in Sub Saharan Africa*

304

02 → Angola

13° Italian Conference on AIDS and Antiviral Research (ICAR 2021)

Riccione, Italy, 21-23 October 2021

- Natali G. et al., *Reaching 90-90-90 in the municipality of Kilamba Kiaxi, Luanda, Angola. The experience of PIPSA project*

ORAL PRESENTATIONS

306

01 → Angola

13° Italian Conference on AIDS and Antiviral Research (ICAR 2021)

Riccione, Italy, 21 – 23 October 2021

- Baldoni T., *Prevalence of HIV infection in the PIPSA project carried out in Luanda, Angola. Data analysis by sex and age group*

307

Nutrition

PAPERS

Below is a list of research papers published in prestigious journals that cited CUAMM's work in 2021.
Qui di seguito riportiamo ricerche di altri autori che nel corso del 2021 hanno citato il lavoro del Cuamm.

A)
TITLE: **Pragmatic Recommendations for the Use of Diagnostic Testing and Prognostic Models in Hospitalized Patients with Severe COVID-19 in Low- and Middle-Income Countries**
AUTHORS: Schultz MJ, Gebremariam TH, Park C, Pisani L, Sivakorn C, Taran S, Papali A
PUBLISHED IN: *American Journal of Tropical Medicine and Hygiene*, January 2021

B)
TITLE: **Awake Proning as an Adjunctive Therapy for Refractory Hypoxemia in Non-Intubated Patients with COVID-19 Acute Respiratory Failure: Guidance from an International Group of Healthcare Workers**
AUTHORS: Stilma W, Åkerman E, Artigas A, Bentley A, Bos LD, Bosman TJC, de Bruin H, Brummaier T, Buiteman-Kruizinga LA, Carcò F, Chesney G, Chu C, Dark P, Dondorp AM, Gijsbers HJH, Gilder ME, Grieco DL, Inglis R, Laffey JG, Landoni G, Lu W, Maduro LMN, McGready R, McNicholas B, de Mendoza D, Morales-Quinteros L, Nosten F, Papali A, Paternoster G, Paulus F, Pisani L, Prud'homme E, Ricard JD, Roca O, Sartini C, Scaravilli V, Schultz MJ, Sivakorn C, Spronk PE, Sztajnbok J, Trigui Y, Vollman KM, van der Woude MCE
PUBLISHED IN: A*merican Journal of Tropical Medicine and Hygiene*, March 2021

C)
TITLE: **Risk factors for preeclampsia and eclampsia at a main referral maternity hospital in Freetown, Sierra Leone: a case-control study**
AUTHORS: Stitterich N., Shepherd J., Koroma M. M., Theuring S.
PUBLISHED IN: *BMC*, June 2021

D)
TITLE: **Patient-incurred costs in a differentiated service delivery club intervention compared to standard clinical care in Northwest Tanzania**
AUTHORS: Okere N.E.,Corball L., Kereto D., Hermans S., Naniche D., Rinke de Wit T.F., Gomez G.B.
PUBLISHED IN: *Journal of the International Aids Society*, June 2021

E)
TITLE: **Global health education for medical students in Italy**
AUTHORS: Civitelli G., Tarsitani G., Censi V., Rinaldi A., Marceca M.
PUBLISHED IN: *BMC Medical Education*, June 2021

F)
TITLE: **The Shinyanga Patient: A Patient's Journey through HIV Treatment Cascade in Rural Tanzania**
AUTHORS: Okere N.E., Sambu V., Ndungile Y., van Praag E., Hermans S., Naniche D., Rinke de Wit T.F., Maokola W., Gomez G.B.
PUBLISHED IN: *International Journal of Environmental Research and Public Health*, August 2021

G)
TITLE: **Use of COVID-19 evidence in humanitarian settings: the need for dynamic guidance adapted to changing humanitarian crisis contexts**
AUTHORS: Odlum A., James R., Mahieu A., Blanchet K., Altare C., Singh N., Spiegel P.
PUBLISHED IN: *BMC*, November 2021

H)
TITLE: **Geoeconomic variations in epidemiology, ventilation management, and outcomes in invasively ventilated intensive care unit patients without acute respiratory distress syndrome: a pooled analysis of four observational studies**
AUTHORS: Pisani L, Algera AG, Neto AS, Azevedo L, Pham T, Paulus F, de Abreu MG, Pelosi P, Dondorp AM, Bellani G, Laffey JG, Schultz MJ; ERICC study investigators; LUNG SAFE study investigators
PUBLISHED IN: *Lancet Global Health*, December 2021

Maternal and child health

Suctioning at birth showed low adherence to official recommendations in a low-resource setting

PAPER

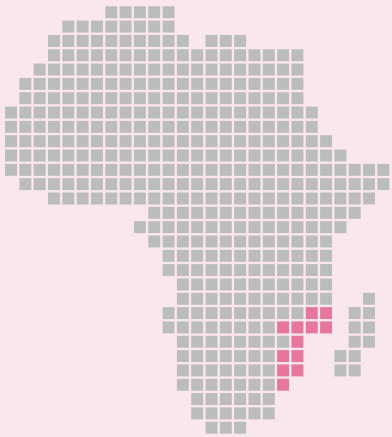
Authors
Cavallin F., Abuelnoor Ahmed Abdelghany S., Calgaro S., Hussein Abubacar Seni A., Rodriguez Cebola B., Putoto G., Trevisanuto D.

Published in
Acta Paediatrica,
January 2021

Link
https://doi.org/10.1111/apa.15448

Topic
Maternal and child health

Focus country
Mozambique



This paper is not available as open access, which is why only an abstract is posted. If you would like to read the entire paper, please go to the web page given and follow the instructions.

Congenital malformations in neonates admitted to a neonatal intensive care unit in a low-resource setting

PAPER

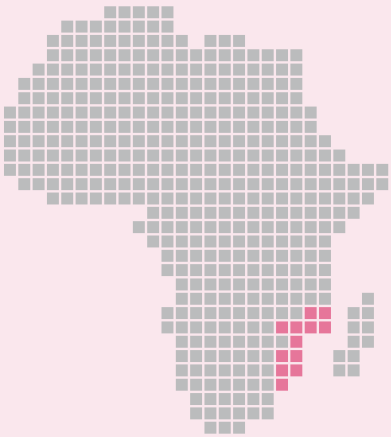
Authors
Cavaliere E., Trevisanuto D., Da Dalt L., Putoto G., Pizzol D., Muhelo A.R., Cavallin F.

Published in
The Journal of Maternal-Fetal & Neonatal Medicine, April 2021

Link
https://doi.org/10.1080/14767058.2021.1912003

Topic
Maternal and child health

Focus country
Mozambique



This paper is not available as open access, which is why only an abstract is posted. If you would like to read the entire paper, please go to the web page given and follow the instructions.

Pediatric Acute Liver. Failure in Central African Republic: Epidemiology and Prognostic Modeling

PAPER

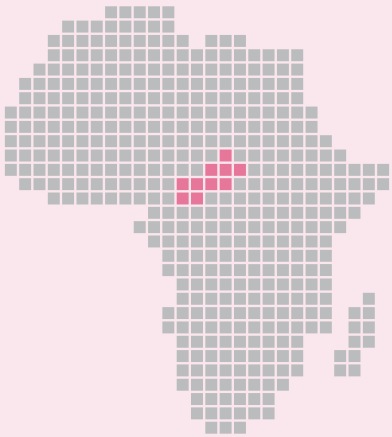
Authors
Radaelli S., Houndjahoue G. F., Bogning Mejiozem O. B., Mattei V., Galloni D., Martin C., Gody J. C.

Published in
Pediatrics&Therapeutics, April 2021

Link
www.researchgate.net/publication/351330545_Pediatric_Acute_Liver_Failure_in_Central_African_Republic_Epidemiology_and_Prognostic_Modeling

Topic
Maternal and child health

Focus country
Tanzania



Pediatrics & Therapeutics

OPEN ACCESS Freely available online

Research Article

Pediatric Acute Liver Failure in Central African Republic: Epidemiology and Prognostic Modeling

Silvia Radaelli[1,2], Ghislain F. Houndjahoue[1,2*], Olivier B. Bogning Mejiozem[1], Vittoria Mattei[1,2], Donata Galloni[1,2], Cecilia Martin[3], Jean-Chrysostome Gody[1,4]

[1]Centre Hospitalier Universitaire Pédiatrique de Bangui (CHUPB), Avenue de l'Indépendance, Bangui, Central African Republic;[2]Médecins avec l'Afrique CUAMM International NGO, via San Francesco 126, 35121 Padova, Italy;[3]King Abdullah University of Science and Technology (KAUST), 23955 Thuwal, Saudi Arabia;[4]Faculté des Sciences de la Santé (FACSS), Université de Bangui, Avenue des Martyrs, Bangui, Central African Republic

ABSTRACT

Objective: Pediatric acute liver failure (PALF) is a potential lethal disease. Few data are available regarding its prevalence, mostly in developing countries. Over the years, several prognostic scores were proposed for the management. However, none of them predicted PALF outcome. The aim of this study is to identify the prevalence, and propose a prognostic score that can be used in pediatric settings.

Study design: It was a retrospective and prospective cross-sectional study, focused on children aged from 1 month to 15-year-old, with acute liver failure (ALF). We tested whether the clinical outcome was influenced by variables and we applied a Logistic regression.

Results: The study included 117 cases of ALF with a prevalence of 2.2‰ in the pediatric ward and 14.5‰ in Intensive Care Unit (ICU). The mean age was 39.5 months. Factors associated with the clinical outcome were: age, hepatic encephalopathy (HE), INR, alanine aminotransferase (ALT), hyperleukocytosis and anemia. Sensitivity and specificity of each prognostic parameter indicated the values that are associated with death are: age>14.5 months, HE stage III or IV, INR>4.55, ALT<219 IU/l, and pallor.

Conclusion: PALF has a significant prevalence in Central African Republic. The prognostic parameters provided in this study could be a useful tool to identify patients with low survival likelihood. However, further researches are still needed in order to focus on the causes.

Keywords: Children liver injury; Prevalence; Prognostic parameters; Developing countries

INTRODUCTION

Paediatric Acute Liver Failure (PALF) is a dynamic clinical condition, resulting from loss of liver function, due to rapid death of a large proportion of hepatocytes. Although rare, this disease is potentially lethal, and accounts for 10-15% of all paediatric liver transplantations [1].

PALF is defined as a liver disease of abrupt onset, with hepatic-based coagulopathy, not corrected by vitamin K administration, and International Normalised Ratio (INR) ≥ 2 if HE is absent, or INR ≥ 1.5 in case of HE, occurring in children with no evidence of chronic liver disease [2].

The exact prevalence of this illness is unknown, and almost all the information available come from developed countries. The PALF study group, created in order to deepen the knowledge on this disease, enrolled 348 patients over 5 years, coming from 24 centres located in Europe and North America. Data from developing countries are scarce, with the few studies available realized in India and South Africa [3-5].

Aetiology in PALF varies significantly according to age and worldwide location. Identifiable causes include infections, metabolic diseases, Drug-Induced Liver Injury (DILI), immune-mediated damage, malignancies, and vascular/ischemic injury

Correspondence to: Ghislain F. Houndjahoue, Centre Hospitalier Universitaire Pédiatrique de Bangui (CHUPB), Avenue de l'Indépendance, Bangui, Central African Republic, Tel: +236 75681611; E-Mail: f.houndjahoue@cuamm.org

Received: March 31, 2021; **Accepted:** April 14, 2021; **Published:** April 21, 2021

Citation: Radaelli S, Houndjahoue GF, Bogning Mejiozem OB, Mattei V, Galloni D, Martin C, et al. (2021) Pediatric Acute Liver Failure in Central African Republic: Epidemiology and Prognostic Modeling. Pediatr Ther. 11:4.

Copyright: © 2021 Silvia Radaelli, et al. This is an open-access article distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.

OPEN ACCESS Freely available online

[6]. In the developed world, most cases have undetermined aetiology. On the contrary, poor hygienic conditions, widespread use of potentially toxic traditional herb-made remedies, and frequent use of over-the-counter drugs, make infections and DILI the 2 most probable causes of PALF in developing countries [7]. Considering the causes, one would expect acute liver failure to be more common in low-income nations, than in the richest areas of the world.

PALF represents one of the most challenging paediatric illnesses, owing to the presence of a rapidly progressive multisystem organ failure and potential neurologic deterioration. One of the most crucial steps in the management of this emergency consists of urgent decision making in regards to prompt liver transplant. Unfortunately, in most African Countries organ transplantation is still a utopian project [8]. In this context, treatment consists of general supportive care, management of associated infections and prevention of HE [9].

The creation of multicentre registers of PALF patients has given the opportunity to improve its treatment, especially in the western world, where nowadays the spontaneous survival rate reaches 73% [10]. Unfortunately, mortality due to PALF remains high in developing countries [3,4].

A prognostic score, identifying patients at higher risk of mortality, could be very useful in both high and low-income countries. In the first case, it could help to identify transplant candidates. In the second one, it could prevent from therapeutic relentlessness. Over the years, several prognostic scoring systems were proposed, such as the Paediatric End-Stage Liver Disease (PELD) or the King's College Hospital Criteria (KCH). However, none of these constituted a satisfactory tool to predict PALF outcome [11].

As far as we know, this is the first article dealing with this issue in Central African Republic (CAR), the second worst country in terms of Human Development Index, with one of the highest child and infant mortality rates in the world [12]. The aim of this observational study is to define the prevalence, prognostic determinants and outcome of PALF in children admitted to a tertiary paediatric care hospital in Bangui, Central African Republic.

MATERIALS AND METHODS

Research design, participants and setting

The current study was lead in the National Pediatric Teaching Hospital of Bangui. The setting was a 22 beds intensive care unit (ICU), providing medical and surgical care for children. It was a retrospective and prospective cross-sectional study, focused on hospitalized children aged from 1 month to 15-year-old, with PALF. We used an updated definition of ALF in children that included a series of clinical and biochemical indicators:

- biochemical evidence of liver injury without previous hepatic illness,
- coagulopathy not responsive to vitamin K,
- An INR greater than 1.5 in patients presenting encephalopathy or greater than 2 in patients without encephalopathy [13,14].

Procedure

The retrospective phase was conducted using the patient discharge register to identify patients diagnosed ALF from January 2017 to July 2019. Once the file was found, we assured that the criteria were met, and then a previously elaborated questionnaire was filled out.

The prospective phase of the study was lead in intensive care unit, from October 2019 to February 2020. We enrolled patients diagnosed ALF based on the criteria above and the same questionnaire was filled out.

We excluded children less than 28 days old, children with an INR<1.5 or with an INR ≥ 1.5 corrected by parenteral vitamin K, children whose legal guardian did not consent and those with a pre-existing liver disease. Moreover, children who died before 24 h and for which there was not time to collect enough data were also excluded.

Information collected including: Demographic data (i.e. age and sex), personal medical history (i.e. underlying diseases, hepatitis B vaccine), treatment before admission (i.e. herbal medicine intake), clinical data (i.e. pallor, jaundice, hepatomegaly, ascites, and stage of encephalopathy), laboratory tests at admission (Hemoglobin (Hb), White blood cell (WBC), Bilirubin, INR, albumin, ALT, AST, glycaemia), treatment with antimalarial, and clinical outcome. The outcome was interpreted as recovery of liver function or death. Acute malnutrition is defined as low weight for height (<2 Z score) for children under 5 and weight for height less than 80% for older children [15]. Hepatic encephalopathy was classified according to the Study Group recommendations [13].

- **Grades I–II:** inconsolable crying; inattention to tasks; "not acting like self," according to parents; normal reflexes or hyperreflexia
- **Grade III:** somnolence, stupor, combativeness, hyperreflexia
- **Grade IV:** coma, reflexes absent, decerebration or decortication

Data analysis

We reported the mean, standard deviation, confidence interval at 95% of the mean, for quantitative variables (i.e. age and laboratory test results), and percentages for qualitative variables (i.e. sex, personal medical history and clinical data). We then tested whether the clinical outcome (dead or recovered patients) was influenced by these variables. We applied a Logistic regression. Categorical variables with more than 2 levels (i.e. hepatic encephalopathy and underlying disease) were entered in the logistic regression by use of dummy coding, which generates dichotomous variables by comparing each level of

the variable with a reference level (i.e. hepatic encephalopathy grade I-II and no underlying disease). The logistic regression was conducted including all the independent variables except herbal medicine intake and hepatitis B vaccine. These two variables were excluded due to high number of missing values (i.e. values were missing for 40% and 72% of the patients, respectively). The clinical outcome was unknown for 8 patients; hence they were also excluded. Due to laboratory constraints, including shortage of reagents and device breakdown, it was not possible to collect all laboratory data for some patients. Since these data are missing for technical failures, we assumed they were missing completely at random and we used a multiple imputations function by Chained Equation to impute them [16]. The number of missing and imputed values was 7.4% of the dataset.

We reduced the number of independent variables by mean of a stepwise regression with backward selection, which excludes one variable at a time, starting from the less significant one. The logistic regression models obtained were compared using the Akaike Information Criteria (AIC) and the model having the lowest AIC was selected as the best one.

We plotted the Receiver-Operating Characteristic (ROC) curves for each of the significant variables resulting from the best logistic model. Based on the ROC curve, for each variable we selected the cut-off value as the value corresponding to the highest Youden's index. Finally, for additional model performance statistics, we identified sensitivity and specificity of these parameters, when present in isolation or together.

Data were recorded and processed with RStudio v. 1.1.383 software. We specifically used the packages 'mice' for the multiple imputations by chained equation and 'pROC' to compute the ROC curves.

Ethical consideration

For prospective phase of the study, each child's parent or guardian was informed and the consent was obtained. All identifying information was kept confidential and patient's anonymity was protected (Table 1).

Table 1: Independent variables for which values were missing.

Variable	No. missing values
Glycaemia	26
Albuminemia	28
Total Bilirubin	25
ALT	22
AST	22
Hb	06
WBC	16

RESULTS

Overall, during the study period, we analyzed 117 cases of acute liver failure out of 52214 admissions in the pediatric ward (2.2‰) and 8071 admissions in ICU (14.5‰). The mean age was 39.5 months and the sex ratio 1.1. The majority did not present any underlying disease. However, we noticed 12% of malnutrition upon admission. Many data were missing owing to incompleteness of the files. Twenty percent of children were vaccinated against hepatitis B; but the immunization status was unknown in 72% of cases. Moreover, the traditional medicine intake was reported in only 60% of case among them one-third had taken prior to admission (Table 2). The type of traditional medicine was often unheeded.

Table 2: Demographic, clinical and anamnestic characteristics of the 117 patients (N) included in the study.

Characteristics	N=117
Age: mean (SD) months	39.47 (45.36)
Sex: Male n (%)	62 (52.99)
Underlying diseases n (%)	
None	93 (79.49)
Sickle cell disease	3 (2.6)
Acute Malnutrition	14 (11.96)
HIV	4 (3.42)
Other	5 (4.27)
Hepatitis B vaccine n (%)	
Yes	23 (19.66)
No	10 (8.55)
Not known	84 (71.80)
Herbal medicine before admission n (%)	
Yes	40 (34.19)
No	30 (25.64)
Not known	47 (40.17)
Clinical signs upon admission n (%)	
Pallor	61(52.14)
Jaundice	33 (28.21)
Hepatomegaly	57(48.72)
Ascites	10 (8.55)
Hepatic encephalopathy stages n (%)	
I-II	69 (58.97)
III	17 (14.53)
IV	31 (26.49)
Antimalarial treatment: n (%)	63 (53.85)
Outcome n (%)	
Death	60 (51.28)
Alive	49 (41.88)
Escape	8 (6.8)

The predominant reasons for admission were neurological disorders followed by fever and digestive symptoms (Figure 1). Physical examination revealed that all patients exhibited neurological disorders of various intensity and the hepatic encephalopathy was classified stage III or IV in respectively

OPEN ACCESS Freely available online

15% and 26% of cases. Pallor and hepatomegaly were found in 53% and 49%, respectively. Half of the patients included in the study died.

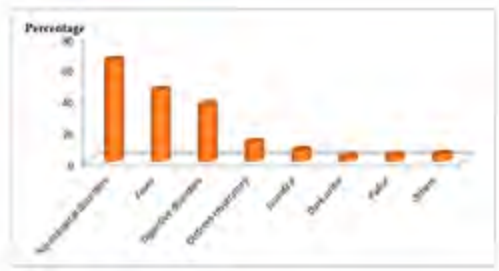


Figure 1: Main reasons for admission.

As mentioned in paragraph Data analysis, some biochemical data were missing for some patients due to laboratory constraints (Table 3). The INR mean at admission was 2.8 with range from 1.5 to 9. Hepatic cytolysis was highly marked with elevated ALT level ranging from 10 to 100 fold normal. The hematologic disorders found were moderate to severe anemia associated with hyper leukocytosis or leukopenia.

Table 3: Biochemical characteristics.

Parameters	Number of patients	Mean (SD)
Glycemia (mg/dl)	88	67.4 (69.13)
INR	117	2.8 (1.7)
Albuminemia (g/dl)	87	2.25 (0.76)
Total Bilirubinemia (mg/dl)	90	13.32 (56.38)
ALT (IU/l)	93	466 (543)
AST (IU/l)	93	593 (568)
Hb (g/dl)	109	9.2 (8.8)
WBC (/mm3)	98	11764 (7438)

The odds of dying are 0.3% lower for every single month of increasing age. Likewise, the odds of dying are 0.04% lower for every 1 point increase in ALT; in other words, 4% lower for each 100 IU/l increment in ALT. Conversely, hepatic encephalopathy stage IV, higher INR values and presence of pallor increase the odds of the death. Specifically, the odds of dying are 35.9% higher for hepatic encephalopathy stage IV compared to stage I-II. For every 1 point increment in INR, the odds of dying are 6.1% higher and the patient who presented with pallor increases his odd of death by 24.4%. In summary, factors that were associated with death a poor prognosis in our study were a younger age, low transaminases, higher INR, HE stage IV and pallor (Table 4).

Table 4: Factors associated with the clinical outcome resulting from the best logistic regression model (lower AIC value) obtained after backward selection. For each variable of the model, we report the odds ratio and the p-value.

Variable	Odds ratio (OR)	95% C.I.	P-value
Age	0.997	0.996-0.998	0.009
Hepatic encephalopathy stage III	1.163	1.029-1.315	0.221
Hepatic encephalopathy stage IV	1.359	1.227-1.506	0.003
INR	1.061	1.034-1.090	0.027
ALT	0.999	0.999-0.999	0.003
WBC	1.0	1.0-1.0	0.079
Hb	1.041	1.019-1.065	0.069
Pallor	1.244	1.116-1.387	0.048

The hepatic encephalopathy stage, followed by ALT and age were the best predicting factors, as demonstrated by the AUC value of the ROC curves generated for each parameter (Figure 2). Indeed, the AUC summarizes how good the factor is at discriminating between clinical outcomes. The cut-off values for each prognostic parameter, obtained from the ROC curves, indicate the values of the parameters that are likely associated with death or recovery. Specifically, we predict death for patients younger than 14.5 months, with a hepatic encephalopathy stage III or IV, INR>4.55, ALT<219 IU/l and showing pallor. The accuracy of the prediction is reported in (Table 5).

Table 5: Sensitivity and specificity at the cut-off value of each prognostic parameter. The direction (e.g. <14.5 months) indicates the values that are associated with death.

Variable (Cut-off values)	Sensitivity (%)	Specificity (%)
Age (<14.5 months)	45.0	77.6
Hepatic encephalopathy (>I-II)	56.7	73.5
INR (>4.55)	16.7	93.9

ALT (<219 IU/l)	53.3	69.4
Pallor	60.0	55.1

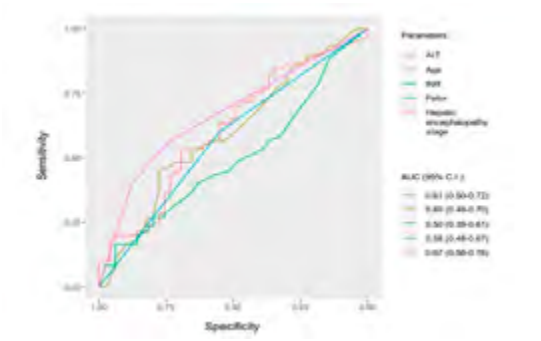


Figure 2: ROC curves for the single prognostic variables and relative Area under the curve (AUC).

When all the 5 prognostic parameters are considered together and death is predicted if at least 1, 2, 3 or 4 of the conditions associated to death are present in a patient, the goodness of the prognosis increases compared to considering the factors individually, as indicated by an AUC value of 0.8 (Figure 3, Table 6). An AUC of "1.0" would be ideal, representing 100% discrimination; however, in practice, AUC>0.8 is considered acceptable [11] .

Table 6: Sensitivity and specificity at the variable.

Variable	Sensitivity (%)	Specificity (%)
Any 1	100.0	18.4
Any 2	81.7	59.2
Any 3	43.3	91.8
Any 4	6.7	100.0

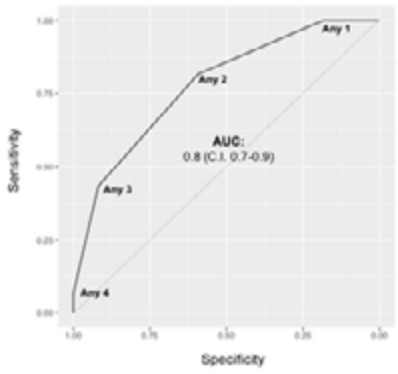


Figure 3: ROC curve considering all the 5 prognostic variables. Any 1, 2, 3 and 4 indicate the values of sensitivity and specificity when death is predicted if at least 1, 2, 3 or 4 conditions associated to death are present in a patient.

The best prognosis is obtained if the criterion used to predict death is that at least 2 of the conditions associated to death are present in a patient. If this is the case, there is an 82% probability of correctly identify the patients that will die and a 59% probability of correctly identify the patients that will recover. When at least 3 of the conditions are met in the patient, the probabilities of correctly identifying the one who will die decreases to 43% while the probability of identifying patients who recover increases to 92%. Finally, when 4 conditions are associated, the probability of identifying the patient who will die reached its lowest rate (6.7%) while it reached its highest rate for identifying patients who will be cured (100%) (Table 6).

DISCUSSION

This study is one of the few works available on PALF in sub-Saharan Africa and the first in Central African Republic. We collected 117 cases of acute liver failure over a period of 36 months. It consists of a significant number, when compared to some of the biggest multi-center studies ever realised on this subject in developed countries, [2,10] showing that PALF is probably more frequent in low-income nations.

Unfortunately, the aetiologies were not accurately defined in most of cases due to the lack of information in the medical records and the investigations restriction subsequent of a limited technical platform.

The main symptoms of admission were neurological disorders, and 41% of patients had a grade III-IV HE. This could be explained by the critical health situation in CAR, which in many cases results in delayed access to a proper medical treatment.

The mortality recorded was unacceptably high (51.28%) when compared to that of USA [10] but similar to the rate reported by other authors in developing countries [3,4]. The high mortality rate in developing countries may be related to the delayed access to care and the level of intensive care unit.

The main prognostic determinants in our study were: young age (<14.5 months), hepatic encephalopathy (III-IV), INR (>4.55), ALT (<219 IU/l) and pallor. It has already been demonstrated that severity of HE [2,11,17,18] and high INR values [2,14,19] are two strong predictors of negative outcome in both adults and children. As it concerns age, many studies, highlighted that young age is associated with poor outcome [2,11,19,20] partly due to the high frequency of multisystemic diseases (metabolic diseases, hemophagocytic lymphohistiocytosis, and herpes simplex virus infection) in this group. We also found out that a higher level of ALT was correlated with a better chance of survival, confirming findings from previous studies [17,21,22]. Lower liver enzymes could reflect the presence of massive organ damage, with loss of a large proportion of hepatocytes. Moreover, the presence of undiagnosed pre-damaged liver or chronic exposure to toxic substances as those contained in traditional herb remedies might be explanation [3,23]. Finally, we discovered that pallor was a predictor of poor outcome; even though Hb values were not found to have an impact on the

OPEN ACCESS Freely available online

outcome. Pallor being a clinician-dependent parameter, it was mentioned in the medical files each time it was noticed; while we had a limited number of Hb due to laboratory constraints. This data could probably suggest the presence of worse health and nutritional status in patients who died.

Based on these results, a score was proposed to estimate prognosis in paediatric patients with ALF. According to ROC curve analysis the best discriminatory capacity of this score occurs when a patient presents any 2 of our prognostic markers.

This study has several limitations. The main one is the lack of data due to the retrospective design of a consistent part of the work, as well as technical problems typical of the developing countries. Another great limit is the inability to detect the causes of PALF in our population. Future research could fill this gap, by means of prospective observational studies and use of serological and toxicological analyses in enrolled patients.

We conclude that PALF has a significant prevalence and mortality in CAR. The study presented the main prognostic parameters in Central African children and provided clinicians a valid tool to identify patients with low survival likelihood. However, future research is needed in order to focus on the causes of this disease.

Financial support

Médecins avec l'Afrique CUAMM through the project "Bekou" financed by the European Union

Potential conflict of interests

Nothing to report.

REFERENCES

1. Devictor D, Tissieres P, Afanetti M, Debray D. Acute liver failure in children. Clin Res Hepatol Gastroenterol. 2011; 35: 430-437.
2. Squires RH Jr, Shneider BL, Bucuvalas J, Alonso E, Sokol RJ, Narkewicz MR, et al. Acute liver failure in children: the first 348 patients in the pediatric acute liver failure study group. J Pediatr. 2006; 148: 652-658.
3. Alam S, Khanna R, Sood V, Lal BB, Rawat D. Profile and outcome of first 109 cases of paediatric acute liver failure at a specialized paediatric liver unit in India. Liver Int. 2017; 37: 1508-1514.
4. Kaur S, Kumar P, Kumar V, Sarin SK, Kumar A. Etiology and prognostic factors of acute liver failure in children. Indian Pediatr. 2013; 50: 677-679.
5. Bruckmann EK, Beretta M, Demopolous D, Brannigan L, Bouter C, Maher H, et al. Minding the gap-Providing quality transplant care for South African children with acute liver failure. Pediatr Transplant. 2020; 24: e13827.
6. Squires JE, McKiernan P, Squires RH. Acute liver failure: An update. Clin Liver Dis. 2018; 22: 773-805.
7. Riebensahm C, Ka D, Sow A, Semmo N, Wandeler G. A closer look at the spectrum of drug-induced liver injury in sub-Saharan Africa. Expert Rev Clin Pharmacol. 2019; 12: 875-883.
8. Spearman CWN, McCulloch MI. Challenges for paediatric transplantation in Africa. Pediatr Transplant. 2014; 18: 668-674.
9. Lutfi R, Abulebda K, Nitu ME, Molleston JP, Bozic MA, Subbarao G. Intensive care management of pediatric acute liver failure. J Pediatr Gastroenterol Nutr. 2017; 64: 660-670.
10. Kulkarni S, Perez C, Pichardo C, Castillo L, Gagnon M, Beck-Sague C, et al. Use of pediatric health information system database to study the trends in the incidence, management, etiology, and outcomes due to pediatric acute liver failure in the United States from 2008 to 2013. Pediatr Transplant. 2015; 19: 888-895.
11. Jain V, Dhawan A. Prognostic modeling in pediatric acute liver failure. Liver Transpl. 2016; 22: 1418-1430.
12. UN Inter-agency Group for Child Mortality. Levels & Trends in Child Mortality- Report 2019.
13. Silverio CE, Smithen-Romany CY, Hondal NI, Díaz HO, Castellanos MI, Sosa O. Acute liver failure in Cuban children. MEDICC Rev. 2015; 17: 48-54.
14. Núñez-Ramos R, Montoro S, Bellusci M, Del Fresno-Valencia MR, Germán-Díaz M, Urruzuno P, et al. Acute liver failure: outcome and value of pediatric end-stage liver disease score in pediatric cases. Pediatr Emerg Care. 2018; 34: 409-412.
15. Ministere de la sante de la population. Protocole national de prise en charge integree de la malnutrition. Republique Centrafricaine. Decembre 2014.
16. Sterne JA, White IR, Carlin JB, Spratt M, Royston P, Kenward MG, et al. Multiple imputation for missing data in epidemiological and clinical research: potential and pitfalls. BMJ. 2009; 29; 338:b2393.
17. Lee WS, McKiernan P, Kelly DA. Etiology, outcome and prognostic indicators of childhood fulminant hepatic failure in the United Kingdom. J Pediatr Gastroenterol Nutr. 2005; 40: 575-581.
18. Di Giorgio A, Sonzogni A, Piccichè A, Alessio G, Bonanomi E, Colledan M, et al. Successful management of acute liver failure in Italian children: A 16-year experience at a referral centre for paediatric liver transplantation. Dig Liver Dis. 2017; 49: 1139-1145.
19. Dhawan A, Cheeseman P, Mieli-Vergani G. Approaches to acute liver failure in children. Pediatr Transplant. 2004; 8: 584-588.
20. Sundaram SS, Alonso EM, Narkewicz MR, Zhang S, Squires RH. Pediatric acute liver failure study group. Characterization and outcomes of young infants with acute liver failure. J Pediatr. 2011; 159: 813-818.

21. Rajanayagam J, Coman D, Cartwright D, Lewindon PJ. Pediatric acute liver failure: etiology, outcomes, and the role of serial pediatric end-stage liver disease scores. Pediatr Transplant. 2013; 17: 362-368.

22. Kathemann S, Bechmann LP, Sowa JP, Manka P, Dechêne A, Gerner P, et al. Etiology, outcome and prognostic factors of childhood acute liver failure in a German Single Center. Ann Hepatol. 2015; 14: 722-728.

23. Chitturi S, Farrell GC. Herbal hepatotoxicity: An expanding but poorly defined problem. J Gastroenterol Hepatol. 2000; 15: 1093-1099.

View publication stats

The effectiveness of maternity waiting homes in reducing perinatal mortality: a case–control study in Ethiopia

PAPER

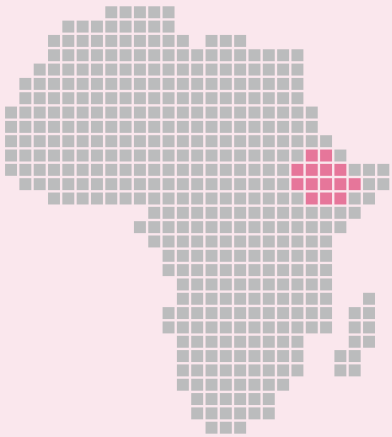
Authors
Dalla Zuanna T., Fonzo M., Sperotto M., Resti C., Tsegaye A., Azzimonti G., Manenti F., Putoto G., Bertoncello C.

Published in
BMJ Global Health,
April 2021

Link
http://dx.doi.org/10.1136/bmjgh-2020-004140

Topic
Maternal and child health

Focus country
Ethiopia



Original research

BMJ Global Health

The effectiveness of maternity waiting homes in reducing perinatal mortality: a case–control study in Ethiopia

Teresa Dalla Zuanna ,[1] Marco Fonzo ,[1] Milena Sperotto,[1] Carlo Resti,[2] Ademe Tsegaye,[3] Gaetano Azzimonti,[4] Fabio Manenti,[4] Giovanni Putoto,[4] Chiara Bertoncello[1]

To cite: Dalla Zuanna T, Fonzo M, Sperotto M, *et al*. The effectiveness of maternity waiting homes in reducing perinatal mortality: a case–control study in Ethiopia. *BMJ Global Health* 2021;**6**:e004140. doi:10.1136/bmjgh-2020-004140

Handling editor Valery Ridde

Received 15 October 2020
Revised 19 March 2021
Accepted 31 March 2021

Check for updates

© Author(s) (or their employer(s)) 2021. Re-use permitted under CC BY-NC. No commercial re-use. See rights and permissions. Published by BMJ.

[1]Hygiene and Public Health Unit, Department of Cardiac Thoracic and Vascular Sciences and Public Health, University of Padua, Padua, Italy
[2]Saint Luke Hospital, Wolisso, Ethiopia
[3]Addis Ababa Coordination Office, Doctors with Africa CUAMM, Addis Ababa, Ethiopia
[4]Headquarters, Doctors with Africa CUAMM, Padua, Italy

Correspondence to
Dr Marco Fonzo;
marco.fonzo@unipd.it

ABSTRACT

Background The 2030 Agenda for Sustainable Development aims to reduce neonatal mortality to at least 12 per 1000 live births. Most of the causes can be prevented or cured. Access to quality healthcare during pregnancy and labour is the key to reduce perinatal deaths, and maternity waiting homes (MWHs) may have an impact, especially for women who live far from the healthcare system. We conducted a case–control study to evaluate the effectiveness of MWH in reducing perinatal mortality in a secondary hospital in Ethiopia.

Methods We did a nested case–control study from January 2014 through December 2017. The enrolled cases were mothers whose childbirth resulted in stillbirth or early neonatal death. The controls were mothers with an alive baby at 7 days or with an alive baby on discharge. We collected demographic, anamnestic, pregnancy-related and obstetric-related data. The effectiveness of the MWH on perinatal death was assessed by a logistic regression model, adjusted for all other variables investigated as potential confounders. We also did a sensitivity analysis to explore the role of twin pregnancies.

Results We included 1175 cases and 2350 controls. The crude analysis showed a protective effect of the MWH towards perinatal mortality (OR=0.700; 95% CI: 0.505 to 0.972), even more protective after adjustment for confounders (adjusted OR (AOR)=0.452; 95% CI: 0.293 to 0.698). Sensitivity analyses showed a consistent result, even excluding twin pregnancies (AOR=0.550; 95% CI: 0.330 to 0.917).

Conclusion MWHs appear to reduce perinatal mortality by 55%. Our findings support the decision to invest in MWH to support pregnant women with higher quality and more comprehensive healthcare strategy, including quality antenatal care in peripheral primary care clinics, where risk factors can be recognised and women can be addressed for admission to MWH.

Key questions

What is already known?

- Although the 2030 Agenda for Sustainable Development aims to reduce perinatal mortality to at least 12 deaths per 1000 live births, this goal is likely to be difficult to achieve in sub-Saharan Africa—even if most causes are preventable or curable.
- Access to quality healthcare during pregnancy and childbirth is of paramount importance and maternity waiting homes (MWHs) may have an impact in this context, especially for people far from the healthcare system.
- The quality of the available evidence in this regard has been so low that in 2015 the WHO gave only a conditional recommendation for the implementation of MWHs, expressing the need for studies with a more robust design.

What are the new findings?

- This study is the first case–control study that evaluates the effectiveness of hospital MWHs in reducing perinatal mortality in a low-to-middle-income country.
- In our study, the risk of perinatal mortality among MWH-user mothers was half of non-users (adjusted OR: 0.452, 95% CI: 0.293 to 0.698), showing the effectiveness of this tool in the struggle against perinatal mortality.
- We investigated a number of maternal, obstetrical and neonatal factors as confounding variables: many disorders associated with stillbirths often coexist and adjustment for these factors is essential to understand the role of a specific intervention.
- In our study, we evaluated the effectiveness of the MWH including also twin births while in previous studies twin births have often been ruled out from the analysis.

INTRODUCTION

The 2030 Agenda for Sustainable Development aims to reduce the neonatal mortality below 12 deaths per 1000 live births by 2030.[1] The Alliance for Maternal and Newborn Health Improvement mortality study group estimated in 2012–2016 a neonatal mortality rate of 20.1 (14.6–27.6 per 1000 live births) and a stillbirth rate of 17.1 (12.5–25.8 per 1000 live births) in sub-Saharan Africa.[2] Public health programmes need to further intensify the delivery of effective interventions to reduce perinatal deaths, since most causes are potentially preventable or treatable.[3] Obstetric haemorrhage, non-obstetric complications, hypertension in pregnancy and pregnancy-related infections account for more than three-quarters of stillbirths. The most common causes of neonatal deaths are perinatal asphyxia and severe neonatal infections, followed by complications of preterm birth.[2]

BMJ Glob Health: first published as 10.1136/bmjgh-2020-004140 on 16 April 2021. Downloaded from http://gh.bmj.com/ on April 6, 2022 by guest. Protected by copyright.

Key questions

What do the new findings imply?

- These characteristics are a strength of this study and go in the direction advocated by the WHO recommendations for improving scientific evidence in similar contexts.
- Our results add to the evidence that the MWH is effective in reducing perinatal mortality, although MWH users show more risk factors, some of which—including twin pregnancy—are clearly involved in driving the decision whether to be admitted to the MWH.
- This study has a number of variables that have been studied so that it may be useful in drawing up priority criteria for admission to MWH on a national basis, supporting the decision to invest in MWH and to provide pregnant women with more comprehensive and skilled healthcare.

The access to quality healthcare during pregnancy, labour, delivery and the neonatal period will be the key to achieve reductions in preventable perinatal deaths especially in case of high-risk pregnancies.[4] Maternity waiting homes (MWHs) may have an impact especially for populations who live far from health system, considering that 40%–45% of perinatal deaths occur during labour, delivery and the 24-hour post partum.[2 5] An MWH is a facility with easy possibility of reaching a hospital or health centre which provides emergency obstetric care. Women are admitted to an MWH to await labour, with the aim of breaking down barriers to access such as distance, unfavourable seasonal climate, lack of infrastructures and means of transportation, cost of transport and inefficient communication between referral points.[6]

Some studies showed a favourable effect of the MWH on the outcomes for both women and newborns.[6 7] However, in 2012 the Cochrane review concluded that there had been insufficient evidence on the benefit of MWH to unequivocally recommend these facilities.[7] In 2015, the WHO gave a conditional recommendation for implementing MWHs given the very low quality of available evidence.[6] In 2017, Buser and Lori reiterated the need to generate further evidence on the effectiveness of MWHs on newborn outcomes in low-resource settings.[8]

Starting from the 1960s and during the last decades of the 20th century, many low-income and middle-income countries, including Ethiopia, have implemented MWHs as part of a national programme, with the aim of reducing perinatal and maternal mortality. In Ethiopia between 2011 and 2016, the perinatal death rate was 33 per 1000 live births.[9] Previous studies conducted in Ethiopia found MWHs to be effective in the reduction of perinatal mortality at hospital level.[10–12] All of them were cross-sectional and did not adjust for confounding factors. In this perspective study, we conducted a nested case–control study with the aim to evaluate the effectiveness of the MWH in reducing perinatal mortality in a secondary hospital in Ethiopia.

METHODS

Context

The Saint Luke Hospital (SLH) is a private not-for-profit hospital, accredited by the Oromiya public health system. It is in Wolisso and serves as the zonal hospital for the South West Shoa Zone (SWSZ, catchment area of 1 223 311 inhabitants in 2017). It is the referral hospital of the three primary hospitals of Ameya, Bantu and Tullu Bolo). The financial support is provided by the Oromiya Region (13.0%), the Italian non-governmental organisation (NGO) 'Doctors With Africa CUAMM' (35.0%), users' fees (35.0%) and other donors (17.0%). The fees for delivery services were kept low by decision of the Board of Governors, and further reduced thanks to the financial support through the CUAMM's project 'Mothers and children first'.

In the SLH, 24 beds in the maternity ward are available for mothers before and immediately after delivery (6 hours or longer if complications occur). The delivery room is provided with six labour and three delivery beds, with a 24/7 obstetric assistance (during the night on call) by midwives, graduated in a 3-year midwifery school. A gynaecologist manages the ward, helped in the operating room by a health officer (health personnel with 5-year training) with a specialisation in emergency obstetric and general surgery. The SLH is the only hospital in the SWSZ which provides 24/7 a comprehensive emergency obstetric and neonatal care assistance, which also includes the performance of caesarean sections and blood transfusions. In 2017, 4300 deliveries were performed; the rate of caesarean sections was 14%. A neonatal unit with six thermal cots is available since 2011, providing pharmacological therapy and kangaroo mother care therapy, although there is no possibility of mechanical ventilation. An emergency referral system deals with complications arising at primary care facilities. The SLH has an MWH which is a corrugated iron roofed and brick walled structure with 27 beds in two rooms, flushing water closet and kitchen. Admitted mothers receive a visit two times per week by a dedicated midwife coming from the maternity ward; they can always refer to the gynaecologist in case of urgent issues. During the stay, the hospital guarantees basic food supply and kitchen utensils and allows the presence of companions to take care of the pregnant women. Pregnant women living far from the hospital are usually referred to the MWH in case of high-risk pregnancy or false labour and when a caesarean section is envisaged or mandatory.

Study design

We conducted a monocentric, nested case–control study at the SLH in Wolisso, SWSZ, Ethiopia.

Cases were all mothers giving birth in the SLH, whose childbirth resulted in stillbirth or early neonatal death. Stillbirth was defined as a baby born with no signs of life after 28 weeks' gestation or weighing more than 1000 g.[13] Both *macerated stillbirth* (dead before the onset of labour and presenting degenerative changes) and *fresh stillbirth* (dead during labour or delivery) were considered.[13] Early neonatal mortality was defined as a baby born alive but dead within 7 days.[14]

Controls were mothers giving birth in SLH, whose childbirth resulted in a baby alive at 7 days or until hospital discharge. For each case, two controls were selected. Controls were the two mothers who followed each case on the delivery registry.[14] This choice of controls was made to minimise the

BMJ Glob Health: first published as 10.1136/bmjgh-2020-004140 on 16 April 2021. Downloaded from http://gh.bmj.com/ on April 6, 2022 by guest. Protected by copyright.

Table 1 Rate of perinatal death by admission to the maternity waiting home (MWH). Ethiopia, 2014-2017.

		Perinatal death		P-value*
		Yes (cases)	No (controls)	
		n (%)	n (%)	
Access to MWH	Yes	51 (4.3)	143 (6.1)	**0.034**
	No	1124 (95.7)	2207 (93.9)	
Total		1175 (100.0)	2350 (100.0)	

*In bold p-value<0.05.

possibility that each case and its controls received a different level of healthcare assistance during labour.[15]

Mothers who gave birth to both dead twins were considered as cases, considering data about the first recorded twin only. Mothers who gave birth to a dead and an alive newborn were selected as cases considering data of the dead one; by definition they could not be chosen as controls. Mothers who gave birth to both twins alive were selected as controls in case they gave birth immediately after a case and data referred to the first recorded baby. The exposure of interest was the admission to MWH before the delivery.

Patient and public involvement

Since this was a retrospective study, patients were not involved in the design or management of the study, while midwives working in MWH were interviewed and contributed to the design of the study and data collection. This study was designed and conducted as part of the broader 'Mothers and children first' project run by the NGO 'Doctors With Africa CUAMM' (https://www.mediciconlafrica.org/en/what-we-do/in-africa/mothers-and-children-first), whose objectives were, among others, the active empowerment of women

Table 2 Conditions related to the maternal health and to the current pregnancy in MWH users and non-users. Ethiopia, 2014-2017.

		Non-MWH	MWH user	P-value*
		% (n)	% (n)	
Age	≤24 years	37.2 (1227)	22.7 (44)	**<0.001**
	25–34 years	50.2 (1658)	56.7 (110)	
	≥35 years	12.6 (415)	20.6 (40)	
Area of residence	Urban	31.9 (1063)	11.9 (23)	**<0.001**
	Rural	68.1 (2268)	88.1 (171)	
Hypertension†		2.3 (77)	2.6 (5)	0.804
Chronic diseases		1.3 (43)	1.0 (2)	1.000
Infectious diseases (except HIV/AIDS)		0.3 (9)	0.0 (0)	1.000
HIV/AIDS		2.0 (68)	1.5 (3)	1.000
Parity	≤4 born	90.2 (3005)	79.4 (154)	**<0.001**
	5 born or more	9.8 (326)	20.6 (40)	
Previous caesarean sections	None	93.8 (3125)	68.0 (132)	**<0.001**
	At least once	6.2 (206)	32.0 (62)	
Previous complicated pregnancies	Negative anamnesis	99.7 (3320)	96.4 (187)	**<0.001**
	Positive anamnesis	0.3 (11)	3.6 (7)	
Access to antenatal care	None	76.1 (2515)	53.9 (104)	**<0.001**
	At least once	23.9 (788)	46.1 (89)	
Type of pregnancy	Single	94.8 (3158)	85.6 (166)	**<0.001**
	Multiple	5.2 (173)	14.4 (28)	
Preeclampsia		3.1 (102)	6.7 (13)	**0.011**
Oligohydramnios		0.6 (21)	1.0 (2)	0.364
Polyhydramnios		1.3 (43)	3.6 (7)	**0.018**
Breech presentation		3.7 (123)	9.3 (18)	**0.001**
Antepartum haemorrhage		3.2 (107)	6.2 (12)	**0.038**
Gestational age	Pre-term/complete	97.7 (3255)	96.4 (187)	0.221
	Post-term	2.3 (76)	3.6 (7)	

Numbers may not add to total sample size due to missing values.
*In bold p-value<0.05.
†Systolic blood pressure >140mm Hg or diastolic blood pressure >90mm Hg.

BMJ Glob Health: first published as 10.1136/bmjgh-2020-004140 on 16 April 2021. Downloaded from http://gh.bmj.com/ on April 6, 2022 by guest. Protected by copyright.

Table 3 Obstetric conditions in MWH users and non-users. Ethiopia, 2014-2017.

	Non-MWH	MWH user	
	% (n)	% (n)	P-value*
Shoulder dystocia	0.5 (17)	0.5 (1)	1.000
Other dystocia	4.6 (153)	7.2 (14)	0.114
Eclampsia	0.7 (24)	0.0 (0)	0.640
Premature rupture of membranes	10.8 (359)	2.1 (4)	**<0.001**
Head stuck	0.5 (18)	1.0 (2)	0.302
Cephalopelvic Disproportion (CPD)	2.5 (84)	0.5 (1)	0.089
Obstructed labour	0.6 (19)	0.0 (0)	0.622
Placental abruption	0.9 (31)	1.5 (3)	0.432
Nuchal cord (or Cord-Around-the Neck)	1.4 (48)	0.5 (1)	0.521
Umbilical cord/hand prolapse	2.6 (85)	1.5 (3)	0.632
Placenta praevia	0.9 (31)	4.1 (8)	**0.001**
Type of delivery			
Spontaneous vaginal delivery	68.4 (2276)	48.5 (94)	**<0.001**
Breech birth	6.3 (209)	10.8 (21)	
Forceps/Windy	6.8 (227)	6.7 (13)	
Caesarean	13.8 (458)	30.4 (59)	
Destructive	4.8 (159)	3.6 (7)	
Presence of meconium			
Absent	96.0 (3199)	99.0 (192)	**0.033**
At least grade I	4.0 (132)	1.0 (2)	

Numbers may not add tototal sample size due to missing values.
*In bold p-value<0.05.

within the community and the increase of technical skills among midwives.

The preliminary results of the project, both on care and research activities, are presented periodically, usually in the form of dissemination workshop, inviting all stakeholders involved, including representatives of the population and local health authorities. In addition, we also intend to spread the main results of this study to community midwives and healthcare professionals working mostly in remote and rural areas, with the aim of providing them with further evidence to refer pregnant women to the MWH in case of real need and trying to overcome social and economic barriers that often discourage referral and admission to the MWH. Healthcare workers in these areas have a crucial role in promoting patient and public involvement.

This *modus operandi* is not new in this context: community awareness and mobility interventions have already been implemented with the aim of constantly increasing knowledge and, finally, access to health services, especially for the most disadvantaged populations. The community awareness has been steadily improved over the previous 6 years, through the provision of various demand creation activities, including pregnant women's forums to discuss birth preparation, safe and free institutional childbirth; mass mobilisation events; awareness campaigns on health education, HIV and tuberculosis prevention; counselling and screening for cervical and breast cancer prevention and counselling for including income-generating activities in women.

Data collection

We collected demographic characteristics and basic anamnestic data about mothers and newborns, considering variables investigated in past studies, as well as conditions that might arise as potential indications for admission to the MWH in our specific context. We collected data on (1) pregnancy-related conditions, (2) obstetric conditions and (3) neonatal conditions. A review of the delivery register, the hospital electronic inpatient database, the neonatal admission charts and the MWH register was undertaken, considering data collected between January 2014 and December 2017. All sources were linkable through the unique admission code that each mother received at admission. Data collection followed the Strengthening the Reporting of Observational Studies in Epidemiology statement for observational studies (see online supplemental appendix for the checklist of items included).

Sample size

A sample size of 3240 mothers (of which 1080 cases) was required to detect a probability of exposure in cases of at least 3.5%, assuming a 5.8% probability of exposure in controls, a case:control ratio of 1:2, an 80% power and a 5% significance

BMJ Glob Health: first published as 10.1136/bmjgh-2020-004140 on 16 April 2021. Downloaded from http://gh.bmj.com/ on April 6, 2022 by guest. Protected by copyright.

level. The assumption of 5.8% probability of exposure was set according to data shown in the SLH annual report.[16]

Data analysis

Data were summarised in contingency tables of frequencies and proportions. A preliminary bivariate analysis was conducted to identify differences between the group exposed to the MWH and the non-exposed group. Fisher's exact test was used to assess the association with potential confounding factors. We performed a crude analysis to establish the association between perinatal mortality (entered as dependent variable) and the access to MWH (as independent variable) for the total sample using logistic regression. All the other investigated variables were included in the multivariate logistic regression to assess this association after adjusting for potential confounders. The variables Apgar at 5 min and birth weight were not included in the model since strongly correlated with outcome mortality, of which may be considered as proxy—the correlation coefficient phi for nominal variables was statistically significant (p<0.001) for both pairs. Unadjusted and adjusted ORs (AORs), 95% CIs and p values are reported. The level of significance was set at a p value of <0.05.

Finally, to further investigate the potential confounding effect of a selection bias, we identified the triplets (one case and two controls) with at least a twin (either the case or one of the controls) and performed a sensitivity analysis by excluding these triplets. Statistical analyses were performed using STATA software, V.12.1 (StataCorp, College Station, Texas, USA).

RESULTS

Overall, 3525 mothers were included in the study, of which 1175 cases and 2350 controls. The proportion of missing data ranged between 0.0% and 0.9% based on variables investigated. As shown in table 1, 4.3% of cases and 6.1% of controls were admitted to the MWH (p=0.034).

MWH users used to hail from rural areas in a significantly larger proportion compared with non-users (88.1% vs 68.1%, p<0.001), as shown in table 2. Mothers attending the MWH were usually older (p<0.001) and the proportion of grand multiparas was twice higher than the counterpart (20.6% vs 9.8%, p<0.001). MWH mothers had more often a history of complicated pregnancies (3.6% vs 0.3%, p<0.001) and caesarean sections (32.0% vs 6.2%, p<0.001); moreover, about half of them underwent at least one antenatal care (ANC) visit (46.1%) compared with 23.9% of mothers who did not attend the MWH (p<0.001). Among MWH users, the prevalence of pre-eclampsia, polyhydramnios, breech presentation and antepartum haemorrhage was significantly higher (see table 2).

While the occurrence of premature rupture of membranes (2.1% vs 10.8%, p<0.001) and ≥1 grade meconium (1.0% vs 4.0%, p=0.033) was lower in MWH users, the prevalence of placental abruption was higher (4.1% vs 0.9%, p<0.001). The proportion of caesarean sections (30.4% vs 13.8%) and breech deliveries (10.8% vs 6.3%) was higher than non-users. While no difference was detected in the occurrence of neonatal malformations in the two groups, the percentage of newborns with 5 min Apgar ≥7 was higher in MWH mothers (72.7% vs 64.5%, p=0.020), as well as babies weighing ≥2500 g (80.4% vs 72.5%, p=0.016) (tables 3 and 4).

The crude analysis showed a protective effect of the MWH towards perinatal mortality (unadjusted OR=0.700; 95% CI: 0.505 to 0.972). The magnitude of this protective effect increased after adjusting for potential confounders (AOR=0.452; 95% CI: 0.293 to 0.698) (table 5).

After having excluded 189 triplets with at least a twin, the AOR showed a slight decrease in the magnitude of the protective effect of the MWH towards perinatal mortality, without, however, losing its statistical significance (AOR=0.550; 95% CI: 0.330 to 0.917).

CONCLUSION

To our knowledge, this study is the first case–control study that evaluates the effectiveness of MWHs in reducing perinatal mortality in a low-to-middle-income country. The risk of perinatal mortality among MWH users was less than half of non-users, showing the effectiveness of this strategy in reducing perinatal mortality.

Table 4 Neonatal characteristics in MWH users and non-users. Ethiopia, 2014–2017.

		Non-MWH	MWH user	
		% (n)	% (n)	P-value*
Malformations		3.2 (105)	4.6 (9)	0.291
Sex of the born	Female	46.0 (1528)	53.1 (103)	0.064
	Male	54.0 (1792)	46.9 (91)	
APGAR at 5 min	7–10	64.5 (2146)	72.7 (141)	**0.020**
	0–6	35.5 (1182)	27.3 (53)	
Birth weight	≥2500 gr	72.5 (2416)	80.4 (156)	**0.016**
	<2500 gr	27.5 (915)	19.6 (38)	

Numbers may not add tototal sample size due to missing values.
*In bold p-value<0.05.

BMJ Glob Health: first published as 10.1136/bmjgh-2020-004140 on 16 April 2021. Downloaded from http://gh.bmj.com/ on April 6, 2022 by guest. Protected by copyright.

Table 5 Logistic regressions. Risk of perinatal mortality. Odds ratios, 95% confidence intervals, p-values. Ethiopia. Years 2014–2017.

	Unadjusted OR	95% CI	P-value*	Adjusted OR†	95% CI	P value*
Access to MWH (all cases)	0.700	0.505 to 0.972	**0.033**	0.452	0.293 to 0.698	**<0.001**
Access to MWH (excluding triplets with at least a twin)	0.764	0.528 to 1.104	0.152	0.550	0.330 to 0.917	**0.022**

*In bold p-value <0.05.
†The regression analysis was adjusted for all variables showed in tables 2–4.

This result is comparable with previous studies from Ethiopia[10–12] and other resource-limited settings,[17–20] although not all of them demonstrated a significant reduction in the risk of perinatal deaths in MWH users.[21 22] Most of the previous studies were cross-sectional, conducted on a limited population and only few of them adjusted for confounding factors. In the document *Recommendations on health promotion interventions for maternal and newborn health*, the WHO has expressed the need for further studies with a more robust design that would measure the contribution of MWHs within a package of interventions aimed at increasing the access to skilled care.[6] Our study relies on a case–control design, and a considerable number of maternal, obstetrical and neonatal factors were included in the analysis as confounding variables. Indeed, many disorders associated with stillbirths often coexist,[23] and adjustment for these factors is essential to understand the role of a specific intervention. In addition, we evaluated the effectiveness of the MWH including also twin births. In previous studies, twin births have often been ruled out from the analysis[18] or findings arising from this subgroup have not been discussed[24] probably because of implications from a potential selection bias or the complexity of handling this variable. However, the suspicion of a multiple pregnancy is one of the most frequent criteria for admission to the MWH and a well-known risk factor for perinatal death.[25] Considering this, the evaluation of the effectiveness of MWH in this category appears even more essential. To handle the risk of a potential selection bias, we decided to perform a sensitivity analysis. Our findings clearly showed how the MWH acted as a significantly protective factor from perinatal mortality either including multiple pregnancies or not.

Compared with non-MWH mothers, MWH users were older, came from rural areas, had a worse obstetric history, higher parity and a higher number of previous caesarean sections. Moreover, MWH users showed a significantly higher prevalence of all risk factors which are detectable during pregnancy (except for oligohydramnios), while the prevalence of maternal pre-existing conditions was similar in the two groups. Based on this set of information, a higher perinatal mortality would be expected in this group[2 26] but our findings show how MWHs are associated with a significant reduction in perinatal death. Our main finding, together with data on risk factors detectable during pregnancy, conforms as regards the risk of a selection bias described in past research.[7] Nevertheless, the presence of peripheral health centres and the ambulance transport service may increase the proportion of women who go directly to the hospital, without being admitted to the MWH, so that women in this catchment area may have more favourable outcome compared with other contexts. However, the availability of ambulance transport has to be considered complementary to the MWH because obstetric emergencies may arise during labour or delivery even in women without a previously detected high-risk pregnancy.[5]

This study also suggests that the MWH is effective in selecting women who actually need additional medical assistance. The WHO, indeed, set as a priority the conduction of studies able to show whether the MWH should be recommended in a specific subset of women sharing potential risk factors as vulnerability, high distance to healthcare facilities or peculiar obstetric risk.[6] Despite a higher prevalence of conditions detected prenatally, MWH users show a similar or even lower prevalence of obstetric complications (except for placenta praevia). A possible explanation may rely on a more timeliness intervention as complications occur, which enables the healthcare professionals to have a wider choice of therapeutic options. For instance, among MWH users, the proportion of caesarean section deliveries was more than twice higher than in non-users.[5] Definitely, this aspect is also reflected in better neonatal outcomes in terms of both Apgar score and birth weight for MWH users. Our study can rely on a plenty of variables investigated, allowing to identify the profile of women at risk who could actually benefit from the admission to MWH. Our results, together with evidence provided in other Ethiopian settings, may be useful for drafting priority criteria for the admission to MWHs on a national basis.[27]

In Ethiopia, faith-based organisations have pioneered the construction of the first MWHs in the late 1980s. Slowly, others were built, some under the aegis of the ministry of health, but in 2012 only nine facilities, including Wolisso Hospital, were provided with an MWH.[27] In 2016 in Ethiopia, 52% of health facilities were provided with an MWH.[28] The main aim of this strategy in the struggle towards the reduction of perinatal mortality in Ethiopia is to bridge the geographical gap in obstetric care between rural and urban areas and areas with poor access to healthcare facilities. Once labour starts, women would rapidly move to the health facility so that they can be assisted by a skilled birth attendant.[28] In addition, during their stay, mothers receive healthy and nutritious food—free of charge for mothers, provided by the community—and they are given specific advice on any problems that may occur in the days immediately following delivery.[28]

BMJ Glob Health: first published as 10.1136/bmjgh-2020-004140 on 16 April 2021. Downloaded from http://gh.bmj.com/ on April 6, 2022 by guest. Protected by copyright.

Our results need necessarily to be contextualised. The hospital involved in the study shows peculiar features—surgical capacity and associated competencies; private ownership; programmes funded by external donors; the presence of HIV treatment programmes in the healthcare—which are known to be associated with higher quality standard of services implemented and, ultimately, lower perinatal mortality: indeed, secondary care facilities—regardless of the delivery volume—appear to be better equipped to provide better care for women experiencing complications during the delivery than primary care facilities.[5]

This study has several strengths. First, it stands out for being the first case–control study investigating the effectiveness of MWHs and handles a high number of variables, which allowed us to adjust for many covariates that could potentially confound our association. These features meet the WHO recommendations for an improvement of scientific evidence in similar contexts.[6] Second, the sample size is relatively large and all cases occurring in the study period were included. Only few other studies investigating the effectiveness of the MWH showed a larger or similar sample size.[11 18] Third, the completeness of variables investigated is very high (99.1% or more, depending on the variable at issue). In low-income and middle-income countries, archives are usually paper based and not well stored. Our decision to conduct a nested case–control study rather than a retrospective cohort study relies on this: in the absence of an integrated electronic health records management system, we preferred to collect all available data on a sample of controls rather than including the whole cohort. Lastly, we were the first to perform a sensitivity analysis which allowed us to take into account—and assess—the effectiveness of MWH on perinatal mortality also in case of twin pregnancies.

The study has also some limitations. We did not retrieve data on the socioeconomic status of the mothers at the individual level. Two recent studies conducted in Ethiopia showed that MWH users were on average less educated and poorer than women admitted directly to hospital.[24 29] In rural areas, the population is poorer and education lower, and maternal lower education and economic hardship were shown to be associated with higher perinatal mortality.[15 25] However, not all of the most recent Ethiopian studies agree on the role of these factors on perinatal mortality; quite the opposite, all show that the number of previous deliveries and previous obstetric complications make the greatest contribution, and among the socioeconomic determinants, the residence in a rural area shows the greatest association with perinatal mortality.[30–32] These three factors are all known during pregnancy and may act as crucial indications for admission to the MWH. In addition to this, our study is monocentric; although a detailed description of the context may allow for comparisons between situations with a similar—or, by contrast, different—background, the extendibility of our findings remains limited, suggesting the need for multicentre researches.

In conclusion, our findings show how MWHs appear to be able to reduce perinatal mortality by 55%. Our study is the first case–control study to estimate the effect of MWH in reducing perinatal mortality, making a substantial contribution in improving the quality of evidence as advocated by the scientific community and the major health authorities at the global level. The MWH is effective in reducing perinatal mortality although MWH users show more risk factors, some of which—including twin pregnancy—are clearly involved in driving the decision whether getting admitted to MWH. Our findings support the decision to invest in MWHs, providing pregnant women with higher quality and more comprehensive healthcare. However, to meet this target, efforts should be addressed also in providing quality ANC in peripheral primary care clinics, where properly trained healthcare professionals may recognise the occurrence of risk factors that may pose an indication for admission to the MWH. Although our findings may be extended to contexts with a background similar to that described in this study, our research lays the basis for a legitimate need for multicentre studies that would act as a driving force for a further generalisation of this achievement.

Contributors TDZ, GP and CB conceived the concept. TDZ and CB designed the protocol. CR, AT and GA oversaw the data collection and monitoring. MF and MS performed statistical analyses. TDZ, MF and CB wrote the initial draft of the paper. FM contributed to the study design and data interpretation. All authors reviewed and approved the final draft of the paper.

Funding The authors have not declared a specific grant for this research from any funding agency in the public, commercial or not-for-profit sectors.

Competing interests None declared.

Patient consent for publication Not required.

Ethics approval The study complied with the Helsinki Declaration. Ethical approval was obtained from the ethical committee of the Saint Luke Hospital. Personal data were processed in an anonymous and aggregate form.

Provenance and peer review Not commissioned; externally peer reviewed.

Data availability statement Data are available upon request.

Supplemental material This content has been supplied by the author(s). It has not been vetted by BMJ Publishing Group Limited (BMJ) and may not have been peer-reviewed. Any opinions or recommendations discussed are solely those of the author(s) and are not endorsed by BMJ. BMJ disclaims all liability and responsibility arising from any reliance placed on the content. Where the content includes any translated material, BMJ does not warrant the accuracy and reliability of the translations (including but not limited to local regulations, clinical guidelines, terminology, drug names and drug dosages), and is not responsible for any error and/or omissions arising from translation and adaptation or otherwise.

Open access This is an open access article distributed in accordance with the Creative Commons Attribution Non Commercial (CC BY-NC 4.0) license, which permits others to distribute, remix, adapt, build upon this work non-commercially, and license their derivative works on different terms, provided the original work is properly cited, appropriate credit is given, any changes made indicated, and the use is non-commercial. See: http://creativecommons.org/licenses/by-nc/4.0/.

ORCID iDs
Teresa Dalla Zuanna http://orcid.org/0000-0003-1244-404X
Marco Fonzo http://orcid.org/0000-0002-9561-0711

REFERENCES

1 United Nations. Transforming our world: the 2030 agenda for sustainable development. Available: https://sustainabledevelopment.un.org/content/documents/21252030%20Agenda%20for%20Sustainable%20Development%20web.pdf
2 Alliance for Maternal and Newborn Health Improvement (AMANHI) mortality study group. Population-based rates, timing, and causes of maternal deaths, stillbirths, and neonatal deaths in South Asia

BMJ Glob Health: first published as 10.1136/bmjgh-2020-004140 on 16 April 2021. Downloaded from http://gh.bmj.com/ on April 6, 2022 by guest. Protected by copyright.

and sub-Saharan Africa: a multi-country prospective cohort study. *Lancet Glob Health* 2018;6:e1297–308.
3 Madhi SA, Briner C, Maswime S, *et al*. Causes of stillbirths among women from South Africa: a prospective, observational study. *Lancet Glob Health* 2019;7:e503–12.
4 Cooper P. Strategies to reduce perinatal mortality. *Lancet Glob Health* 2016;4:e6–7.
5 Kruk ME, Leslie HH, Verguet S, *et al*. Quality of basic maternal care functions in health facilities of five African countries: an analysis of national health system surveys. *Lancet Glob Health* 2016;4:e845–55.
6 World Health Organization. Who recommendations on health promotion interventions for maternal and newborn health, 2015. Available: http://www.ncbi.nlm.nih.gov/books/NBK304983/ [Accessed 6 Dec 2018].
7 van Lonkhuijzen L, Stekelenburg J, van Roosmalen J. Maternity waiting facilities for improving maternal and neonatal outcome in low-resource countries. *Cochrane Database Syst Rev* 2012;10:CD006759.
8 Buser JM, Lori JR. Newborn outcomes and maternity waiting homes in low and middle-income countries: a scoping review. *Matern Child Health J* 2017;21:760–9.
9 Central Statistical Agency (CSA), ICF. *Ethiopia demographic and health survey 2016*, 2017.
10 Poovan P, Kifle F, Kwast BE. A maternity waiting home reduces obstetric catastrophes. *World Health Forum* 1990;11:440-5.
11 Kelly J, Kohls E, Poovan P, *et al*. The role of a maternity waiting area (MWA) in reducing maternal mortality and stillbirths in high-risk women in rural Ethiopia. *BJOG* 2010;117:1377–83.
12 Tiruneh GT, Taye BW, Karim AM. Maternity waiting homes in Rural Health Centers of Ethiop: The situation, women's experiences and challenges. *Ethiop J Health Dev*;10.
13 WHO. *Making every baby count. audit and review of stillbirths and neonatal deaths*, 2016.
14 Musafili A, Essén B, Baribwira C, *et al*. Social equity in perinatal survival: a case-control study at hospitals in Kigali, Rwanda. *Acta Paediatr* 2015;104:1233–40.
15 McClure EM, Pasha O, Goudar SS, *et al*. Epidemiology of stillbirth in low-middle income countries: a global network study. *Acta Obstet Gynecol Scand* 2011;90:1379–85.
16 Saint Luke Hospital. Annual report of St. Luke Catholic hospital and College of nursing and midwifery, 2017. Available: http://stlukecatholichospital.org/2017%20Annual%20Report.pdf [Accessed 11 Dec 2018].
17 Millard P, Bailey J, Hanson J. Antenatal village stay and pregnancy outcome in rural Zimbabwe. *Cent Afr J Med* 1991;37:1–4.
18 Chandramohan D, Cutts F, Millard P. The effect of stay in a maternity waiting home on perinatal mortality in rural Zimbabwe. *J Trop Med Hyg* 1995;98:261–7.
19 Tumwine JK, Dungare PS. Maternity waiting shelters and pregnancy outcome: experience from a rural area in Zimbabwe. *Ann Trop Paediatr* 1996;16:55–9.
20 Lori JR, Munro ML, Rominski S, *et al*. Maternity waiting homes and traditional midwives in rural Liberia. *Int J Gynaecol Obstet* 2013;123:114–8.
21 van Lonkhuijzen L, Stegeman M, Nyirongo R, *et al*. Use of maternity waiting home in rural Zambia. *Afr J Reprod Health* 2003;7:32.
22 Singh K, Speizer I, Kim ET, *et al*. Reaching vulnerable women through maternity waiting homes in Malawi. *Int J Gynecol Obstet* 2017;136:91–7.
23 Lawn JE, Blencowe H, Waiswa P, *et al*. Stillbirths: rates, risk factors, and acceleration towards 2030. *Lancet* 2016;387:587–603.
24 Braat F, Vermeiden T, Getnet G, *et al*. Comparison of pregnancy outcomes between maternity waiting home users and non-users at hospitals with and without a maternity waiting home: retrospective cohort study. *Int Health* 2018;10:47–53.
25 Andargie G, Berhane Y, Worku A, *et al*. Predictors of perinatal mortality in rural population of northwest Ethiopia: a prospective longitudinal study. *BMC Public Health* 2013;13:168.
26 Bishop D, Dyer RA, Maswime S, *et al*. Maternal and neonatal outcomes after caesarean delivery in the African surgical outcomes study: a 7-day prospective observational cohort study. *Lancet Glob Health* 2019;7:e513–22.
27 Gaym A, Pearson L. *Maternity waiting homes in Ethiopia –three decades experience*. 12, 2012.
28 EPHI, FMoH, AMDD. Ethiopian emergency obstetric and newborn care (EmONC) assessment 2016: final report, 2017. Available: https://www.ephi.gov.et/images/pictures/download2010/FINAL-EmONC-Final-Report-Oct25-2017.pdf [Accessed 30 Aug 2020].
29 Fogliati P, Straneo M, Mangi S, *et al*. A new use for an old tool: maternity waiting homes to improve equity in rural childbirth care. results from a cross-sectional hospital and community survey in Tanzania. *Health Policy Plan* 2017;32:1354–60.
30 Yirgu R, Molla M, Sibley L. Determinants of neonatal mortality in rural Northern Ethiopia: a population based nested case control study. *PLoS One* 2017;12:e0172875.
31 Fenta SM, Biresaw HB, Fentaw KD. Risk factor of neonatal mortality in Ethiopia: multilevel analysis of 2016 demographic and health survey. *Trop Med Health* 2021;49:14.
32 Basha GW, Woya AA, Tekile AK. Determinants of neonatal mortality in Ethiopia: an analysis of the 2016 Ethiopia demographic and health survey. *Afr Health Sci* 2020;20:715–23.

BMJ Glob Health: first published as 10.1136/bmjgh-2020-004140 on 16 April 2021. Downloaded from http://gh.bmj.com/ on April 6, 2022 by guest. Protected by copyright.

Determinants of breastfeeding practice in Pujehun district, southern Sierra Leone: a mixed-method study

PAPER

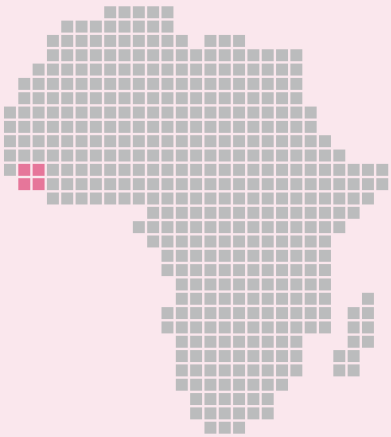
Authors
van Breevoort D., Tognon F., Beguin A., Ngegbai A. S., Putoto G. & van den Broek A.

Published in
International Breastfeeding Journal, May 2021

Link
https://doi.org/10.1186/s13006-021-00390-4

Topic
Maternal and child health

Focus country
Sierra Leone



Breevoort et al. International Breastfeeding Journal (2021) 16:42
https://doi.org/10.1186/s13006-021-00390-4

International Breastfeeding Journal

RESEARCH Open Access

Determinants of breastfeeding practice in Pujehun district, southern Sierra Leone: a mixed-method study

Dorothee van Breevoort[1,2*], Francesca Tognon[3], Arne Beguin[1], Amara S. Ngegbai[4], Giovanni Putoto[2] and Ankie van den Broek[5]

Abstract

Background: It is well established that exclusive breastfeeding can play a critical role in reducing child morbidity and mortality. Limited research has been done thus far on the practice and perceptions of breastfeeding in Sierra Leone, where more than 10 % of children die before the age of five. This study aimed to gain understanding into and explore both matters in order to develop recommendations for effective strategies to promote breastfeeding practice in Pujehun District, Southern Sierra Leone.

Methods: This exploratory mixed-method study included a cross-sectional survey of 194 mothers, semi-structured interviews and focus group discussions. Logistic regression analysis was used calculated odds ratios of factors associated with primarily breastfeeding practice, defined as 'Children under six months of age who are fed with breast milk only and children older than six months of age that were exclusively breastfed up to six months', based on recall from birth. Exclusive breastfeeding rate was based on breastfeeding practice 24 h prior to the survey. Qualitative data was analysed through a deductive approach, using a pre-determined framework on determinants of breastfeeding.

Results: This study revealed an exclusive breastfeeding rate of 62.8% (95% CI 53.9, 71.7); dropping from 74% in the 0–1-month age group to 33% in the 4–5 months group. Triangulation of qualitative and quantitative data revealed enabling factors for primarily breastfeeding practice included mothers receiving support during their first breastfeed, pregnant women being provided with information on the benefits of the practice, counselling by nurses, support from husbands, and women's awareness of how their friends and family members fed their own babies. The main barriers were a lack of encouragement by husbands, women's perception that their infants' stools were abnormal or that they were not producing enough breast milk.

Conclusions: Although the exclusive breastfeeding may have risen over recent years, a gap remains compared to World Health Organization recommendations. According to the breastfeeding determinants identified in this study, promotion of counselling by a nurse, encouragement of husbands' support, and improve knowledge of mothers on breastfeeding are recommended to be incorporated in the design of future health programs.

Keywords: Breastfeeding, Determinants, Sierra Leone, Child health, Mix-method

* Correspondence: dorotheevanbreevoort@gmail.com
[1]Doctors with Africa CUAMM, Pujehun-Freetown, Sierra Leone
[2]Doctors with Africa CUAMM, Via San Francesco, 126, 35121 Padua, Italy
Full list of author information is available at the end of the article

© The Author(s). 2021 **Open Access** This article is licensed under a Creative Commons Attribution 4.0 International License, which permits use, sharing, adaptation, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons licence, and indicate if changes were made. The images or other third party material in this article are included in the article's Creative Commons licence, unless indicated otherwise in a credit line to the material. If material is not included in the article's Creative Commons licence and your intended use is not permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder. To view a copy of this licence, visit http://creativecommons.org/licenses/by/4.0/. The Creative Commons Public Domain Dedication waiver (http://creativecommons.org/publicdomain/zero/1.0/) applies to the data made available in this article, unless otherwise stated in a credit line to the data.

Background

Breastfeeding has major benefits for infants' and young children's health and survival [1]. It has been shown that exclusive breastfeeding (EBF) reduces morbidity and mortality due to infectious diseases, with a particular protective effect against diarrhea, respiratory infections and otitis media; moreover, breastfed infants have a lower risk of hospital admission [1, 2]. Exclusive breastfeeding is defined as "the infant receives breastmilk and allows the infant to receive ORS, drops, syrups but nothing else" [3]. The EBF rate is based on feeding practice 24 h prior the assessment [4]. It has been established that EBF for the first 6 months of life and continued breastfeeding with adequate complementary foods up to the age of 2 years or beyond, can play a critical role in reducing child mortality, saving the lives of over 820,000 children below the age of 5 years worldwide, every year [2, 5].

Despite the recommendations of the World Health Organization (WHO) that infants be exclusively breastfed for the first 6 months of life [6], it is estimated that only 36% of infants under 6 months old were exclusively breastfed worldwide in the 2007–14 period [5]. In 2017, the number rose only slightly, to 40% [7].

Sierra Leone has one of Africa's highest rates of child mortality: in 2013, the country's infant mortality rate was 92 deaths per 1000 live births and its under-five mortality rate was 156 deaths per 1000 live births [8]. Exclusive breastfeeding rates have risen in the country in recent years: SLDHS 2019 showed an increase from 32% in 2013 to 54% in 2019 [8, 9], and the 2017 nutrition survey showed an EBF rate of 61.6% for Pujehun District [10]. However, despite the expansion of EBF in recent years and improvement in under-five mortality, which fell to 94 per 1000 live births in 2017 [11], there are still opportunities to improve breastfeeding practice. It is essential that policymakers understand the determinants underlying the practice in order to design appropriate and effective interventions aimed at improving child health.

Studies have been conducted worldwide, including in several low- and middle-income countries, to gain understanding into the determinants that contribute to breastfeeding practices. Such factors include women's attending antenatal care and postnatal care services [12], caregivers' knowledge about breastfeeding [13], the influence of family and community members [13, 14], and the burden of other responsibilities [13]. Thus, the range of determinants contributing to breastfeeding practices in low-resource settings is wide. However, only limited research has been conducted thus far to investigate the social determinants of breastfeeding in Sierra Leone. Sharkey et al. found that some mothers believe their infants' frequent stools are an indication that breast milk is harmful to them [15]. Some are convinced that having sex while breastfeeding will contaminate their breast milk [15]. Further research needs to be done to gain in-depth knowledge of the determinants of EBF in Sierra Leone, so as to be able to devise appropriate strategies to improve the practice. The aim of this study was to understand current breastfeeding practice and perceptions in Sierra Leone, and more specifically in Pujehun District.

Methods

Study setting

Pujehun is a rural district in the Southern Province of Sierra Leone. It has 346,461 inhabitants, including an estimated under-five population of 56,990 and an estimated 15,244 pregnant women every year, according to the most recent population report (2015 [16];). The district is divided into 12 administrative subdivisions known as chiefdoms. Data from 2017 showed that 98.8% of the district's women had attended at least one antenatal care visit, and 90.9% had delivered their babies in a health facility. Immunization coverage of pentavalent 3 and Oral Polio Vaccination (OPV) 3 was 99.2 and 96.5%, respectively [11].

Study design

We conducted an exploratory mixed-methods study. A cross-sectional survey, semi-structured interviews (SSIs) and Focus Groups Discussions (FGDs) were carried out from May to July 2018 in Pujehun District, Sierra Leone.

Sampling methods and data collection

The survey involved 194 mothers of children younger than 24 months of age. The sample size was calculated based on a confidence level of 95% and a margin of error of 10%, an expected prevalence of 0.5 (for social determinants, since there is no standard prevalence for social determinants) and a design effect of two. The respondents were selected during their routine visits to health posts in five purposely selected chiefdoms, the latter having been selected based on their geographical variation (physical accessibility) and variation in users' health-seeking behavior (percentage of institutional deliveries).

Our survey was conducted at the facility level during routine under-five clinic days for the vaccination and growth-monitoring of children. Mothers of children under 2 years of age were randomly selected and asked to participate in the study. Inclusion criteria for the mother-child pair was that woman is the biological mother from a child and the mother is 16 years or above. One health center was purposely selected in each of the five chiefdoms based on the size of the target population. We interviewed 113 mothers of children under 6 months of age and 81 mothers of children aged from six

to 23 months. The questionnaire was adapted from a validated questionnaire to assess breastfeeding intentions and practice in Nigeria [17]. The interviewer administered pretested questionnaire requesting information on social demographics, obstetric factors, breastfeeding practice and breastfeeding-related factors. The survey was administered in the respondents' local language (Mende or Krio).

In a convergent parallel approach, SSI were conducted with mothers of children under 2 years and with healthcare workers (HCW). Twenty mothers were purposely selected based on their breastfeeding practices and asked to participate in an SSI after completing the questionnaire in the five health centers. The SSI was used to collect more in-depth information on breastfeeding-related factors e.g., reasons behind the decision to continue or stop EBF and factors influencing the mothers in decision making regarding breastfeeding practice. Participants were selected based on their practice of EBF for children under the age of 6 months (five mothers), non-EBF of children under the age of 6 months (10 mothers), and mothers of children aged six to 23 months (five mothers) In addition, six HCW were purposely chosen from each of the selected health facilities for an SSI in order to collect data regarding breastfeeding at the health-system level. Questions were related to the role of the HCW regarding EBF, knowledge and awareness of tools and guidelines for HCW and the reason of women to stop or continue EBF according to the Health Care Worker. The HCW interviews were conducted in English and audio-recorded, with notes being taken contemporaneously.

In July 2018, a sequential mixed-method approach was introduced with the use of FGDs to delve deeper into the findings of the questionnaires and the SSIs. Seven FGDs were conducted with mothers of children under the age of 2 years (two groups of 7 to 8 women), fathers (two groups of 9 men) and community members (two groups of 9 to 11 people). Participants were purposely selected based on the criteria of the groups (mothers, fathers, community members), and asked by the research assistant to attend the Focus Groups Discussions. Focus Groups Discussions were conducted at two communities where questionnaires had previously been administered. In addition, one FGD was conducted with six Health Care Workers. All of the FGDs were conducted in the Mende language except for the HCW FDG, which was conducted in English. Each interview and FGD was audio-recorded, and notes were taken during the Focus Group Discussions.

Data analysis

The questionnaire data was entered into a Kobo toolbox database and systematically analyzed using Epi-Info 7, MS Excel, and SPSS statistics 25. As part of the data-quality assurance procedure, the main investigator double-checked all of the data entry and a second member of the research team cross-checked a sample of the data. The statistical analyses of the EBF rate were based on a 24-h recall including the 113 participants (mothers of children under 6 months of age). Potential determinants revealed by the survey were investigated for correlation with breastfeeding practice. The statistical analysis of the determinants was based on 'recall from birth'. These analyses included all 194 participants. Simple logistic regression analysis was used to calculate crude odds ratio (COR) and 95% confidence interval (CI). All covariates associated with outcome variable were included in a multiple logistic regression analysis to assess the association of independent variable with the outcome variable. Adjusted odds ratio (AOR) and 95% CI was used to measure the strength of the independent association. A *P*-value less than 0.05 was considered as significant. The audio recordings of the SSIs and FGDs were transcribed and translated into English by a multilingual (Krio Mende and English) speaker. Analysis of the transcript was based on the deductive content analysis approach. The data was coded and systematically analyzed after being entered into an Excel spreadsheet.

Definitions

Exclusive breastfeeding

Infants under 6 months of age who are fed exclusively with breast milk and allows the infant to receive ORS, drops, syrups but nothing else, based on 24-h recall.

Early initiation

Children born in the last 24 months who were put to the breast within 1 hour of birth based on recall from birth.

Primarily breastfeeding

Children under 6 months of age who are fed with breast milk only and children older than 6 months of age that were exclusively breastfed up to 6 months, based on recall from birth.

Results

Overview of participants

A total of 194 mothers of children under the age of 2 years responded to the interviewer-administered questionnaire, including 113 mothers of infants under 6 months of age and 81 mothers of children age six to 23 months. The mean age (± SD) of the participants was 24.5 (6.6) years, with a range of 16 to 48 years. Of the mothers interviewed 43% reported not to have received education, while 35% attended secondary education. The majority of the mothers were self-employed (56%) (e.g., farmer or trader), while 8% were student (secondary school). The vast majority of the mothers were married

or had a partner (94%). Fifty-three of the women (27.3%) who brought a child they came with to clinic was their first child (primipara). The range of multipara was 2–11 births. The mean age (± SD) of the infants was 6 months (5.4) with a range of 2 days to 23.9 months. These and other social demographic characteristics are shown in Table 1.

Table 2 shows the main maternal health related characteristics. The vast majority of the mothers received antenatal care at least once (193; 99.5%) and 66.4% (129) had received postnatal care. Most of the mothers (182; 94%) had received information about the feeding of children prior to giving birth, although not all of those who received such information reported having also received information on the benefits of breastfeeding (177; 91%). All but two of the women reported having had a facility-based delivery (either hospital or health center). Of those who reported problems with breastfeeding (22), 18 (9% of all of the mothers) said they experienced nipple pain.

Breastfeeding practices among respondents

WHO has developed several indicators to assess infant and young child feeding practice, among other, early initiation of breastfeeding, EBF under 6 months, and children ever breastfed [3]. Of all the mothers included in the study, 71.6% (95% CI 65.2, 78.1) reported having initiated breastfeeding within the first hour after birth.

Of the 113 mothers of infants under 6 months of age, 71 reported having fed breastmilk alone in the previous 24 h, given an EBF rate of 62.8% (95% CI 53.9, 71.7) based on a 24-h recall. Disaggregating the data into smaller age groups revealed that of the infants within the 0–1-month group, 74% were exclusively breastfed. EBF decreased in the 2–3 months (66%) and 4–5 months (33%) age groups. There was no significant difference in EBF rates among the five health centers.

All of the mothers surveyed (194, 100%) reported having breastfed their child at least once.

Table 1 Social demographic characteristics of mothers with children under the age of 2 in Pujehun District

		Mothers of child < 6 months	Mothers of Child 6–23 months	Total
Variable		n (%)	n (%)	n (%)
No. of participants		113 (58.2)	81 (41.8)	**194 (100)**
Age of mother	16–19	30 (28.3)	18 (23.7)	**48 (26.4)**
	20–25	44 (41.5)	27 (35.5)	**71 (39.1)**
	26–30	17 (16.0)	20 (26.0)	**37 (20.3)**
	31–35	5 (4.7)	5 (6.5)	**10 (5.5)**
	> 35	10 (9.4)	6 (7.8)	**16 (8.8)**
Age of mother (mean, DS)		24.2 (7.0)	24.9 (5.9)	**24.5 (6.6)**
Mother's educational level	No education	48 (42.5)	35 (43.2)	**83 (42.7)**
	Primary education	24 (21.2)	16 (19.8)	**40 (20.6)**
	Secondary education	39 (34.5)	30 (37.0)	**69 (35.16)**
	Tertiary education	2 (1.8)	0	**2 (1.0)**
Mother's occupation	Employed	3 (2.7)	0	**3 (1.6)**
	Housewife	42 (37.2)	18 (22.2)	**60 (30.9)**
	Self-employed	57 (50.44)	52 (64.2)	**109 (56.2)**
	Student	7 (6.19)	9 (11.1)	**16 (8.3)**
	Other	4 (3.5)	2 (2.5)	**6 (3.1)**
Marital status	Married/partner	105 (92.9)	78 (96.3)	**183 (94.3)**
	Single	8 (7.1)	3 (3.7)	**11 (5.7)**
Parity	Primipara	30 (26.5)	23 (28.4)	**53 (27.3)**
	Multipara (2–4)	64 (56.6)	39 (48.1)	**103 (53.1)**
	Grand multipara (> 4–11)	19 (16.8)	19 (23.4)	**38 (19.6)**
Number of children delivered (mean, SD)	3.0 (2.1)	2.9 (2.1)	3.1 (1.0)	**3.0 (2.1)**
Children alive (mean, SD)	2.4 (1.5)	2.4 (1.5)	2.5 (1.5)	**2.4 (1.5)**
Sex of child	Male	60 (53.1)	41 (50.6)	**101 (52.1)**
	Female	53 (46.9)	40 (49.4)	**93 (47.9)**
Age of child in months (mean, SD)		2.4 (1.6)	11.7 (4.7)	**6.0 (5.4)**

Table 2 Maternal health-related characteristics of mothers with children under the age of 2 in Pujehun District

Variable		Number	%
ANC[a] services attended	Yes	**193**	99.5
	No	**1**	0.5
PNC[b] services attended	Yes	**129**	66.5
	No	**65**	33.5
Receiving information during pregnancy on feeding	Yes	**182**	93.8
	No	**12**	6.2
Information on health benefits of breastfeeding received during pregnancy	Yes	**177**	91.2
	No	**17**	8.8
Place of delivery	Health center	**138**	71.1
	Hospital	**54**	27.8
	Home	**2**	1.0
Mode of delivery	Vaginal	**175**	90.2
	Caesarean section	**19**	9.8
Initiation of breastfeeding (from time of delivery)	Within one hour	**139**	71.6
	From 1 to 24 h	**47**	24.2
	More than 24 h	**8**	4.1
Assisted by HCW during first breastfeeding	Yes	**147**	75.8
	No	**47**	24.2
Difficulties with breastfeeding	No	**172**	88.7
	Mastitis	**4**	2.1
	Nipple pain	**18**	9.3

[a] Antenatal Care
[b] Postnatal Care

Factors associated with breastfeeding practices

Age and parity of the mother

The age of mothers is significantly associated with primarily breastfeeding. While 73% (106/146) of the mothers 20 years or older practiced primarily breastfeeding, only 42% (20/48) of teenage mothers (16–19 years of age) did so (COR 0.3; 95% CI 0.1, 0.5, $p < 0.001$, Table 3). Focus Group Discussion participants mentioned several possible reasons as to why some teenage mothers do not practice EBF, including their need to attend school, their belief that if they do so "the breast will slack", and time constraints due to competing activities e.g., social networking with other adolescence.

In addition, we found a significant association between the parity of the mother and primarily breastfeeding. Seventy-two percent (102/141) of the (grand) multiparas practiced primarily breastfeeding, while only 45% (24/53) of the primiparas did so (COR 3.1; 95% CI 1.6, 6.1, $P < 0.001$, Table 3).

Of all the primipara mothers, 55% (29/53) were teenagers. Although fewer teenage primiparas practiced exclusive breastfeeding (10/29; 34%), the primarily breastfeeding rate of primipara mothers older than 19 was also lower (14/24; 58%) than that of (grand) multiparas, as shown in Fig. 1.

During the FGDs some of the women talked about their experiences as multigravidas:

> *"I suffer the act of giving hot water to my children, but when I began to do exclusive breastfeeding for six months, I saw the difference: my child is very strong."* (Community member, Bandajuma).

Assistance by HCW on early initiation of breastfeeding

In total 147 mothers (76%) had received assistance for the positioning of the baby to the breast by an HCW during the first breastfeeding, although not all the 147 gave breastfeeding within the first hour. Of those mothers who gave breastfeeding within 1 h, 80% (118) were assisted by a Health Care Worker. While women who did not breastfeed within 1 h, 47% (26) were not assisted by 81 % (112) of the 138 mothers who delivered in a health center were assisted by an HCW, while only 65% (35) of the 54 mothers who delivered in the hospital were assisted by an Health Care Worker. During the interviews and FGDs

Table 3 Determinants associated with primarily breastfeeding based on logistic regression

Variable (*n* = 194)	Total (*n*)	Primarily BF *n* (%)	Non-primarily BF (%)	COR (95% CI)	AOR (95% CI)
Age					
< 20 years old (teenager)	48	20 (*42*)	28 (*58*)	0.3 (0.1,0.5)***	0.5 (0.2,1.3)
≥ 20 years	146	106 (*73*)	40 (*27*)	1	1
Parity					
(Grand) multipara	141	102 (*72*)	39 (*28*)	3.1 (1.6,6.1)***	2.2 (0.9,5.3)
Primipara	53	24 (*45*)	29 (*55*)	1	1
Information on benefits of breastfeeding received during pregnancy					
Yes	177	119 (*67*)	58 (*33*)	2.9 (1.1,8.1)*	2.5 (0.7,9.2)
No	17	7 (*41*)	10 (*59*)	1	1
Most family and/or friends breastfeed					
Yes	72	55 (*76*)	17 (*24*)	2.3 (1.2,4.5)**	1.4 (0.6,3.3)
No	122	71 (*58*)	51 (*42*)	1	1
Half of the family and/or friends breastfed other half give their infants formula milk					
Yes	40	15 (*38*)	25 (*62*)	0.4 (0.2,0.7)**	0.3 (0.1,0.8)*
No	154	111 (*72*)	43 (*28*)	1	1
Awareness on how family and friends feed their young children					
Not aware	31	15 (*48*)	16 (*52*)	0.4 (0.2,0.96)*	0.8 (0.3,2.3)
Aware	163	111 (*68*)	52 (*32*)	1	1
Aware of having been breastfed as an infant herself					
Mother have been breastfed as infant	67	52 (*78*)	15 (*22*)	2.5 (1.3,4.9)***	1.9 (0.8,4.5)
Mother has not been breastfed as infant or don't know	127	74 (*58*)	53 (*42*)	1	1
Intention while pregnant to breastfeed					
Yes	128	99 (*77*)	29 (*23*)	5.1 (2.7,9.9)***	4.0 (1.9,8.4)***
No	66	27 (*41*)	39 (*59*)	1	1
Employment					
Self-employed	109	79 (*72*)	30 (*28*)	2.1 (1.2,3.9)**	2.1 (1.0,4.7)
Not self-employed	85	47 (*55*)	38 (*45*)	1	1
Nipple pain					
Yes	18	6 (*33*)	12 (*66*)	0.2 (0.1,0.7)*	0.3 (0.1,0.9)*
No	176	120 (*68*)	56 (*32*)	1	1

Primarily breastfeeding: Children under 6 months of age who are fed with breast milk only and children older than 6 months of age that were exclusively breastfed up to six months, based on recall from birth

***P-value < 0.001, **$0.001 \leq P < 0.01$, *$0.01 \leq P < 0.05$ *COR* Crude Odds Ratio, *AOR* Adjusted Odds Ratio

mothers also mentioned that they received assistance from the HCW with the early initiation of breastfeeding:

> *"When I gave birth, after the cord was cut, the nurse, who was my aunt, took my baby and placed him on my chest to breastfeed him. She assisted me."* (Mother, Sahn Malen, 27 years).

HCWs saw it as part of their role to assist women with their first breastfeeding.

> *"To put the baby to the breast. That is my role."* (Nurse).

Hospital midwives also saw promoting breastfeeding as part of their job; however, they faced challenges in doing so due to time constraints.

> *"Yes, we try, when they are in the ward, when we have time. .. They spend less time with us and most of the time we tend to forget to talk to them about breastfeeding. They deliver, and they are fine."* (Hospital HCW).

In addition, 86% (150/175) of women who had vaginal deliveries breastfed their infants within the first hour, while only 53% of women who delivered by Caesarean section did so.

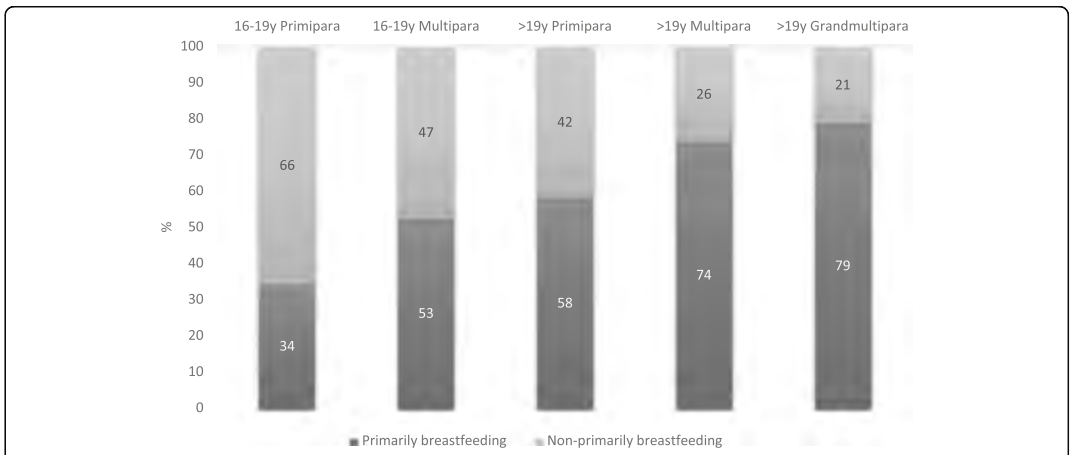


Fig. 1 Distribution of primarily breastfeeding practice proportions by maternal age and parity

Provision of information

Table 3 shows the odds ratio of factors significantly associated with primarily breastfeeding, including factors related to the provision of information to women. Antenatal care visits provide the pregnant women with an opportunity to receive information on child feeding. As mentioned before, 182 women (94%) reported having received information during their pregnancies about the feeding of infants of which most of the women (178, 92%) received this information at the health center. A slightly lower number (177, 91%) received specific information on the health benefits of breastfeeding. Providing information alone is not a factor significantly associated with primarily breastfeeding, while receiving *specific* information on the benefits of breastfeeding is significantly associated with primarily breastfeeding practice (COR 2.9; 95% CI 1.1, 8.1, Table 3). Examples of the information provided are shown in Table 4, as described by mothers during the interviews and FGDs. Qualitative data show that HCWs do not refer to the counselling cards available at all health facilities as a tool to provide information. Almost all of the women (181/194; 93%) reported having heard about breastfeeding on the radio:

Table 4 Information provided at the health center on exclusive breastfeeding (EBF)

• Breastfeeding is good.
• Practice EBF for 6 months.
• Your baby will become healthy, strong, plump and intelligent.
• Your baby will not become malnourished.
• Your baby will not get sick.
• Do not nourish your baby with anything other than breast milk.
• Do not give your baby hot water, native herbs or other foods.

> *"They advise us [on the radio] about exclusive breastfeeding for six months and taking good care of our babies."* (Mother, Bandajuma, FGD).

During the FGDs, fathers, family and other community members also mentioned having received information on breastfeeding via the radio:

> *"Yes, we get a lot of learning from the radio and hospital that breastmilk is good for babies."* (Father, Bandajuma).

Influencers on decision-making

This study reveals that HCWs greatly influence the decision-making process of mothers around child feeding. Fifty-six percent (108/194) of the mothers in our study indicated that an HCW helped them with breastfeeding. The qualitative data showed that a large majority of the mothers were influenced by an HCW on breastfeeding practice (Table 5). Not only HCWs, but also community health workers (CHWs), provide information on breastfeeding in the villages. While many mothers stated they had received information from HCWs at the health center, some fathers and community members did so from CHWs:

> *"We have CHWs who are also helping to inform us."* (Father Bandajuma).

Although the qualitative data revealed that mothers and community members received information on EBF from traditional birth attendants (TBAs), the qualitative results revealed no major influence of TBAs over women's decision-making with respect to primarily

Table 5 Themes and illustrative quotations related to breastfeeding determinants

Theme	Quotes
HCWs' influence mothers' feeding decisions	"*It was the nurse* [who influenced me regarding the way I fed my baby]." (Mother, Pujehun, 23 years) "*After two weeks she was just crying, I wanted to give her* [powder] *milk but the nurse advised me* [not to]." (Mother, Sahn Malen, 26 years). "*The nurses* [had me feed my baby this way.]" (Mother, Pujehun, 33 years)
Husbands' involvement with child feeding practices	"*The father of the baby* is supporting me *because he gives me enough food. He encourages me.*" (Mother, Sahn Malen,22 years) "*My husband supports me, for example by providing food for me.*" (Mother, FGD, Bandajuma) "*We fathers should support lactating mothers by giving them enough food so that they can feed our babies well. Encouragement is also important, because without encouragement the woman will find it difficult to breastfeed her baby.*" (Father, Pujehun) "*Yes, if you are a farmer, businessman or carpenter, just work hard to provide food for your wife. If not, she will not breastfeed your baby exclusively and she will go out for food. When your wife is without food, she will disobey you.*" (Father, Bandajuma) "*Most people used to say that a newborn given exclusive breastfeeding will feel hungry, and sometimes they feed babies hot water, but now I have realized that is not true, that the best food* *for a baby is breastmilk. In fact, giving hot water to baby will result to cough.*" (Father, Pujehun) "*It was his father who decided to give the baby hot water, because her stomach kept drying, so he told me to give her hot water one morning and after that the child has passed stool.*" (Mother, Zimmi, 26 years) "*Most women also refused to breastfeed their babies because of lack of encouragement from their husbands. Today most young husbands do not take care of their wife, they will neglect them for another woman because they are lactating mothers*" (Mother FGD, Bandajuma)
Issues of sex and breastfeeding	"*[No sex] For the simple reason that it will affect the breastmilk, and if you feed your baby with such breastmilk the baby will end up malnourished. Also, just having sex could lead to another pregnancy, which would mean there is not enough time to care for the baby properly. For me, whenever my wife is breastfeeding, I go out.*" (Father Pujehun) "*I heard a mother went to have sex with someone else to get food and then her child became ill.*" (Father Bandajuma)
Mothers' reasons for feeding items alongside breastmilk before the child reaches 6 months of age	"*When he was 3 weeks old [I started giving him other food]. That is because my breast was not having enough breast milk.*" (Mother Pujehun, 20 years) "*Because there are times that the breast milk was not enough for him.*" (Mother, Bandajuma, 23 years) "*Her stomach was dry; it kept drying. She could not pass stools.*" (Mother, Zimmi,26 years) "*Because the baby is always crying, I give it hot water.*" (Mother, Bandajuma, 20 years) "*Lack of enough food for the mother; if the mother is not satisfied, she can hardly feed her baby.*" (Mother, Pujehun FGD) "*Except if I am hungry. If I am hungry, I will not be able to breastfeed my child because my head will start to spin.*' (Mother, Gbondapi, 40 years).

breastfeeding. Health Care Workers mentioned that TBAs could be helpful in disseminating information; however, they also stated that some TBAs do not encourage women to go to health facilities.

> *"They are very important, TBAs and CHWs. Because they live with them [breastfeeding mothers]. They are on the front line. They know everything about them. They listen to them. Some things that they [breastfeeding mothers] will not share with us, they will tell them ". (*HCW, Pujehun).

In addition to HCWs, husbands also greatly influence women's decision-making on breastfeeding practices. Nineteen percent of the women (37/194) indicated that their husbands had supported them to continue breastfeeding. Of these women who are supported by their husband, 78% (24/37) of mothers practiced primarily breastfeeding. Furthermore, 9% (6/68) of the mothers who did not practice primarily breastfeeding for the first 6 months of their infants' lives indicated that their husbands had influenced them in deciding to stop breastfeeding. During the SSIs, a quarter of the mothers stated that they were supported by their husbands, mentioning examples such as provision of food and encouragement. The fathers themselves saw it as a husband's role to provide food and encourage one's wife (Table 5). Qualitative data revealed that many respondents believed that having sex during breastfeeding would contaminate a woman's breast milk and lead to malnutrition in her infant (Table 5). None of the single mothers ($n = 11$) practiced primarily breastfeeding, with a correlation coefficient of – 0.33 (not statistically significant).

The mothers mentioned the influence of other family members and friends to a lesser extent. Four percent (8/194) of all mothers stated that they were supported by their families, and 10% (7/68) of the mothers who were not practicing primarily breastfeeding indicated that family members had influenced them to stop exclusive breastfeeding. In line with these results, qualitative data also show that family influence can be both a contributing factor and a barrier in terms of exclusive breastfeeding.

> *"Family, my mother. She used to tell me that people were saying that breast milk is very good for the baby and it is good that every mother should breastfeed her baby from birth to six months."* (Mother Gbondapi, 29 years).

> *"When my baby was four months old my aunty told me to try some other food. Corn milk."* (Mother Pujehun, 26 years).

> *"At first somebody in the community will come and just say there is bad water in the baby's stomach, and the only thing that will remove the bad water is hot water." (*Community member, Bandajuma).

The knowledge and the ways in which a mother's family and friends fed their babies was significantly associated with her own breastfeeding practice. There is an independent negative association in terms of the woman's own primarily breastfeeding practice if some woman's family members and friends breastfed and some and gave their babies infant formula (AOR 0.3; 95% CI 0.1, 0.8; $P < 0.1$, Table 3). If a mother was unaware of what her family members and friends were feeding their children, there was the same negative association (COR 0.4; 95% CI 0.2, 0.96; $P < 0.05$, Table 3). Mothers' awareness of having been breastfed as babies themselves was associated with primarily breastfeeding practice (COR 2.5; 95% CI 1.3, 4.9; $P < 0.001$, Table 3). Fifty-one percent of all the mothers surveyed did not know how they had been fed as babies.

Attributes of the mothers

We found a significant independent association between a mother's intention to breastfeed and her primarily breastfeeding practice (AOR 4.0; 95% CI 1.9, 8.4; $P < 0.001$), Table 3). Of the mothers surveyed, 66% (128/194) stated that they intended to breastfeed their children, when they were pregnant. Of the women who intended to breastfeed, 77% (99/128) ended up practicing primarily breastfeeding. This is comparable with the qualitative data, where slightly more than half of the mothers interviewed indicated that they intended to breastfeed.

Despite the influence of other people on maternal decision-making, a majority of the mothers who stopped EBF prior to 6 months indicated that the decision was their own (41/68, 60%).

> *"The baby cried a lot and I tried to breastfeed her, but she did not accept the breast milk, so I boiled a little bit of hot water and gave it to her. After that she fell asleep. It is my own experience that influenced me."* (Mother, Gbondapi, age above 19 years).

> *"I decided myself. .. They were all advising me to breastfeed my baby and no one was supporting me about giving corn milk or rice pap."* (Mother, Sahn Malen, 19 years).

Workplace and employment

Although the majority of the surveyed women indicated that it was possible to breastfeed their babies during work, FGD participants suggested that women experience difficulties practicing EBF while farming.

> *"They don't have time to sit and breastfeed their babies. Sometimes when farming, the baby will be in the hut while they are busy working on the farm. So, most of the time they give enough strong food (*such as corn milk or a porridge made of rice, beans, fish, and sesame seeds or groundnuts, homemade or prepacked) *so that they will have time to do their farm work."* (Mother, Bandajuma FGD).

> *"Also, it is difficult for those who work on farms to go to the hut repeatedly, so they give hot water to their babies so they will sleep, and the mother will have time to work on the farm."* (Mother, FGD, Bandajuma).

> *"Some women start weaning at two months and start giving pap. If you give pap, the child will sleep more so you have more time to work."* (HCW, Pujehun FGD).

A mothers being self-employed was positively associated with primarily breastfeeding (COR 2.1; 95% CI 1.2, 3.9, P 0.01). Although being a student was not statistically significantly associated with breastfeeding practice, Focus Group Discussion participants suggested that mothers who attended school found it difficult to breastfeed.

> *"Some lactating mothers attend school, so most of the time they leave their babies at home with their*

parents, and if they are crying the only thing, they can do is give them milk or hot water." (Mother, Bandajuma FGD).

Reasons given for feeding babies something other than breastmilk before they turn six months old

Our quantitative data showed that one of mothers' major reasons for giving their babies something other than breastmilk was their perception that the babies felt hungry (31%) or were unwell (31%).

The qualitative data revealed that a major barrier to mothers' continuing to practice EBF was their perception that they were producing insufficient breast milk and that their baby's stomach was "dry" (meaning that its stools were infrequent). Other frequent reasons given by mothers were that their baby was crying and/or that they themselves were hungry because of a lack of food (Table 5). A factor mentioned by HCWs, though not confirmed by the mothers, was that some women do not practice EBF due to a belief that babies who are breastfed alone get worms. In addition, difficulties with breastfeeding were mentioned as a barrier to practicing exclusive breastfeeding. This was confirmed by quantitative data: 9 % (18/194) of the women reported having had problems with nipple pain, and two-third of these mothers did not practice primarily breastfeeding all the way through their baby's first 6 months. Experience of nipple pain was independent negatively associated with primarily breastfeeding (AOR 0.3; 95% CI 0.8, 0.9, $P < 0.05$, Table 3).

Discussion

Under-five morbidity and mortality in Sierra Leone is still alarmingly high. Practicing EFB and appropriate complementary feeding contribute to prevent child mortality and positively affects children health, nutrition and developmental outcome [1, 18]. Improving the nutritional status of children is a priority in the strategic plan to decrease the mortality rate in Sierra Leone [18], and understanding breastfeeding practice determinants is essential in order to devise appropriate strategies to promote EBF practice and improve child health.

The present study revealed an increased EBF rate in Pujehun District, compared to national surveys data of 2013 and 2019 [8, 9]. However, this study also shows a sharp decrease of EBF for children in age group 4–5 months. These results underscore the need for continues interventions in order to improve EBF practices to improve child health. This study suggest that interventions might be need starting from the antenatal care throughout the first 6 months of life of the newborn and at healthcare level as well as community level.

In this study, almost 30% of the mothers were teenage mothers and 27% were primipara. Our study revealed that teenagers and primipara were at-risk groups for non-EBF practice. These findings were similar to findings in other developing countries [19], and underscore the need to target teenagers and primigravida in tailor-made breastfeeding promotion activities. Further investigation will be necessary to establish whether teenagers experience different barriers from non-teenagers, for example school related barriers, something that this study suggests. However, breastfeeding promotion activities should not exclude multigravida, given the fact that not all multigravida practice exclusive breastfeeding.

This study highlighted that the HCWs present in health centers are an important source of information for mothers on child feeding: providing women with information on the health benefits of breastfeeding during pregnancy and the intention of women during pregnancy to breastfeed are both positively associated with exclusive breastfeeding. The women in our study indicated that nurses heavily influenced their breastfeeding practices, confirming, as shown in previous studies [15], that they play an important role in women's decision making regarding pregnancy, delivery and the first few months of the child life.

As this study demonstrates, 71.6% of the mothers said that they started breastfeeding within 1 hour after their child's birth, showing an increase from the 2013 figure of 57.8% and similar to the data from 2017 (75%) [8, 11]. Interestingly, of the women who breastfed within 1 hour after their children's births, 80% received assistance from an HCW, while of the women who did *not* breastfeed within that first hour, 47% did not receive assistance from an HCW. This study suggests that there are still opportunities to improve mothers' initiative to breastfeed their infants within 1 hour of their births and EBF practice till 6 months by improving the care which HCW are providing during pregnancy, post-delivery care and the first 6 months of life of the newborn.

Not only nurses have a role to play in promoting breastfeeding practice, so do CHWs, by providing information to fathers and other village stakeholders. As this study shows, and in line with a previous study in Sierra Leone [15], also fathers/husbands are major influencers regarding women's child-feeding practices, in fact the majority of the women in our study who felt supported by their husbands practiced exclusive breastfeeding. However, some husbands influence women to discontinue exclusive breastfeeding. Expanding the work of CHWs in promoting best breastfeeding practice among husbands might be a good strategy for better equipping the latter in terms of their involvement with their wives' child-feeding decisions. As well as promoting talking on breastfeeding in women's groups, as mother's knowledge that her family members and friends breastfed their children had a positive influence on her own breastfeeding

practice, as well as the awareness of having been breastfed as a baby herself. These findings also has been found in other developed and countries [18, 19] and suggest that talking to the entire community about the benefits of breastfeeding might have a positive influence on women's practice of exclusive breastfeeding.

Although nurses, husbands, and other family members or friends are breastfeeding influencers, the majority of the mothers who participated in this study stated that they made their own decision to stop breastfeeding. In our study, nipple pain, described as an individual determinant, was negatively associated with primarily breastfeeding, as confirmed by literature [19, 20]. Since breast complications could be prevented by teaching mothers the correct position and attachment methods, or can be reduced by expressing breastmilk or treated with antibiotics in case of severe infection of the breast [21, 22], it may be possible to overcome this barrier by e.g. early recognizing and treatment of the problem by the HCW and/or providing adequate information on prevention and treatment of breast complications toward the mothers. Another factor related to breastfeeding practice is occupation. Although the questionnaire indicated the women are more likely to practice primarily breastfeeding when self-employed compare to other occupations, participant of the FGD revealed that working on the farming might be a barrier for EBF practice. Qualitative data did not specify between different kind of self-employment.

Interesting, women gave several reasons for having started complementary feeding before 6 months. One major reason was their perception that their babies were hungry, and/or that they were not producing sufficient quantities of breastmilk, or that their baby was crying. A systematic review of factors influencing EBF in developing countries has shown that these barriers are found in several other developing countries [19]. It has yet to be determined whether the perceptions of mothers about not having sufficient breastmilk is related to their actual breast milk production, but it could be that there are other factors related to this perception, and breastfeeding counselling might help alter it. Counselling on correct breastfeeding techniques and on taking enough time to breastfeed infants might contribute, for example, to improved breast milk production [22]. Another reason provided by mothers for giving their babies something in addition to breast milk (mainly boiled water and herbs) was their perception that their babies were having "bad" stools. Participants of the interviews and FGDs referred to black meconium and infant constipation. There is no evidence that mothers' perception of their babies' constipation was related to actual medical issues; it could instead have been due to their inadequate knowledge of infant stool patterns. The stools of infants can be irregular and have a variable appearance [23]. Further investigation is needed to establish whether the infants believed by their mothers to have stool difficulties were actually suffering from constipation or whether that was merely the mothers' perception. It is essential to provide information to mothers and community members on meconium and "normal stools" in order to try to prevent babies from being fed water and herbs early in life.

The study was subject to limitations. One major limitation of the design was that it was a facility-based survey, therefore the study was representative for the population visiting the health center only, as was described in the objective of the study, and could be associated with a higher health promotion exposure and higher EBF rate among this population compared to the general population. Despite this the high institutional delivery (90.2%), antenatal visits (98.8%) and immunization rates (96.5% for Pentavalent 3 and 96.5% for OPV3) in Pujehun District [11], could indicate that the population visiting the facility is representative for the general population. Another limitation of the study was that it was carried out in a single district of Sierra Leone, and might not be able to be extrapolated to the entire country. Although the EBF rate was calculated on 24-h recall, the statistically significant factors related to primarily breastfeeding and determinants revealed in the qualitative research were based on recall from birth, which may have introduced a recall bias.

Conclusions

In conclusion, although the exclusive breastfeeding rate in Pujehun District is not yet optimal, it has grown over the years. However, the sharp decrease in the EBF rate by age group shows that more effort is needed to promote exclusive breastfeeding practice for all newborns under the age of 6 months.

This study revealed several barriers and enabling factors which can be taken into consideration to design new strategies to improve child health. Breastfeeding promotion campaigns focusing on specific messages adapted to the local context and beliefs can be a solution to avoid premature and unjustified interruption of breastfeeding practice. Furthermore, receiving information during pregnancy on the benefits of EBF, awareness on how family and friends feed their babies, support from husbands and counselling by the nurses are factors associated with breastfeeding practice. It therefore seems relevant to include health workers and family members in promotion programs to have a greater adherence of mothers to breastfeeding.

Abbreviations

ANC: Antenatal Care; CHW: Community Health Worker; CI: Confidence Interval; EBF: Exclusive Breast Feeding; FGD: Focus Group Discussion; HCW: Health Care Worker; IYCF: Infant and Young Child Feeding; OPV: Oral

Polio Vaccination; PNC: Postnatal Care; SD : Standard Deviation; SLDHS: Sierra Leone Demographic Health Survey; SSI: Semi-structured Interview; TBA: Traditional Birth Attendant; WHO: World Health Organization

Acknowledgements
We would like to express our special thanks to everyone who participated in this study, including the HCWs and District Health Management Team (DHMT) members who helped facilitate it. We would also like to express our acknowledgement to the district nutritionist, Mariamma George, and research assistants Hawa Jellow and Mathilda Macarthy for their support with the data collection. We are also grateful for the input of Stacy Griswold (Tufts University), Maaike Flinkenflögel and Sandra Alba (both of the KIT Royal Tropical Institute of Amsterdam).

Authors' contributions
DvB designed the study, supervised the data collection, analyzed and participated in interpretation of the data and wrote the draft manuscript. AB, ASN and GP contributed to the study design and revision of the manuscript. FT and AvdB contributed to the design, data analysis and interpretation of the findings and contributed to the revision of the manuscript. All authors read and approved the final version of the manuscript.

Funding
The study was funded by Doctors with Africa CUAMM and it was conducted in the framework of an ongoing project in Pujehun District. The funders played no decision-making role for the study, nor in its design, data analysis or in the writing of the manuscript.

Availability of data and materials
The datasets used and analyzed during this study are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate
The study was granted ethical approval by the Sierra Leone Ethics and Scientific Review Committee and the KIT Research Ethical Committee of the KIT Royal Tropical Institute, Amsterdam, The Netherlands (n. S88).
No participant was coerced to participate in the study. Interviewees were not named either in the questionnaires or the interviews. All data were handled confidentially, and participants cannot be traced by people outside of the research group. All participants were asked to sign a written consent form in the appropriate language (English or Krio) before taking part in the study. Literate witnesses signed on behalf of participants who were illiterate, with the latter signing using their thumb prints.

Consent for publication
Not applicable.

Competing interests
The authors declare that they have no competing interests.

Author details
[1]Doctors with Africa CUAMM, Pujehun-Freetown, Sierra Leone. [2]Doctors with Africa CUAMM, Via San Francesco, 126, 35121 Padua, Italy. [3]Department of Women's and Children's Health, University of Padua, Padua, Italy. [4]MoHS Sierra Leone, Pujehun District, Sierra Leone. [5]Department of Global Health, Royal Tropical Institute (KIT), Amsterdam, The Netherlands.

Received: 23 June 2020 Accepted: 13 May 2021
Published online: 26 May 2021

References

1. Victora CG, Bahl R, Barros AJD, França GVA, Horton S, Krasevec J, et al. Breastfeeding in the 21st century: epidemiology, mechanisms, and lifelong effect. Lancet. 2016;387(10017):475–90. https://doi.org/10.1016/S0140-6736(15)01024-7.
2. Jones G, Steketee RW, Black RE, Bhutta ZA, Morris SS. How many child deaths can we prevent this year? Lancet. 2003;362(9377):65–71. https://doi.org/10.1016/S0140-6736(03)13811-1.
3. World Health Organization. Indicators for assessing infant and young child feeding practices, part 1. Geneva: World Health Organization; 2008.
4. World Health Organization. Indicators for assessing infant and young child feeding practice. Part 2. Geneva: World Health Organization; 2008.
5. World Health Organization. Infant and young child feeding Factsheet; 2017. p. 2–7. [cited 2017 Nov 14]. Available from: http://www.who.int/mediacentre/factsheets/fs342/en/
6. World Health Organization. The optimal duration of exclusive breastfeeding - Report of an expert consultation. Dep Nutr Health. 2001;10:1-10.
7. World Health Organization (WHO). 10 facts on breastfeeding. 2017 [cited 2019 Jan 10]. Available from: https://wwhttps//www.who.int/features/factfiles/breastfeeding/en/
8. Statistics Sierra Leone (SSL) and ICF International. Sierra Leone Demographic and Health Survey 2013, vol. 6. Sierra Leone: SSL and ICF international; 2014.
9. Statistics Sierra Leone (SSL). Demographic and Health Survey Key Indicators Report 2019: Ministry of Health and sanitation. Freetown: Government of Sierra Leone; 2019.
10. Directorate of Food and Nutrition. Sierra Leone National Nutrition Survey 2017. Sierra Leone: Ministry of Health and sanitation; 2018.
11. Statistics Sierra Leone, UNICEF Sierra Leone. Sierra Leone Multiple Indicator Cluster Survey 2017: Survey findings report. Freetown: Stat SL and ICF; 2017.
12. Tadesse T, Mesfin F, Chane T. Prevalence and associated factors of non-exclusive breastfeeding of infants during the first six months in rural area of Sorro District, Southern Ethiopia: a cross-sectional study. Int Breastfeed J. 2016;11:25.
13. Nankumbi J, Muliira JK. Barriers to infant and child-feeding practices: a qualitative study of primary caregivers in rural Uganda. J Health Popul Nutr. 2015;33(1):106–16.
14. Bezner Kerr R, Dakishoni L, Shumba L, Msachi R, Chirwa M. "We grandmothers know plenty": breastfeeding, complementary feeding and the multifaceted role of grandmothers in Malawi. Soc Sci Med. 2008;66(5):1095–105. https://doi.org/10.1016/j.socscimed.2007.11.019.
15. Sharkey A, Yansaneh A, Bangura PS, Kabano A, Brady E, Yumkella F, et al. Maternal and newborn care practices in Sierra Leone: a mixed methods study of four underserved districts. Health Policy Plan. 2017;32(2):151–62.
16. Statistics Sierra Leone (SSL). Sierra Leone 2015 population and housing census; Thematic report on population structure and population distribution. Sierra Leone: SSL Sierra Leone; 2017.
17. Emmanuel A, Clow SE. A questionnaire for assessing breastfeeding intentions and practices in Nigeria: validity, reliability and translation. BMC Pregnancy Childbirth. 2017;17(1):174. https://doi.org/10.1186/s12884-017-1366-9.
18. Government of Sierra Leone. National Food and Nutrition Security Implementation Plan 2013-2017. Sierra Leone: UNICEF Sierra Leone; 2013.
19. Balogun OO, Dagvadorj A, Anigo KM, Ota E, Sasaki S. Factors influencing breastfeeding exclusivity during the first 6 months of life in developing countries: a quantitative and qualitative systematic review. Matern Child Nutr. 2015;11(4):433–51. https://doi.org/10.1111/mcn.12180.
20. Adugna B, Tadele H, Reta F, Berhan Y. Determinants of exclusive breastfeeding in infants less than six months of age in Hawassa, an urban setting, Ethiopa. Int Breastfeed J. 2017;12(1):45. https://doi.org/10.1186/s13006-017-0137-6.
21. NTVG. Richtlijn Borstvoeding (2015, multidisciplinair). Netherlands; 2015. [cited 2018 Oct 18]. Available from: https://assets.ncj.nl/docs/e63a9fdd-5990-4217-b04a-228e5270683a.pdf
22. Amir LH, Bearzatto A. Overcoming challenges faced by breastfeeding mothers. Aust Fam Physician. 2016;45(8):552–6.
23. Marks K. Infant and toddler nutrition. Aust Fam Physician. 2015;44(12):886–9.

Publisher's Note

Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

Back rubs or foot flicks for neonatal stimulation at birth in a low-resource setting: A randomized controlled trial

PAPER

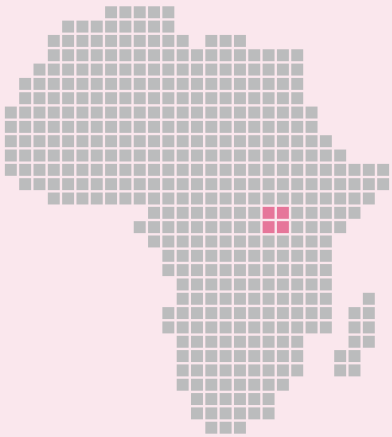
Authors
Cavallin F.

Published in
Resuscitation,
October 2021

Link
https://doi.org/10.1016/j.resuscitation.2021.08.028

Topic
Maternal and child health

Focus country
Uganda



This paper is not available as open access, which is why only an abstract is posted. If you would like to read the entire paper, please go to the web page given and follow the instructions.

Parents' Experience and Satisfaction in Neonatal Intensive Care Units in Ethiopia: A Multicenter Cross-Sectional Study Using an Adapted Version of EMPATHIC-N

PAPER

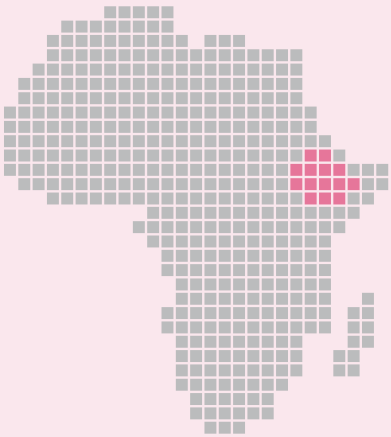
Authors
Gulo B., Miglierina L., Tognon F., Panunzi S., Tsegaye A., Asnake T., Manenti F., Dall'Oglio I.

Published in
Frontiers in Pediatrics,
October 2021

Link
https://doi.org/10.3389/fped.2021.738863

Topic
Maternal and child health

Focus country
Ethiopia



frontiers in Pediatrics

ORIGINAL RESEARCH
published: 08 October 2021
doi: 10.3389/fped.2021.738863

Parents' Experience and Satisfaction in Neonatal Intensive Care Units in Ethiopia: A Multicenter Cross-Sectional Study Using an Adapted Version of EMPATHIC-N

Berhanu Gulo[1], Laura Miglierina[1], Francesca Tognon[2,3], Silvia Panunzi[4], Ademe Tsegaye[1], Tina Asnake[5], Fabio Manenti[2] and Immacolata Dall'Oglio[6]*

[1] Doctors With Africa CUAMM, Addis Ababa, Ethiopia, [2] Doctors With Africa CUAMM, Padua, Italy, [3] Department of Women's and Children's Health, University of Padua, Padua, Italy, [4] Unit of Epidemiology and Medical Statistics, Department of Diagnostics and Public Health, University of Verona, Verona, Italy, [5] Federal Ministry of Health, Addis Ababa, Ethiopia, [6] Professional Development, Continuous Education and Research Service, Bambino Gesù Children's Hospital IRCCS, Rome, Italy

OPEN ACCESS

Edited by:
Jos M. Latour, University of Plymouth, United Kingdom

Reviewed by:
Nursan Çinar, Sakarya University, Turkey
Anne-Sylvie Ramelet, University of Lausanne, Switzerland

***Correspondence:**
Francesca Tognon
f.tognon@cuamm.org

Specialty section:
This article was submitted to Pediatric Critical Care, a section of the journal Frontiers in Pediatrics

Received: *09 July 2021*
Accepted: *13 September 2021*
Published: *08 October 2021*

Citation:
Gulo B, Miglierina L, Tognon F, Panunzi S, Tsegaye A, Asnake T, Manenti F and Dall'Oglio I (2021) Parents' Experience and Satisfaction in Neonatal Intensive Care Units in Ethiopia: A Multicenter Cross-Sectional Study Using an Adapted Version of EMPATHIC-N. Front. Pediatr. 9:738863. doi: 10.3389/fped.2021.738863

Background: In neonatal intensive care units (NICU) setting, parents' experience and satisfaction permit to evaluate clinical practice and improve the care of infants and parents. Little is known about this topic in low resource settings. The aim of this study was to (1) translate, adapt and validate the EMpowerment of PArents in THe Intensive Care-Neonatology (EMPHATIC-N) questionnaire in two languages in Ethiopia (2) explore parents' satisfaction with the care received in the NICUs in three hospitals; and, (3) explore socio-demographic characteristics and level of the NICU influence on the EMPATHIC-N domains.

Methods: This was a cross-sectional multicenter study. Participants were recruited from three different NICUs in Ethiopia upon discharge. We reduced the original EMPATHIC-N instrument to 38 items, culturally adapted and validated it in two local languages. Confirmatory Factor Analysis (CFA) was applied to verify the factor structure of the questionnaire, investigating the relationship between items and the five latent domains. Single item scores and the aggregate scores of the domains were investigated across NICUs and in the sample overall. Differences in the distribution of the domain scores were tested according to socio-demographic participants' characteristics. The scores of four general questions about overall experience and satisfaction were investigated in relation to the participant's characteristics and NICU levels. Qualitative data were collected using four open-ended questions and a synthesis of results was provided.

Results: Almost all the parents answered to the questionnaire (92%, $n = 386$). Questionnaire items on satisfaction on average scored more than four. The highest mean scores were obtained for Parental participation (median: 5.17; iqr: 4.67–5.62), while they were lower for Organization/Hospital environment (median: 4.67; iqr:4.33–5.17). Different levels of parent satisfaction were observed across the NICU levels showing a statistically higher satisfaction in level II NICU compared to the other levels. Education, place of residence and length of stay were associated with parental satisfaction and experience.

Conclusion: This study validated two Ethiopian versions of the EMPATHIC-N questionnaire to assess parents' experience and satisfaction during their child's stay in the NICU. The differences found across the three levels of NICU suggest the need to further investigate the determinants of satisfaction.

Keywords: parents, satisfaction, neonatal intensive care unit, validation study, surveys and questionnaires, EMPATHIC, multicenter study, Ethiopia

INTRODUCTION

Parental experience is a crucial measure of service quality and could point to ways of improving health care delivery (1, 2). Particularly in the neonatal intensive care unit (NICU) setting, parent satisfaction is one of the quality care indicators mainly concerned with fulfilling parents' positive expectations of the perceived factors of the child's care (1).

Parent involvement and empowerment play an important role in building a family-centered care (FCC) environment (3) with beneficial effects for both infants and parents (4). The attributes of FCC in the NICU have been recognized as participation of the family (in care planning, decision making, and providing care from routine to specialized care), family's respect and dignity, and knowledge transformation (information sharing between healthcare providers and families, complete information sharing according to the family's learning style) (5).

Studies have shown significant associations between parental satisfaction with health care in NICUs and their ability to provide appropriate care for their infants. Generally, higher satisfaction with health care is reported to yield better treatment compliance (1, 3). Interaction with healthcare professionals (HCPs) is crucial for parental experience (6). For health workers, it is important to understand parents' expectations when infants are admitted to the NICU, to meet their needs and concerns and increase their satisfaction, which will promote more appropriate attachment and bonding (7).

The EMpowerment of PArents in THe Intensive Care-Neonatology (EMPATHIC-N) questionnaire was developed in the Netherlands to measure NICU parent satisfaction and experience (3) and has been translated and culturally adapted in several countries (2, 8–10). A similar questionnaire related to the pediatric intensive care unit was culturally translated in South Africa (11). Although parents' experiences in pediatric health services have already been evaluated by other authors in Ethiopia (12, 13), currently a validated instrument to specifically evaluate the NICU context is still not available in that country.

In the last 10 years, the Ethiopian Ministry of Health has worked hard to establish new NICUs in hospitals, and strengthen existing ones through training and continued support for newborn HCPs providers and managers, ensuring the equipment and supplies are in place, and strengthening the facility infrastructure and the referral system (14, 15).

The Ethiopian Federal Ministry of Health (FMOH) is formalizing the guidelines regarding the level of neonatal care services, defining the standards in terms of space, personnel, quantity of NICU supplies and equipment. The draft of this document, shared by the FMOH to the authors, divides NICUs into 3 levels. Level-I NICUs are supposed to have personnel and equipment to perform neonatal resuscitation, evaluate and provide postnatal care for healthy and sick newborn infants, stabilize and provide care for infants born between 35 and 37 weeks of gestation and should be guaranteed by all district hospitals. Level-II NICUs should provide care to infants born after 32 weeks of gestation and weighing more than 1500 g (managing problems caused by physiologic immaturity) and should be found at least in all regional referral hospitals. Specialized teaching hospitals should have a Level-III NICU to provide life support and comprehensive care for extremely high-risk newborn infants and those with complex and critical illnesses (16).

The three levels of complexity imply different structural organizations and different expectations of the population which can greatly influence the parental experience. Investigating these differences can be helpful when planning specific interventions depending on the level of NICU.

This study was conducted within the framework of a 3-year project implemented by Doctors with Africa CUAMM (University College for Aspiring Missionary Doctors) that aimed at improving the quality of NICU services in the three selected hospitals. The project, designed together with the FMOH, started in 2018 and included operational research and surveys on newborn care to generate evidence to enable the FMOH to make informed decisions.

Since sociocultural and economic contexts may have a strong influence on parents' experiences (17), it is important to take into account the peculiarities of the context both during the validation process of the tool and the interpretation of the data.

The complexity of applying a user assessment tool in the Ethiopian context is increased by the many different languages spoken by the population in Ethiopia.

The aim of this study was to (1) translate, adapt and validate the EMPHATIC-N in two spoken languages in Ethiopia (2) explore parents' satisfaction with the care and treatment received in the NICUs in three hospitals and (3) explore socio-demographic characteristics and level of the NICU influence on the EMPATHIC-N domains.

MATERIALS AND METHODS

Design

This is was multi-center cross-sectional quantitative study that measured client satisfaction with NICU services. The study

included a qualitative section to explore the parents' answers to the open questions.

Ethical Issues

The medical research ethics review board of one of the hospitals (an Academic Hospital) and of the Oromia Regional Health Bureau approved the study protocol. Considering the local cultural context (18), a verbal informed consent was obtained from all study participants (19–21). Parents were informed about the study objectives and data were collected anonymously. The interviewer gave the respondents enough information so that they could provide an informed decision on whether to participate in part or in the entire interview. Afterwards, the consent forms were signed by the interviewer as evidence that informed consent had been obtained from the interviewer.

Setting

The study was conducted in three different types of NICUs in Ethiopia: a Level I NICU with 8 beds run by one General Practitioner and 7 Nurses (4 of them with a 1-month training session for NICU care); a Level II NICU with 6 beds run by a Pediatrician, a Health Officer and 12 Nurses (4 of them with a 1-month training session for NICU care); a Level III NICU with 14 beds run by 2 Neonatologists, 2 Pediatricians, 9 Resident Doctors, 8 Neonatal Nurses, 48 Nurses (12 of them with a 1-month training session on NICU care). The average number of monthly admissions in the first semester of 2019 was 23, 81, and 168 for Level I, II, and III, respectively. Level I and II were located in the Oromia region, while Level III, an Academic Hospital, was located in Addis Abebe, the capital city. Level I and Level III NICUs were located in government hospitals, while Level II NICU was located in a private not-for-profit hospital supported by Doctors with Africa CUAMM. Admission and treatment costs in all the NICUs were free of charge as per national policy.

Sample

Study participants were all parents whose newborns had been discharged from one of the three NICUs or transferred to another unit during the study period.

Only the parents of the newborns admitted to the NICUs for more than 2 days were included in the study. Parents with multiple births discharged on the same day, received only one satisfaction questionnaire. Parents whose infants died while in the unit were excluded from this study.

If both parents were present, only one of the parents was interviewed, leaving the decision to the couple.

Sample size was determined conservatively by considering 10 respondents for each of the items (22) and a possible 10% non-response rate was calculated, with $N = 418$ parents to be interviewed.

The sample size was divided proportionally across the three hospitals considering the average monthly admissions of newborns. All the eligible respondents were interviewed until the desired sample size was achieved.

Study Variables and Operational Definition

Socio-demographic variables such as age, sex, educational level (high level of education was considered from secondary schools, high school, grade 9–12 in Ethiopia), occupation (housekeeping or any type of occupation) and place of residence (urban or rural, based on the country's administrative arrangements), were collected from the parents interviewed. Moreover, infants' sex and length of hospital stay were collected from inpatients' clinical records.

Five specific dimensions (Communication-Information and Education, Care & treatment, Organization/ Hospital Environment, Parental participation, and Professional Attitude) related to parent satisfaction were investigated.

A 6-point Likert scale, from one, "not at all satisfied," to six, "all the time satisfied," was used to assess the 38 questionnaire items -responses, with higher scores indicating greater parent satisfaction.

General experience outcomes answers (items Q39 and Q40), "Recommend this NICU to anyone" and "Would you come back" were conveniently dichotomized from the above 6-point scale to "Not at all/a little/to some extent" if 1–4 points were scored and to "Most of the time /always" if items were scored 5–6 points. Answers "in some extend/largely satisfied" were included in the first level together with the "not and little satisfied" to have more balanced groups, because almost every parent was answering "very largely/all the time satisfied" to these questions.

Answers about general impression (items Q41 and Q42 were dichotomized conveniently from a 5-point scale into "Very dissatisfied, quite dissatisfied, and neither satisfied nor dissatisfied" if 1–3 points were scored and "Quite satisfied and very satisfied" if 4–5 points were scored.

The Instrument

The questionnaire was adapted from an internationally validated tool for the assessment of parent experience and satisfaction in the NICUs called the EMPATHIC-N Instrument, which consisted of 57 items (3). Permission to translate and adapt the original questionnaire was obtained from the author. A short version of the instrument was developed, considering the previous experience in reducing a similar questionnaire related to the Pediatric Intensive Care Unit (23). During the reduction process, attention was paid to keep the original balance among the different items for each domain of the questionnaire. The project team working on quality improvement in the three NICUs was involved in this reduction process. Moreover, the medical director of one of the involved hospitals, a NICU pediatrician and President of the Ethiopian Pediatric Society participated in this task.

All the suggested steps for translation and cultural adaptation were followed (24, 25). Starting from the 57 items of the EMPATHIC-N questionnaire (English version), 19 items were considered inappropriate for the Ethiopian setting both for cultural and organizational reasons. The reasons for the removal of the items are reported in **Supplementary File 1**. Similarly, the original final questions regarding overall satisfaction with physicians and nurses (Q41 and Q42) from the original EMPATHIC-N were substituted with more general questions

evaluating care and treatment received from HCPs by the infant and the parent, retrieved from another validated questionnaire on NICU parents' satisfaction, the NSS-13 tool (26). The questionnaire also included four open questions to collect comments or suggestions from the parents about their experience with care received in the NICU during admission, stay, and discharge plus a general comment on the service received.

The instrument was translated into the two languages mainly spoken in the areas where the three hospitals were located—Afan Oromo and Amharic—and back-translated into English to check for consistency. Finally, a pre-test was administered on a small sample ($n = 10$) of the target population to assess the comprehensibility of the instrument questions in the two language versions.

Data Collection

The study was conducted between July and October 2019. Three health care providers, who had no direct connection with the service, were recruited as data collectors and received a 1-day training session about the study tool and methodology. The principal investigator supervised the data collection processes. The interviewer invited the parents to participate in the survey and to complete the questionnaire upon discharge from the NICU. The interview was conducted in a previously identified quiet location within the hospital and lasted on average of 20–30 min. The interviewer marked the respondent's response on paper questionnaires and literally transcribed the answers given to the open-ended questions. Then the data collector copied the answers into an electronic database. The interviews were not audio recorded. A number code was sequentially assigned to the enrolled parents to ensure anonymity.

Data Analysis

Statistical analysis was conducted with R software (R version 4.0.3). Data coding, clearance and entry to the designed format was done after completing data collection.

Descriptive analyses exploring participants' characteristics were included for the total sample and separately for the three NICU levels. Frequencies and percentages were reported for categorical variables, and medians with the interquartile range (iqr) for continuous variables. Raw means and standard deviations were included to describe single item results in the sample.

The Kaiser-Meyer-Olkin (KMO) test of factorial adequacy and Bartlett's test were used to measure the factorability of the correlation matrix.

Confirmatory factor analysis (CFA) was conducted to examine the validity of EMPATHIC-N in this study. Five construct domains were identified as latent variables, which had been defined according to correspondent items in the original EMPATHIC-N instrument. Goodness of fit was investigated considering standard measures such as Comparative Fit Index (CFI;), Root Mean Square Error of Approximation (RMSEA), and Standardized Root Mean Square Residual (SRMR) (27). The reliability of each factor was examined through internal consistency using Cronbach's alpha coefficients. Congruent validity was examined by correlating the domains of the questionnaire with the four general questions on parents' overall experience and impression.

Univariate associations between participants' sociodemographic characteristics and mean scores for the five domains and for a total satisfaction score (calculated as overall mean for all item scores), and for the dichotomized general questions on overall experience and impression (Q39–Q42) were investigated. The Wilcoxon rank-sum and Kruskal Wallis tests were used for continuous variables and Fisher's exact tests was used for categorical variables. Multiple median regression and logistic regression models were additionally implemented to model multivariate associations between parents and patients' characteristics (age, residence, education, occupation, length of hospital stay) and the outcomes (domain scores and binary outcomes representing the four general satisfaction items agreement). The level of statistical significance was set at $p < 0.05$.

Qualitative data were collected from the open-ended questions and analyzed through inductive content analysis (28). The contents of the answers were compiled and coded into subthemes independently by the principal investigator and a co-investigator. The researchers created a consolidated checklist that was used to independently apply the coding. The subthemes were categorized into 6 themes: General reaction, Communication, Relationship with Health Workers, Clinical management, Organizational aspects and Environmental factors.

RESULTS

Characteristics of the Study Participants

Of the 418 parents who were invited to participate in the study, 386 accepted. Therefore, the overall response rate was 92%. Specifically 91% ($n = 32$ out of 35) in NICU Level I, 94% ($n = 117$ out of 124) in Level II and 92% ($n = 237$ out of 258) in Level III. Most of the questionnaires were filled in Amharic (71.8%, n. 277). Almost all the respondents were the mothers (98.7%, n. 381), most of them were married (97.7%, n. 378) and were housewives (64%, n. 248). **Table 1** reports the distribution of participants' socio-demographic characteristics both in the whole sample and across the NICU levels. Only the 9.8% of the responders' infants were hospitalized for more than 2 weeks.

Parents' spoken language, place of residence, education level and children's length of stay were found to be differently distributed across the NICU levels (**Table 1**).

Instrument Validation

Questions 12 ("We were daily informed about the physicians and the nurses who were in charge of our child") and 29 ("Nurses and physician always identified themselves saying their name and their role") were not answered consistently. Low item-total correlations ($r = 0.02$ and $r = 0.03$ respectively) and higher "alpha-drop" estimates (Cronbach's alpha for a group of items if each item were dropped) showed that items were not correlating well with the scale overall.

The Kaiser-Meyer-Olkin (KMO) statistic measure was 0.94 and Bartlett's test resulted significative. Confirmatory factor

TABLE 1 | Socio-demographic characteristics of the respondents and child admission variables ($N = 386$) in the whole sample and across the three NICU levels.

Variable	N	Level I ($n = 32$)	Level II ($n = 117$)	Level III ($n = 237$)	Whole sample ($n = 386$)	P^a
Age, Median (q1, q3)[b]	386	25.5 (21.5, 30.5)	26.0 (22.0, 30.0)	26.0 (24.0, 29.0)	26.0 (24.0, 29.0)	0.56
Language, *n* (%)	386					<0.001
Amharic		5 (15.6)	35 (29.9)	237 (100.0)	277 (71.8)	
Afan Oromo		27 (84.4)	82 (70.1)	0 (0.0)	109 (28.2)	
Residence, *n* (%)	380					<0.001
Rural		21 (70.0)	70 (61.9)	37 (15.6)	128 (33.7)	
Urban		9 (30.0)	43 (38.1)	200 (84.4)	252 (66.3)	
Education, *n* (%)	386					
No education		9 (0.3)	38 (0.3)	29 (0.1)	76 (19.7)	<0.001
Low education		13 (0.4)	38 (0.3)	83 (0.4)	134 (34.7)	
High education		10 (0.3)	41 (0.4)	125 (0.5)	176 (45.6)	
Occupation, *n* (%)						0.08
Homeworking		22 (68.8)	84 (71.8)	142 (59.9)	248 (64.2)	
Other		10 (31.2)	33 (28.2)	95 (40.1)	138 (35.8)	
Parent gender, *n* (%)	386					0.78
Father		5 (1.3)	2 (1.7)	0 (0.0)	3 (1.3)	
Mother		381 (98.7)	115 (98.3)	32 (100.0)	234 (98.7)	
Child gender, *n* (%)	386					0.41
Male		20 (62.5)	70 (59.8)	127 (53.6)	217 (56.2)	
Female		12 (37.5)	47 (40.2)	110 (46.4)	169 (43.8)	
Length of stay, *n* (%)	386					0.04
<1 week		15 (46.9)	64 (54.7)	152 (64.1)	231 (59.8)	
1–2 weeks		13 (40.6)	45 (38.5)	59 (24.9)	117 (30.3)	
>2 weeks		4 (12.5)	8 (6.8)	26 (11.0)	38 (9.8)	

[a] *Kruskal test for continuous variables and Fisher tests for categorical variables.*
[b] *q1 = first percentile, q3 = third percentile.*

TABLE 2 | Confirmatory factor analyses results.

Measures of fit[a]	First order CFA			Second order CFA		
	Amharic	Afan Oromo	Whole sample	Amharic	Afan Oromo	Whole sample
CFI	0.81	0.71	0.80	0.80	0.70	0.79
RMSEA	0.06	0.10	0.06	0.07	0.10	0.07
SRMR	0.07	0.10	0.07	0.08	0.15	0.09

[a] *CFI, comparative fit index; RMSEA, root mean square error of approximation; CFA, confirmatory factor analysis; TLI, Tucker–Lewis index.*
A good model fit was attained for CFI close to 1, RMSEA < 0.06 and SRMR <0.08.

analysis (CFA) was performed for the whole sample and separately for the two languages.

In line with the original instrument (3) and with the following adapted versions (2, 8, 29, 30), five latent factors were specified (Communication, Care & Treatment, Parental Participation, Organization, Professional Attitude). Since all factors were highly correlated (**Supplementary File 2**; **Supplementary Table 1**), the model was re-specified by defining a second order factor measured by the five domains of the questionnaire. Model goodness of fit is reported in **Table 2**, indices were not optimal but comparable with results from previous studies (29). Second-order CFA Factor loadings are available in the **Supplementary File 2**; **Supplementary Table 2**.

Cronbach's alpha coefficients for the two language subsamples and for the whole sample analyses (Afan Oromo and Amharic questionnaires combined) were very high (>0.70), confirming the reliability of all the five construct domains across the three combinations (**Table 3**).

There was congruence between the results obtained in the two language samples and in the combined sample. For this reason, the authors decided to describe the questionnaire outputs in the overall sample of respondents, without distinguishing them by language.

TABLE 3 | Cronbach's alpha internal consistency for each of the five construct domains, separately for the two language sample subsets and for the total sample.

	Amharic	Afan Oromo	Total sample
Communication (information and education)	0.84	0.89	0.86
Care and treatment	0.90	0.87	0.90
Parental participation	0.77	0.77	0.74
Organization/hospital environment	0.76	0.92	0.79
Professional attitude	0.88	0.94	0.90
Overall measure	0.95	0.96	0.95

TABLE 4 | Domains Scores and total satisfaction score per each site ($N = 386$).

Variable, median (q1, q3)	Level I ($n = 32$)	Level II ($n = 117$)	Level III ($n = 237$)	Overall sample ($n = 386$)	P^a
Communication (Information and education)	3.79 (2.68, 4.64)	5.29 (4.86, 5.71)	4.57 (3.86, 4.86)	4.71 (4.00, 5.14)	*<0.001*
Care and treatment	4.75 (4.38, 5.03)	5.62 (5.25, 6.00)	4.88 (4.38, 5.00)	5.00 (4.62, 5.50)	*<0.001*
Parental participation	4.37 (3.96, 4.83)	5.17 (5.00, 6.00)	5.17 (4.83, 5.50)	5.17 (4.67, 5.62)	*<0.001*
Organization/ hospital environment	4.50 (4.33, 4.83)	6.00 (5.00, 6.00)	4.50 (4.17, 4.67)	4.67 (4.33, 5.17)	*<0.001*
Professional attitude	4.00 (3.64, 4.25)	5.89 (5.44, 6.00)	5.00 (4.67, 5.22)	5.11 (4.67, 5.67)	*<0.001*
Total satisfaction score [b]	4.25 (3.96, 4.50)	5.56 (5.14, 5.81)	4.83 (4.44, 5.03)	4.92 (4.53, 5.38)	*<0.001*

[a] *Kruskal Wallis tests.*
[b] *Calculated as mean of all the items scores.*

Finally, correlations between the five domain scores and the scores of items Q39–Q42, regarding general questions on parents' overall experience and impression, were all significant (**Supplementary File 2**; **Supplementary Table 5**).

Parent Satisfaction and Association With the NICU Level

For almost all the items, parent satisfaction with the quality of care received in the NICU, the mean scores were higher than four on the 6-point Likert scale (**Supplementary File 2**; **Supplementary Table 3**).

The parents of children in the Level II NICU consistently reported higher mean scores in all the questionnaire items and for all the five domains. In the analysis of the five item-aggregated latent domains (Q12 and Q29 excluded) the highest mean scores were obtained (in descendent order) for Parental participation [median 5.17; iqr (4.67, 5.62)], Professional Attitude [median 5.11; iqr (4.67, 5.67)] and Care and Treatment [median 5.00; iqr (4.62, 5.50)]; while the total scores were relatively lower for the domain areas of Communication [median 4.71; iqr (4.00, 5.14)] and Organization/Hospital environment [median 4.67; iqr (4.33, 5.17)] (**Table 4**).

Table 5 shows statistic of the domain scores according to the participants' characteristics. The total satisfaction score varied according to participants' language, place of residence, and level of education. Multivariate analyses showed consistent results with univariate analyses (**Supplementary File 2**; **Supplementary Table 6**). The language variable was not considered in the models because Afan Oromo was not spoken in one of the three hospitals (**Table 1**). Satisfaction scores were always reported to be significantly lower in Level I and Level III NICUs compared to Level II NICU (reference category).

Table 6 reports frequencies and percentages for the four general questions, concerning parents' overall experience and impression. For the two "general experience" questions and the two "general impression" questions, the percentage of parents satisfied with the level of care in Level II NICU was higher than 90%. In the Level II NICU, for questions 39 and 40 almost 100% of the parents were very or totally satisfied, and for questions 41 and 42, 95 and 90%, respectively, of the parents were quite satisfied or very satisfied. Descriptions of the overall experience and impression scores in the original undichotomized scales are reported in **Supplementary File 2**; **Supplementary Table 4**.

NICU level, level of education and occupation were found to be possibly associated to a different resulting outcome in general question outcomes (**Supplementary File 2**; **Supplementary Table 7**). Additionally, language and place of residence were found to be possibly associated with answers to question Q40. Multivariate logistic regression analyses (**Supplementary File 2**; **Supplementary Table 8**) confirmed, for the four outcomes, that the odds of being very largely/all the time in agreement with Q39 and Q40 and quite/largely satisfied with Q41 and Q42 were lower in Level I and III NICUs compared to the Level II NICU, while holding the other variables constant.

Open Questions About Parents' Experience

All the participants answered to at least three of the four open-ended questions, providing 1,541 answers. Fourteen comments contained two different subthemes generating a total of 1,555 comments.

Aspects related to admission, stay and discharge were often reported in the "General experience" question, therefore the authors decided to code together all the comments given to the four questions.

Most of the comments were simple opinions or statements about personal feelings. The main aspects commented in relation to the experience were: information received (227 respondents), speed of treatment (207 respondents), and HCPs' behavior (110 respondents). The complete list of the subthemes is reported in **Table 7**.

DISCUSSION

This study aimed to investigate parents' experience and satisfaction with the care received in three different level NICUs in Ethiopia. Therefore, two language translations, cultural adaptation and validation of the questionnaire EMPATHIC-N (3) were performed in this setting.

TABLE 5 | Statistics of the domain scores according to participants' characteristics.

Sample characteristic, median (q1, q3)	Communication	Care and Treatment	Parental Participation	Organization/ Hospital environment	Professional Attitude	Total satisfaction score
Age						
≤26 years	4.71 (4.00, 5.07)	5.00 (4.62, 5.56)	5.17 (4.67, 5.50)	4.83 (4.33, 5.17)	5.11 (4.78, 5.67)	4.97 (4.58, 5.38)
>26 years	4.71 (4.00, 5.14)	4.88 (4.62, 5.50)	5.17 (4.67, 5.67)	4.50 (4.17, 5.17)	5.11 (4.56, 5.67)	4.89 (4.47, 5.38)
P[a]	*0.63*	*0.15*	*0.27*	*0.02*	*0.48*	*0.36*
Language						
Amharic	4.57 (3.86, 4.86)	4.88 (4.50, 5.25)	5.17 (4.83, 5.50)	4.50 (4.17, 5.00)	5.11 (4.67, 5.22)	4.86 (4.47, 5.11)
Afan Oromo	5.00 (4.57, 5.57)	5.50 (5.00, 5.88)	5.00 (4.40, 6.00)	5.17 (5.00, 6.00)	5.56 (4.67, 6.00)	5.22 (4.61, 5.78)
P[a]	*<0.001*	*<0.001*	*0.56*	*<0.001*	*<0.001*	*<0.001*
Residence						
Rural	5.00 (4.39, 5.43)	5.19 (4.75, 5.75)	5.17 (4.50, 5.71)	5.00 (4.50, 6.00)	5.22 (4.86, 6.00)	5.11 (4.69, 5.64)
Urban	4.57 (3.96, 4.86)	4.88 (4.50, 5.25)	5.17 (4.67, 5.50)	4.67 (4.17, 5.00)	5.00 (4.67, 5.25)	4.86 (4.47, 5.14)
P[a]	*<0.001*	*<0.001*	*0.39*	*<0.001*	*<0.001*	*<0.001*
Education						
No education	4.86 (4.25, 5.43)	5.00 (4.84, 5.62)	5.00 (4.67, 5.38)	5.00 (4.46, 5.33)	5.11 (4.97, 5.78)	4.96 (4.58, 5.47)
Low education	4.71 (4.00, 5.14)	5.00 (4.75, 5.62)	5.33 (4.88, 5.67)	4.67 (4.33, 5.46)	5.11 (4.81, 5.78)	4.92 (4.62, 5.52)
High education	4.64 (3.86, 5.00)	4.88 (4.38, 5.50)	5.00 (4.50, 5.50)	4.67 (4.17, 5.00)	5.11 (4.44, 5.36)	4.89 (4.38, 5.18)
P[b]	*0.15*	*0.004*	*0.009*	*0.03*	*0.04*	*0.06*
Occupation						
Housewife	4.71 (4.00, 5.14)	5.00 (4.72, 5.50)	5.17 (4.83, 5.54)	4.67 (4.33, 5.17)	5.11 (4.78, 5.67)	4.92 (4.58, 5.42)
Other	4.57 (4.00, 5.00)	5.00 (4.38, 5.62)	5.17 (4.50, 5.62)	4.67 (4.17, 5.00)	5.11 (4.44, 5.56)	4.89 (4.33, 5.30)
P[a]	*0.12*	*0.15*	*0.3*	*0.06*	*0.13*	*0.13*
Length of stay						
<1 week	4.71 (4.00, 5.14)	5.00 (4.62, 5.62)	5.17 (4.67, 5.67)	4.67 (4.33, 5.17)	5.11 (4.78, 5.67)	4.92 (4.56, 5.35)
1–2 weeks	4.71 (4.14, 5.14)	5.00 (4.62, 5.62)	5.17 (4.50, 5.50)	4.83 (4.33, 5.83)	5.11 (4.78, 5.78)	4.92 (4.53, 5.47)
>2 weeks	4.64 (3.86, 4.86)	4.69 (4.25, 5.00)	5.17 (4.71, 5.67)	4.50 (3.88, 4.83)	5.00 (4.33, 5.22)	4.81 (4.17, 5.06)
P[b]	*0.59*	*0.01*	*0.39*	*0.11*	*0.11*	*0.24*

[a]*Wilcoxon rank sum.* [b]*Kruskal tests.*

The lack of attention of parents in distinguishing the health professional figures who were responsible for the care of the newborn had already been taken into account during the adaptation of the questionnaire, but was further confirmed by the non-correlation of questions 12 and 29 relating to the identification of health personnel. This study had a higher response rate (94%) compared to other studies (2, 23), similarly to one study conducted in a Pediatric ICU in Spain where the questionnaire was administered at the time of discharge (30). This high response rate could be partly explained by the data collection method (direct interviews instead of self-compilation) and by the level of satisfaction across all the sites, confirming that people who report high satisfaction levels are more likely to participate in a survey (31).

Most of the respondents were mothers. Such a high percentage of mothers compared to fathers was also revealed in the validation of EMPATHIC in Turkey (29) where—unlike other contexts where both parents were given the opportunity to respond together (2, 10, 11)—the couple was free to choose whether the mother or the father wished to answer. This may also

TABLE 6 | General questions on parents' experience and impression.

Variable, *n* (%)	Level I (*n* = 32)	Level II (*n* = 117)	Level III (*n* = 237)	Overall sample (*n* = 386)	*P*[a]
Overall experience					
1. We would recommend this NICU to anyone facing a similar situation					*<0.001*
Not at all/to a small extent/to some extent/to a large extent	12 (37.5)	2 (1.7)	47 (19.8)	61 (15.8)	
To a very large extent/all the time	20 (62.5)	115 (98.3)	190 (80.2)	325 (84.2)	
2. If ever we would get in the same situation again, we would like to come back to this NICU					*<0.001*
Not at all/to a small extent/to some extent/to a large extent	8 (25.0)	2 (1.7)	46 (19.4)	56 (14.5)	
To a very large extent/all the time	24 (75.0)	115 (98.3)	191 (80.6)	330 (5.5)	
Overall impression					
3. All in all, how satisfied or dissatisfied are you with the treatment the child received at the NICU?					*<0.001*
Very dissatisfied /dissatisfied /quite dissatisfied/neither satisfied nor dissatisfied	5 (15.6)	6 (5.1)	45 (19.0)	56 (14.5)	
Quite satisfied/very satisfied	27 (84.4)	111 (94.9)	192 (81.0)	330 (85.5)	
4. All in all, how satisfied or dissatisfied are you with how you were treated as a parent?					*<0.001*
Very dissatisfied /dissatisfied /quiet dissatisfied/neither satisfied nor dissatisfied	12 (37.5)	11 (9.4)	46 (19.4)	69 (17.9)	
Quite satisfied/very satisfied	20 (62.5)	106 (90.6)	191 (80.6)	317 (82.1)	

[a] *Fisher exact tests.*

TABLE 7 | Themes and selected verbatim responses to open questions about parents' experience.

Theme	Sub theme	Participants	Verbatim data extracts (Positive and Negative comments)
General reaction	General opinion	378	*Pos (360): "It was nice/great/perfect/wonderful/good/not bad" "No problem"* *Neg (10): "I can't say that it was good" "Not good. But I will come here If any problem because I have no choice"*
	Feeling	205	*Pos (205): "I'm happy/glad" "Leave with happiness"*
	Thanks	129	*Pos (129): "Thank you" "May god bless all of them"*
	Recommendations	67	*Pos (66): "Keep up the good work", "Let the service continue as it is"* *Neg (1): "I wish they could do more to improve"*
	Description	24	*Pos (24): "I delivered in this hospital" "They took my baby with care and provided the service"*
Communication	Language	3	*Neg (3): "I have a language problem. Some of them don't understand me"*
	Information received	227	*Pos (205): "They listen to me and answer my question properly","I got a good response for my questions", "I got health education on how to care for my baby"* *Neg (22): "When I asked about my baby's condition some nurses gave me the wrong information", "They didn't discuss with the mother", "No needful advice"*
Relationship with health workers	Behavioral	110	*Pos (91): "They were welcoming" "They treated me well/with love and care"* *Neg (19): "They didn't have any sympathy" "Some nurses have no respect for mothers"*
Clinical management	Care	56	*Pos (38): "My baby got good care and treatment" "Compared to the health center, the care and treatment is very good", "Preparation service is good"* *Neg (18): "I don't believe my baby got good care", "Some nurses did not follow children well especially during night time", "There is negligence in the night shift"*
	Equality	8	*Neg (8): "The service should be the same for everyone" "I Suggest If we get equal care and treatment from all the nurses all the time"*
Organizational aspects	Speed of treatment	207	*Pos (203): "My child was admitted soon" "They were fast"* *Neg (4): "There was a problem during admission, I was waiting", "Not fast"*
	Services	20	*Neg (20): "There is a problem in the laboratory, they were taking our blood outside the hospital" "There is no good coordination to get laboratory results", "Even the oxygen is outside"*
	Equity	3	*Pos (3): "We got help for free it is good especially for poor people"*
	Priority	1	*Neg (1): "I wish the ward room service gave priority to infant patients"*
Environmental factors	Comfort	96	*Pos (87): "The place was comfortable" "I felt comfortable"* *Neg (9): "It doesn't give me comfort"*
	Equipment	17	*Neg (17): "There are no beds for mothers, especially for mothers who delivered", "I slept on the chair/on the floor", "There are not enough gowns and caps"*
	Space	3	*Neg (3): "I wish there were additional rooms" "The room is too small"*
	Cleanness	1	*Neg (1): "The Kangaroo Mother Care room is not clean"*

because mothers are more present in hospitals and more involved in the care of newborns, especially in low-resource settings.

In the whole sample, parents resulted to be altogether satisfied with the care received in NICUs. Questionnaire items scored similarly to those of previous studies conducted in different international contexts with average scores even higher than the averages we found (2, 11, 30). These results may suggest a possible ceiling effect that could be due to the parents' feelings of gratitude at the time of their infant's discharge. The implementation of a different scale could be tested in future studies for EMPATHIC-N.

In this study setting, parental participation scored highest among all the five questionnaire domains, whereas the organization/hospital environment domain received the lowest scores for parent satisfaction. This was not highlighted in other study settings (2, 8, 29, 30, 32).

The scores across the five domains were found to vary significantly across the three NICU levels (Level I, II, and III).

Parents of infants assisted in the Level II NICU, expressed a higher level of satisfaction, in all domains, after adjusting the results for parents' socio-demographic characteristics. Instead, satisfaction with Level I NICU resulted in scores lower than four, especially for Communication and Professional Attitude domains. This evidence might be due to the different NICU levels, to whether the hospitals were public or private and to the intervention in the level II NICU supported by CUAMM.

From the point of view of the NICU level it can be assumed that the intermediate level was the one that satisfied parents most, because it offered more services than level I, but did not suffer from heavy workload like in level III (33).

In the literature it has been shown how drugs and medical equipment availability (13), availability of laboratory, radiology services and rooms for accommodation (19) can influence patients' satisfaction. On the other hand, there is evidence that parental satisfaction in provincial centers is higher than in national specialist centers, probably due to the lower severity of cases and less stressful working conditions (34, 35). Moreover, a greater satisfaction of patients in hospitals with a private-public-partnership than in public hospitals has already been previously reported (36). Among other aspects this may have influenced parental satisfaction with discharge preparation (37) and health workers' care and behavior (38, 39). In fact, there is also evidence that the working environment and infrastructure could motivate HCPs to deliver high quality of care (40).

The respondents' level of education was found to be inversely associated with the level of satisfaction, as already reported by other authors (12, 41). This might indicate that parents with a higher level of education have a greater expectations regarding the quality of care provided to their newborn.

Similarly, it has been shown that place of residence might influence satisfaction, whereby people living in rural areas tend to be more satisfied compared to those living in urban areas (12, 41). Levels of parent satisfaction in Care and Treatment for their children were also found to be lower for longer lengths of hospital stay. As also reported by other authors, longer hospitalization tends to be associated to lower satisfaction ratings (42). This could also be due to the greater seriousness of the clinical conditions of the infants who stayed longer in the NICU, and parents had more time to observe the NICU environment and its weaknesses. Therefore, the evaluations by parents who were older, more educated, lived in urban areas, and whose child had a longer length of stay in the NICU, should be used as benchmarks to guide the improvement interventions. In fact, the needs of this population should constitute the basis for more targeted health services for infants and parents in NICUs also in Ethiopia.

In the open questions, parents often gave either positive or negative opinions, but there were many who pointed out possible areas for improvement, even without expressing a direct judgment.

Much attention was paid to the relationships they built with the hospital staff (information received and HCPs' behavior) as also highlighted in other contexts (11).

Positive comments can be very useful to share with the staff to reinforce trust in the HCPs. On the other hand, criticism can be useful to policy makers to improve and make specific interventions. These findings could be used to prompt further discussion, consideration and evaluation for themes such as the cultural approach methodology to apply in these settings. The staff would then be invited to evaluate the parents' feedback, understand any issues and gaps they might encounter and find solutions to address them.

Comments to open questions have also been made available in disaggregate versions (for each study site) to stakeholders and policy makers, but were not presented in this paper.

LIMITATIONS

This survey was conducted upon discharge of the patient from the NICU. Although investigators tried to conduct the interview only after discharge was completed, guaranteeing the anonymity of the interview, being still in the hospital setting may have induced fear of retaliation from the medical and nursing staff for negative or non-favorable reports on the care they provided (11).

The study design provided for a long period (45–60 days) of data collection. This could have led the data collector to develop emotional attachment with the NICU staff and therefore could have prompted staff to improve in their actions and impressions with the parents. To minimize it, data collectors were asked to limit their interactions with staff.

Despite the attempt to guarantee the privacy of the parents during the data collection interview, it could be possible that noise and distractions in the NICU may have led to environmental bias, not allowing the parent to fully concentrate on the questions of the survey. Moreover, collecting data in the same day the infants were discharged could have overwhelmed the parents, but this was the same timing used in similar studies (2).

The data collection tool used in this study, the 6 point-likert scale questionnaire, was not originally designed to be administered by interviewer (3, 23), but as a self-administered questionnaire. The approach/questioning of the interviewer to make clarification on the scales combined with the low level of educational status of the respondents may have led to response

bias. To minimize this issue, the interviewers were oriented prior to data collection to suggest respondents to choose between numbers 1 to 6 indicating that 1 for *"Not at all"* to 6 for *"All the time"*.

When comparing satisfaction across the different NICU levels, the health personnel staffing levels and their job satisfaction, which may have affected their care activities, were not taken into consideration. Future studies on this issue will also need to take these aspects into account.

The role played by public or private hospital ownership in the provision of care was not been investigated in the present study. Further insights are needed to distinguish whether private non-profit NICU facilities led to better parent satisfaction than the public ones investigated in this paper.

In addition, some of the parents' characteristics that may have influenced their experience were not considered in our study, such as having other children at home to care for or having had previous experience with NICU services.

CONCLUSION

In the present study, we found that the EMPATHIC-N questionnaire can be applied to measure parental satisfaction and can be adapted to different cultural contexts. This study investigated parents' satisfaction in Ethiopia, also comparing results across three different NICU levels. Parents' overall level of satisfaction with the care provided to their child was good, in particular with regard to "Parental participation." Another interesting finding of this study was that healthcare workers tended not to give much importance to introducing themselves to the patients and their parents. In addition, we found that different domains in the healthcare service might influence the level of parent satisfaction according to characteristics such as education and place of residence. Healthcare team members need to be aware of the increasing importance of identifying parental expectations and understanding its significance. In addition to the clinical care they provide to the newborn, the healthcare staff must also consider the needs of parents as part of their daily practice.

Further studies are needed to improve staff awareness about parent satisfaction and more precisely on their evaluation of aspects related to the care provided across the different NICU levels. Long-term investigation is also recommended to better evaluate and understand differences in the way care is provided across the different NICU levels in Ethiopia.

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by St. Paul's Hospital Millennium Medical College/Oromia Regional Health Bureau. Verbal informed consent was obtained from all participants for their participation in this study.

AUTHOR CONTRIBUTIONS

BG and LM conceived and implemented the study, collected data, participated in the data analysis, and drafted the manuscript. FT drafted and edited the manuscript and participated in the interpretation of the findings. SP performed the data analysis, gave a substantial contribution to the interpretation of the data, and drafted and edited the manuscript. AT and FM supervised all the phases of study and made a substantial contribution to the interpretation of the data. TA reviewed and gave substantial contribution to the manuscript. ID conceived, designed and supervised all the phases of study, and drafted and revised the manuscript for important intellectual content. All authors contributed, read, and approved the final manuscript.

FUNDING

This research was conducted in the framework of project supported by Italian Agency for Development Cooperation (AICS) (Grant No. AID 11512/CUAMM/ETH). The project supported the research costs and the publication fees. The founders had no role in study design, data collection, data analysis, data interpretation, or writing of the report.

ACKNOWLEDGMENTS

The authors thank the parents who participated in our study and the staff of the hospitals involved for their availability and collaboration. We are also grateful to Dr. Andrea Dotta, MD, MS, Ph.D., Head of the NICU, Prof. Andrea Finocchi, MD, MS, Ph.D. Head of the Unit of Immuno-infectivology, the staff working in their units and the International Activities Department of Bambino Gesù Children's Hospital IRCCS for the support to the quality improvement project in the Ethiopian NICUs. A special thanks goes to Prof. Worku Bogale, of the Ethiopian Pediatric Society, for his suggestions during the implementation of the study and to Dr. Meseret Zelalem, the Mother and Child Health Director FMoH, for her support and collaboration. Finally, we thank Jos M. Latour, Professor in Clinical Nursing at the University of Plymouth, author of the original EMPATHIC-N for granting us the permission to translate and adapt the questionnaire to the Ethiopian context.

SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fped.2021.738863/full#supplementary-material

REFERENCES

1. Latour JM, van Goudoever JB, Hazelzet JA. Parent Satisfaction in the Pediatric ICU. *Pediatr Clin North Am*. (2008) 55:779–90. doi: 10.1016/j.pcl.2008.02.013
2. Dall'Oglio I, Fiori M, Tiozzo E, Mascolo R, Portanova A, Gawronski O, et al. Neonatal intensive care parent satisfaction: a multicenter study translating and validating the Italian EMPATHIC-N questionnaire. *Ital J Pediatr*. (2018) 44:5. doi: 10.1186/s13052-017-0439-8
3. Latour J, Hazelzet J, Goudoever J. Development and validation of a neonatal intensive care parent satisfaction instrument. *Pediatr Crit Care Med*. (2012) 13:554–9. doi: 10.1097/PCC.0b013e318238b80a
4. Tsironi S, Bovaretos N, Tsoumakas K, Giannakopoulou M, Matziou V. Factors affecting parental satisfaction in the neonatal intensive care unit. *J Neonatal Nurs*. (2012) 18:183–92. doi: 10.1016/j.jnn.2011.11.005
5. Ramezani T, Hadian Shirazi Z, Sabet Sarvestani R, Moattari M. Family-Centered care in neonatal intensive care unit: a concept analysis. *Int J Community Based Nurs Midwifery*. (2014) 2:268–78. Available online at: https://ijcbnm.sums.ac.ir/
6. Gallagher K, Shaw C, Aladangady N, Marlow N. Parental experience of interaction with healthcare professionals during their infant's stay in the neonatal intensive care unit. *Arch Dis Child - Fetal Neonatal Ed*. (2018) 103:F343–8. doi: 10.1136/archdischild-2016-312278
7. Obeidat HM, Bond EA, Callister LC. The parental experience of having an infant in the newborn intensive care unit. *J Perinat Educ*. (2009) 18:23–9. doi: 10.1624/105812409X461199
8. Gomez D, Vidal S, Lima L. Brazilian adaptation and validation of the Empowerment of Parents in the Intensive Care-Neonatology (EMPATHIC-N) questionnaire. *J Pediatr*. (2016) 93:156–64. doi: 10.1016/j.jped.2016.06.007
9. Papamichael E, Ioannou M, Talias MA. EMPATHIC-N in a Greek-Cypriot sample: confirming its factorial structure. *BMC Health Serv Res*. (2018) 18:968. doi: 10.1186/s12913-018-3793-3
10. Lake ET, Smith JG, Staiger DO, Schoenauer KM, Rogowski JA. Measuring parent satisfaction with care in neonatal intensive care units: the EMPATHIC-NICU-USA questionnaire. *Front Pediatr*. (2020) 8: 541573. doi: 10.3389/fped.2020.541573
11. Mol C, Argent A, Morrow B. Parental satisfaction with the quality of care in a South African paediatric intensive care unit. *South Afr J Crit Care*. (2018) 34:51–8. doi: 10.7196/SAJCC.2018.v34i2.366
12. Mengesha EW, Zelellw D, Asfaw L, Tesfa M, Debela M, Ambaw F. *Parental Experiences in Neonatal Intensive Care Unit at Felege Hiwot Comprehensive Specialized Hospital, Bahir Dar, Ethiopia: A Phenomenological Study*. (2020). doi: 10.21203/rs.3.rs-127179/v1
13. Alemu AT, Walle AA, Atnafu DD. Quality of pediatric healthcare services and associated factors in Felege-Hiwot comprehensive specialized hospital, North-West Ethiopia: parental perception. *Patient Prefer Adherence*. (2020) 14:1649–58. doi: 10.2147/PPA.S264106
14. The Federal Democratic Republic of Ethiopia Ministry of Health. *Health Sector Transformation Plan: 2015/16–2019/20*. (2015). Available online at: https://ehia.gov.et/sites/default/files/Resources/HSTP%20Final%20Print%202015-11-27%20Print%20size.pdf (accessed: February 28, 2021).
15. Asrat D, Girum S, Yohannes G, Yeshi B, Amina N, Askal A, et al. Clinical audit on neonatal care unit structure in five selected governmental hospitals of Addis Ababa, Ethiopia 2019. *Int Arch Nurs Health Care*. (2020) 6:140. doi: 10.23937/2469-5823/1510140
16. Maternal and Child Health Directorate - Federal Ministry of Health. National Strategy for Newborn and Child Survival in Ethiopia. Available online at: https://www.healthynewbornnetwork.org/resource/national-strategy-newborn-child-survival-ethiopia/ (accessed: February 2, 2021).
17. Irlam LK, Bruce JC. Family-Centred care in paediatric and neonatal nursing- a literature review. *Curationis*. (2002) 25:28–34. doi: 10.4102/curationis.v25i3.781
18. Abay S, Addissie A, Davey G, Farsides B, Addissie T. Rapid ethical assessment on informed consent content and procedure in Hintalo-Wajirat, Northern Ethiopia: a qualitative study. *PLoS ONE*. (2016) 11:e0157056. doi: 10.1371/journal.pone.0157056
19. Asamrew N, Endris AA, Tadesse M. Level of patient satisfaction with inpatient services and its determinants: a study of a specialized hospital in Ethiopia. *J Environ Public Health*. (2020) 2020:e2473469. doi: 10.1155/2020/2473469
20. Getachew S, Tesfaw A, Kaba M, Wienke A, Taylor L, Kantelhardt EJ, et al. Perceived barriers to early diagnosis of breast Cancer in south and southwestern Ethiopia: a qualitative study. *BMC Womens Health*. (2020) 20:38. doi: 10.1186/s12905-020-00909-7
21. Malako D, Yoseph F, Bekele ML. Assessment of knowledge, attitude and practice and associated factors of blood donation among health care workers in Ethiopia: a cross-sectional study. *BMC Hematol*. (2019) 19:10. doi: 10.1186/s12878-019-0140-9
22. Hair JF Jr, Black WC, Babin BJ, Anderson RE. *Multivariate Data Analisys. 7th Edn*. Upper Saddle River, NJ: Prentice Hall (2009).
23. Latour JM, Duivenvoorden HJ, Tibboel D, Hazelzet JA, EMPATHIC Study Group. The shortened EMpowerment of PArents in THe Intensive Care 30 questionnaire adequately measured parent satisfaction in pediatric intensive care units. *J Clin Epidemiol*. (2013) 66:1045–50. doi: 10.1016/j.jclinepi.2013.02.010
24. Wild D, Grove A, Martin M, Eremenco S, McElroy S, Verjee-Lorenz A, et al. Principles of good practice for the translation and cultural adaptation process for Patient-Reported Outcomes (PRO) measures: report of the ISPOR task force for translation and cultural adaptation. *Value Health*. (2005) 8:94–104. doi: 10.1111/j.1524-4733.2005.04054.x
25. Gjersing L, Caplehorn JRM, Clausen T. Cross-cultural adaptation of research instruments: language, setting, time and statistical considerations. *BMC Med Res Methodol*. (2010) 10:13. doi: 10.1186/1471-2288-10-13
26. Hagen IH, Vadset TB, Barstad J, Svindseth MF. Development and validation of neonatal satisfaction survey – NSS-13. *Scand J Caring Sci*. (2015) 29:395–406. doi: 10.1111/scs.12156
27. Bentler PM. Comparative fit indexes in structural models. *Psychol Bull*. (1990) 107:238–46. doi: 10.1037/0033-2909.107.2.238
28. Elo S, Kyngäs H. The qualitative content analysis process. *J Adv Nurs*. (2008) 62:107–15. doi: 10.1111/j.1365-2648.2007.04569.x
29. Tiryaki Ö, Zengin H, Çinar N, Umaroglu MM, Latour JM. Turkish adaptation and validation of the EMpowerment of PArents in THe Intensive Care (EMPATHIC-30) questionnaire to measure parent satisfaction in neonatal intensive care units. *Front Pediatr*. (2020) 8:421. doi: 10.3389/fped.2020.00421
30. Pilar Orive FJ, Basabe Lozano J, López Zuñiga A, López Fernández YM, Escudero Argaluza J, Latour JM. Spanish translation and validation of the EMPATHIC-30 questionnaire to measure parental satisfaction in intensive care units. *An Pediatría Engl Ed*. (2018) 89:50–7. doi: 10.1016/j.anpede.2017.08.006
31. Perneger TV, Peytremann-Bridevaux I, Combescure C. Patient satisfaction and survey response in 717 hospital surveys in Switzerland: a cross-sectional study. *BMC Health Serv Res*. (2020) 20:158. doi: 10.1186/s12913-020-5012-2
32. Gill FJ, Wilson S, Aydon L, Leslie GD, Latour JM. Empowering parents of Australian infants and children in hospital: translation, cultural adaptation, and validation of the EMpowerment of PArents in The Intensive Care-30-AUS questionnaire. *Pediatr Crit Care Med*. (2017) 18:e506–13. doi: 10.1097/PCC.0000000000001309
33. Corchia C, Fanelli S, Gagliardi L, Bellù R, Zangrandi A, Persico A, Zanini R, SONAR-Nurse Study Group. Work environment, volume of activity and staffing in neonatal intensive care units in Italy: results of the SONAR-nurse study. *Ital J Pediatr*. (2016) 42:34. doi: 10.1186/s13052-016-0247-6
34. Nguyen ATB, Nguyen NTK, Phan PH, van Eeuwijk P, Fink G. Parental satisfaction with quality of neonatal care in different level hospitals: evidence from Vietnam. *BMC Health Serv Res*. (2020) 20:238. doi: 10.1186/s12913-020-5070-5
35. Negash AK, Negussie WD, Demissie AF. Patients' satisfaction and associated factors with nursing care services in selected hospitals, Northwest Ethiopia. *Am J Nurs Sci*. (2014) 3:34–42. doi: 10.11648/j.ajns.20140303.12
36. Baliga BS, Ravikiran SR, Rao SS, Coutinho A, Jain A. Public-Private partnership in health care: a comparative cross-sectional study of perceived quality of care among parents of children admitted in two government district-hospitals, Southern India. *J Clin Diagn Res JCDR*. (2016) 10:SC05–09. doi: 10.7860/JCDR/2016/17124.7250

37. Smith VC, Mao W, McCormick MC. Changes in assessment of and satisfaction with discharge preparation from the neonatal intensive care unit. *Adv Neonatal Care*. (2021) 21:E144–51. doi: 10.1097/ANC.0000000000000862
38. Lake ET, Smith JG, Staiger DO, Hatfield LA, Cramer E, Kalisch BJ, et al. Parent satisfaction with care and treatment relates to missed nursing care in neonatal intensive care units. *Front Pediatr*. (2020) 8:74. doi: 10.3389/fped.2020.00074
39. Keiza EM, Chege MN, Omuga BO. Assessment of parents' perception of quality of pediatric oncology inpatient care at Kenyatta National Hospital. *Asia Pac J Oncol Nurs*. (2017) 4:29–37. doi: 10.4103/2347-5625.199071
40. Remtullah AZ, Sirili N, Anaeli A, Massawe A, Manji K, Sunguya BF. Quality of healthcare in acute pediatric care unit in a tertiary hospital in Tanzania: a case of Muhimbili National Hospital. *Front Pediatr*. (2020) 8:496. doi: 10.3389/fped.2020.00496
41. Beyene W, Jira C, Sudhakar M. Assessment of quality of health care in Jimma Zone, Southwest Ethiopia. *Ethiop J Health Sci*. (2011) 21:49–58. Available online at: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3275883/ (Accessed May 11, 2021).
42. Hagen IH, Iversen VC, Nesset E, Orner R, Svindseth MF. Parental satisfaction with neonatal intensive care units: a quantitative cross-sectional study. *BMC Health Serv Res*. (2019) 19:37. doi: 10.1186/s12913-018-3854-7

Conflict of Interest: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

The Handling Editor declared a past collaboration with one of the authors, ID.

Publisher's Note: All claims expressed in this article are solely those of the authors and do not necessarily represent those of their affiliated organizations, or those of the publisher, the editors and the reviewers. Any product that may be evaluated in this article, or claim that may be made by its manufacturer, is not guaranteed or endorsed by the publisher.

Copyright © 2021 Gulo, Miglierina, Tognon, Panunzi, Tsegaye, Asnake, Manenti and Dall'Oglio. This is an open-access article distributed under the terms of the Creative Commons Attribution License (CC BY). The use, distribution or reproduction in other forums is permitted, provided the original author(s) and the copyright owner(s) are credited and that the original publication in this journal is cited, in accordance with accepted academic practice. No use, distribution or reproduction is permitted which does not comply with these terms.

Risk Factors of Early Neonatal Deaths in Pediatric Teaching Hospital in Bangui, Central African Republic

PAPER

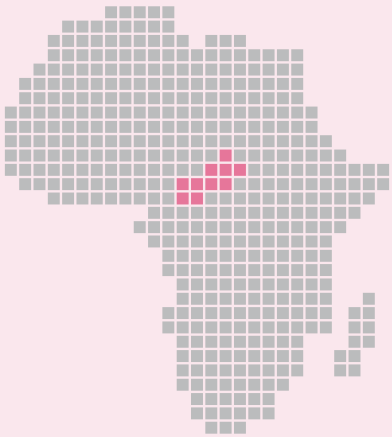
Authors
Gody J.C., Engoba M., Bogning Mejiozem B.O., Danebera L.V., Kakouguere E.P., Nganda Bangue M.C., Kiteze Nguinzanemou C.J., Belly de Dieu Komangoya Kpembi R., Waraka P., Ngoyoli Mbode D.L., Mande Djapou M., Ghislain Franck Houndjahoue, Moyen G.

Published in
Open Journal of Pediatrics, December 2021

Link
10.4236/ojped.2021.114079

Topic
Maternal and child health

Focus country
Central African Republic



Scientific Research Publishing

Open Journal of Pediatrics, 2021, 11, 840-853
https://www.scirp.org/journal/ojped
ISSN Online: 2160-8776
ISSN Print: 2160-8741

Risk Factors of Early Neonatal Deaths in Pediatric Teaching Hospital in Bangui, Central African Republic

Jean Chrysostome Gody[1*], Moyen Engoba[3], Brice Olivier Bogning Mejiozem[1], Lydie Verleine Danebera[1], Evodie Pierrette Kakouguere[1], Marie Collette Nganda Bangue[1], Carine Judith Kiteze Nguinzanemou[1], Romuald Belly de Dieu Komangoya Kpembi[1], Petula Waraka[1], Dusie Lesly Ngoyoli Mbode[1], Mireille Mande Djapou[1], Ghislain Franck Houndjahoue[1,2], George Moyen[3]

[1]Centre Hospitalier Universitaire Pédiatrique de Bangui (CHUPB), Bangui, République Centrafricaine
[2]Médecins avec l'Afrique CUAMM International NGO, Padova, Italie
[3]Université Marien Ngouabi, Brazzaville, Congo
Email: *jcgody@hotmail.com

How to cite this paper: Gody, J.C., Engoba, M., Mejiozem, B.O.B., Danebera, L.V., Kakouguere, E.P., Bangue, M.C.N., Nguinzanemou, C.J.K., de Dieu Komangoya Kpembi, R.B., Waraka, P., Mbode, D.L.N., Djapou, M.M., Houndjahoue, G.F. and Moyen, G. (2021) Risk Factors of Early Neonatal Deaths in Pediatric Teaching Hospital in Bangui, Central African Republic. *Open Journal of Pediatrics*, **11**, 840-853.
https://doi.org/10.4236/ojped.2021.114079

Received: November 28, 2021
Accepted: December 27, 2021
Published: December 30, 2021

Copyright © 2021 by author(s) and Scientific Research Publishing Inc.
This work is licensed under the Creative Commons Attribution International License (CC BY 4.0).
http://creativecommons.org/licenses/by/4.0/
Open Access

Abstract

Background: The neonatal mortality rate in the Central African Republic (CAR) is 42.3 per 1000 live births in 2017, indicating that CAR is with the highest number of newborn deaths. **Objective:** The objective is to clarify the risk factors of neonatal deaths in this area. **Methodology:** A case-control study with retrospective data collection. Targets were newborns >7 days, hospitalized and dead (cases), and newborns admitted after the respective case during the study period and discharged before the 7th day of life. This study was carried out between 2016 and 2018 in the neonatal unit of the "Complexe Hospitalier Universitaire Pédiatrique de Bangui" (CHUPB), the only national hospital for newborns care in the CAR. **Results:** We included 902 newborns, with 451 cases of early neonatal death and 451 controls. 4168 newborns were admitted to the neonatology unit with 621 early death cases; a lethality rate of 14.9%. Early neonatal deaths factors were: newborns with low birth weight (OR = 22.59; 95% CI [15.93 - 32.04]; P < 0.001); mothers who did not attend antenatal care (OR = 5.54; 95% CI [3.95 - 7.79]; P < 0.001), home delivery (OR = 0.70; 95% CI [0.03 - 0.15]; P < 0.001); young maternal age < 25 years (OR = 2.08; 95% CI [1.58 - 2.73]; P < 0.001); non-medical transport (OR = 2.14; 95% CI [1.03 - 4.46]; P = 0.03); origin from remote areas (OR = 5.25; 95% CI [3.95 - 6.98]; P < 0.001); isolated prematurity (P < 0.01); anoxo-ischemic encephalopathy (OR = 12.72; 95% CI [6.54 - 34.73]; P < 0.01); delivery by cesarean section (OR = 0.59; 95% CI [0.41 - 0.84]; P < 0.001); pre-

term delivery (OR = 29.36; 95% CI [20.12 - 42.81]; P < 0.001), and maternal lower education (OR = 5.65; 95% CI [4.08 - 7.81]; P < 0.001). **Conclusion:** The early neonatal mortality rate remains high in this area. Controlling the factors mentioned above might lead to improving the survival of newborns.

Keywords

Early Neonatal Mortality, Risk Factors, CHUPB, CAR

1. Introduction

Neonatal death, including children born alive and dead between birth and the 28th day of life, is a public health concern. It is considered early death when it occurs before the first week of life [1]. It can be divided into two sub-categories: early neonatal mortality between 0 and 6 days and late neonatal mortality between 7 and 27 days [2].

According to the World Health Organization (WHO), overall neonatal deaths are 2.6 million [3]. This neonatal mortality is an indicator of obstetric and neonatal care quality which is the witness of the socio-economic development level of a country. This mortality remains 10 to 15 times higher in developing countries than in developed ones [4]. Thus, only one in 1000 dies in the first 28 days of life in Japan but, in CAR, out of 1000 babies born, 42.3 will not survive at one month of life, otherwise one in 20 newborns. This epidemiological profile data makes CAR the first in the world among low-income countries with the highest number of neonatal deaths [5]. Likewise, intra-hospital neonatal mortality is higher and varies according to the health setting. Early neonatal mortality can exceed 50% in the neonatal units in low-income countries' hospitals [6] [7]; the contributing factors are the socio-economic environment, access to care, the type of patients, the medical equipment, and human resources [7].

In sub-Saharan Africa, where the Central African Republic is located, the birth of a baby is an important and joyful social event for the family and the whole community. However, the death of a newborn is a trauma to the family for which the community often tries to find fatalistic explanations. Few data on early neonatal death in CAR are available; hence this case-control study aims to determine the frequency, clinical, and outcome characteristics and to identify the risk factors associated with early neonatal mortality at the pediatric teaching hospital of Bangui.

2. Methodology

The study was retrospective. It was carried out between 2016 and 2018 in the neonatal unit of the pediatric teaching hospital of Bangui, the only national hospital for newborn care in the CAR. No conventional care system and graduated patient management are operational in the current health pyramid. Barely 4% of

patients are referred from peripheral health facilities to the pediatric hospital.

The unit includes in situ diagnostic tools (pulse oximeter, transcutaneous bilirubinometer, glucometer, and urine strips), warming (radiant lamps), manual ventilation, oxygen therapy (oxygen concentrator, masks, and nasal cannula) as well, as for intravenous and umbilical infusions. Cardiorespiratory monitors, phototherapy devices, and syringe pumps are also available. Assisted ventilation and positive airways pressure at the end of expiration are not available. The skin-to-skin or kangaroo method sub-unit has 8 beds with breastfeeding support. The hospital laboratory operates 24 hours 7 days and performs biological hematologic, biochemical investigations (dosage of C-reactive protein, serum creatinine, bilirubin, and blood ionogram) and bacteriology (blood cultures, urine cultures, etc. analyzes of cerebrospinal fluid). The imaging department can perform standard radiology and ultrasound. Computed tomography is feasible in the imaging unit close to the hospital but is not free of charge. The staff members of the neonatal unit include a pediatric neonatologist, residents in pediatrics, two nursery nurses, and ten nurses. The ratio is equal to one nurse for 4.2 newborns.

The retrospective data collection included as cases: any newborn less than seven days hospitalized in the ward and died during the study period. The control group consisted of all newborns admitted to the ward immediately after their respective cases during the study period and who survived till their seventh day of life. Those who died upon arrival or after seven days of life, as well as those released alive after seven days of life, were not included. The study variables related to the mother were age, parity, quality of antenatal care, occupation, socio-economic level, education level, location, marital status, and Clinical incidents during the current gestation. Newborn variables were origin, mean of transport, reason for hospitalization, type of delivery, gestational age, sex, birth weight, hospitalization duration, clinical signs, diagnosis, treatment and outcome.

A low level of education was defined by education not exceeding elementary level or lack of education. The housewife is defined as any woman whose main occupation is to take care of the household tasks. Low birth weight is defined as a birth weight less than 2500 grams. Respiratory distress is defined as a Silverman score ≥ 4. The model of appropriate antenatal care (ANC) used for this study is that of WHO 2016, with eight ANC [8]. Data was collected from the service's registers and medical records. These collected data have been kept secret for the respect of confidentiality. The data had been analyzed using Epi Info 7 software in version 7.1.3.3. The p-value < 0.05 was considered significant, and the odds ratio was calculated with a 95% confidence interval.

3. Results

Out of 4168 newborns admitted to the neonatal department of the pediatric hospital, early death occurred in 621; a lethality of 14.90%. From one year to anoth-

er, we observed a lethality rate of 14.41% (195/1353) in 2016, 17.12% (245/1431) in 2017, and 13.07% (181/1384) in 2018, as shown in Figure 1.

Among the 621 files of newborns that died early, we kept 451 files whose information could be used in accordance with the case inclusion criteria.

Likewise, out of the 2245 files of newborns survived before the 7th day, we selected 451 files whose information could be used in accordance with the case control criteria. One control was matched to each case.

3.1. Maternal Characteristics and Early Neonatal Death

The mean age of the mothers in the cases group was 22 ± 6 years versus 26 ± 5 years for the control group's mothers (P < 0.001). Teenager and young mothers (under 25 year-old) represented 60.53% (n = 546), with the percentage of 57.14% (n = 312) and 42.86% (n = 234), respectively among cases and controls. They lived in rural areas in 68.25% (n = 329) for the cases and 31.75% (n = 153) for the controls (p < 0.001) and were primiparous in 50.16% (n = 311) for the cases versus 49.83% (n = 309) for the controls. Among the cases, mothers have no education in 62.14% (n = 384) versus 37.86% for controls (n = 234). Newborns of women who did not attend antenatal care were 5 times more likely to die early (OR = 5.54 95% CI [3.95 - 7.79]; P < 0.001). About one in seven women (58.10%) with Clinical incidents during the current gestation had the risk of losing her baby early (OR = 1.4; 95% CI [1.04 - 2.10]; P = 0.02). Childbirth in a hospital was a protective factor against death (OR = 0.70; 95% CI [0.03 - 0.15]; P < 0.001). Cesarean delivery was counted among the risk factors for early neonatal death (OR = 0.59; 95% CI [0.41 - 0.84]; P < 0.001). Finally, newborns of women with lower education, were 5.65 time more likely to die (OR = 5.65; 95% CI [4.08 - 7.81]; P < 0.001). See Table 1.

3.2. Characteristics of the Newborn and Early Neonatal Death

Male sex was 48.27% (n = 307) among cases and 51.73% (n = 329) among controls. The sex ratio was 2.13 for cases and 2.69 for controls.

Newborns with low birth weight were 22.59 times more at risk of early neonatal death (OR = 22.59; 95% CI [15.93 - 32.04]; P < 0.001). The risk of early neonatal death was 29.36 times greater in newborns of gestational age below 37 weeks of amenorrhea based on Finnstrom score (OR = 29.36; 95% CI [20.12 - 42.81]; P < 0.001). Non-medical transport increased the risk of early neonatal

Figure 1. Distribution of early neonatal death by year.

Table 1. Relationship between early neonatal death and the characteristics of the mother.

Parameter	Death cases (N, %)	Cases controls (N, %)	OR	P
Mothers age (in year)				
< 25 (n = 546)	312 (57.14)	234 (42.86)	2.08 [1.58 - 2.73]	<0.01
≥ 25 (n = 356)	139 (39.05)	217 (60.95)		
Location				
Rural (n = 482)	329 (68.25)	153 (31.75)	5.25 [3.95 - 6.98]	<0.01
Urban (n = 420)	122 (29.1)	298 (70.9)		
Marital status				
Singles (n = 521)	250 (47.98)	271 (52.02)	0.82 [0.63 - 1.07]	0.07
Maried (n = 381)	201 (52.75)	180 (47.25)		
Education level				
No education (n = 618)	384 (62.14)	234 (37.86)	5.65 [4.08 - 7.81]	<0.01
Educateds (n = 280)	63 (22.50)	217 (77.50)		
Profession				
Paid employment (n = 72)	33 (45.83)	39 (54.17)	0.83 [0.5 - 1.35]	0.23
Other Jobs (n = 830)	418 (50.36)	412 (49.64)		
Parity				
Primiparous (n = 620)	311 (50.16)	309 (49.84)	1.02 [0.77 - 1.35]	0.88
Multiparous (n = 282)	140 (49.64)	142 (50.36)		
Antenal care well followed				
No (n = 248)	194 (78.22)	54 (21.78)	5.54 [3.95 - 7.79]	<0.01
Yes (n = 654)	257 (39.29)	397 (60.71)		
Delivery place				
Hospital (n = 805)	362 (44.96)	443 (55.04)	0.70 [0.03 - 0.15]	<0.01
Home (n = 97)	89 (91.75)	8 (8.25)		
Type of delivery				
Vaginal (n = 747)	357 (47.79)	390 (52.21)	0.59 [0.41 - 0.84]	<0.01
Ceasarian section (n = 155)	94 (60.64)	61 (39.36)		
Clinical incidents during the current gestation				
Yes (n = 155)	90 (58.10)	65 (41.90)	1.4 [1.04 - 2.10]	0.02
No (n = 747)	361 (48.33)	386 (51.67)		

death by 2.14 (OR = 2.14; 95% CI [1.03 - 4.46]; P = 0.03). The risk of early neonatal death was 12.72 times in anoxic ischemic encephalopathy (OR = 12.72; 95% CI [6.54 - 24.73]; P < 0.001). Congenital malformations increased the risk of

early neonatal death by 1.2, but the link was not statistically significant (OR = 1.2; 95% CI [0.36 - 3.96]; P = 0.09). See Table 2.

Table 2. Relationship between early neonatal death and newborn characteristics.

Parameters	Death cases N (%)	Case control N (%)	OR	P
Sex				
Male (n = 636)	307 (48.27)	329 (51.73)	0.79 [0.5 - 1.05]	0.10
Female (n = 266)	144 (54.14)	122 (45.86)		
Gestationnal age (in week)				
<37 (n = 390)	345 (88.46)	45 (11.54)	29.36 [20.12 - 42.81]	<0.01
≥37 (n = 512)	106 (20.70)	406 (79.30)		
Weight (in grams)				
<2500 (n = 487)	389 (79.87)	98 (20.13)	22.59 [15.93 - 32.04]	<0.01
≥2500 (n = 415)	62 (14.94)	353 (85.06)		
Transportation means				
Non médicalisé (n = 868)	440 (50.7)	428 (49.3)	2.14 [1.03 - 4.46]	0.03
Médicalisé (n = 34)	11 (32.35)	23 (67.65)		
Diagnosis at time of death				
Prematurity with complication				
Yes (n = 184)	150 (81.53)	34 (18.47)	6.11 [4.09 - 9.12]	<0.01
No (n = 718)	301 (41.9)	417 (58.1)		
Prematurity without complication				
Yes (n = 142)	0 (00)	142 (100)	--------	<0.01
No (n = 760)	451 (59.4)	309 (40.6)		
Neonatal distress respiratory				
Yes (n = 191)	103 (53.92)	88 (46.08)	1.22 [0.88 - 1.68]	0.22
No (n = 711)	348 (48.9)	363 (51.1)		
Encephalopathy anoxo-ischémia				
Yes (n = 111)	101 (90.99)	10 (9.01)	12.72 [6.54 - 24.73]	<0.01
No (n = 791)	350 (44.3)	441 (55.7)		
Neonatal infection				
Yes (n = 253)	85 (33.59)	168 (66.40)	0.39 [15.93 - 32.04]	<0.01
No (n = 649)	366 (33.6)	283 (66.4)		
Congenital malformation				
Yes (n = 11)	6 (54.54)	5 (45.46)	1.2 [0.36 - 3.96]	0.09
No (n = 891)	445 (49.9)	446 (50.1)		

Maternal and child health Papers 08 → Central African Republic

Continued

Jaundice encephalopathy				
Yes (n = 3)	2 (66.6)	1 (33.4)	2 [0.18 - 22.18]	0.56
No (n = 899)	449 (49.9)	450 (50.1)		
Neonatal Tetanus				
Yes (n = 3)	2 (66.6)	1 (33.4)	2 [0.18 - 22.18]	0.56
No (n = 899)	449 (49.9)	450 (50.1)		
Hemorrhagic disease of newborns				
Yes (n = 2)	2 (100)	0 (00)	--------	0.15
No (n = 900)	449 (49.88)	451 (50.2)		

4. Discussion

The present study focused on newborns managed in a neonatal unit of the only national referral hospital center, which receives approximately 95% of births with problems in Bangui and its surroundings. These newborns already have a higher risk of mortality compared to healthy newborns. Thus, the results obtained remain valid for the framework of the study and do not reflect the situation in the general population where the neonatal mortality rate is 42.3 deaths per 1000 live births [3]. Under the conditions of hospital care in Bangui, Bobossi in 1999 reported the result of a pediatric intervention in the delivery room for newborns requiring intensive care. The hospital mortality rate was 9.7% [9]. In 2003, the latter observed this time, at the Pediatric hospital—the only pediatric unit in the Central African Republic geographically separated from maternity hospitals—overall intra-hospital mortality of around 28.4% [10]. By applying the 2/3 rule according to Lawn [11], we would have an early intra-hospital mortality rate of about 18.9% in 2003, close to the trend observed in 2017. These comparisons show a fluctuation in the rate of early intra-hospital mortality from 13.07% to 18.9%, clearly superior to the results obtained in the first hours after resuscitation in the maternity ward of the Bangui Community Hospital in 1999 (9.7%).

It was a pilot project that was never carried out. According to this analysis, it is more than urgent to reduce external transfer by creating neonatal units in the referral maternities in Bangui; waiting for decentralization in the different health regions of the country. The low mortality in facilities caring for mother and newborn is a reality confirmed by the observations of Kedy in Douala with 6.6% [12], Garba in Niamey with 6.31% [13], Manzar in Pakistan with 6.39% [14], and Baker in New York with 1.9 per 1000; materializing both the protective aspect of in situ interventions for the newborn and the quality of care in developed countries [15]. The difference in care observed, between developed and developing countries, for hospitals with neonatal intensive care units as well as in health systems where referral to tertiary care is possible, reveals the lack of interventions upstream of maternity hospitals and pediatric units to prevent obstetric

complications [16] [17] [18].

For the Central African Republic, during the study period, the lack of antenatal and pre-natal interventions would be partly induced by armed conflicts. Indeed, in addition to the conflicts responsible for the decline in the use of services, the weak contribution of the State to health expenditure previously prevented the development of the health system in a context where the population—mostly poor—struggled to access care [19]. Thus, with free care, already effective in the pediatric unit, it is necessary to combine the optimization of pregnancy monitoring and the organization of timely transfers of parturients to obstetric referral centers to reduce the cause of the obstetric complications of neonatal deaths [20] [21]; waiting for the end of armed conflicts and the increase in the financial contribution of the State to health care.

4.1. About the Relationship between Early Neonatal Death and Maternal Characteristics

For maternal factors, our results showed that parturients under 25-year-old, primiparous, and not attending school are the most affected by early neonatal deaths. This observation was made by Blondel in France [22] and could be explained, among others, by the fact that in CAR, sexual activities are precocious, in particular with unwanted pregnancies: a source of inappropriate follow-up; negatively impacting the quality of antenatal and post-natal. The data from our work supported observations on the barriers to accessing pregnancy follow-up [23]. Thus, the lack of prenatal consultation, multiplying by 5.54 the risk of death of the newborn, is usual [7] [24] [25] [26] [27]. For Garba in Niger, mothers who have had a good ANC are 3.72 times less likely to see their child die [13]. Like poor pregnancy follow-up, rural origin increases the risk of early neonatal death. This has been reported in several studies suggesting the geographic barrier and/or life in rural areas as risk factors for neonatal death [25] [28] [29].

Contrary to the majority of studies that consider the cesarean section as a protective factor of early neonatal death and would even make it possible to avoid perinatal mortality by 71% [30], in our study; this mode of delivery is linked to the risk of early neonatal death. This observation, which corroborates Akinyemi's observations [21], would be because cesarean sections are often indicated in our maternity hospitals for maternal rescue or acute fetal suffering; exposing them to the risk of induced prematurity and neonatal asphyxia; so many clinical situations unfavorable to the survival of the newborn.

4.2. About the Relationship between the Early Neonatal Death and Newborn Characteristics

In our study, most newborns are male, of low birth weight, and for most of the time, born before 37 weeks of gestation in respiratory distress and transported to the pediatric unit by non-medical transportation. This male predominance does not influence the occurrence of early neonatal deaths, unlike observations showing the male sex as a risk factor for neonatal mortality [31] [32] [33] [34] [35]. The

factors that cause early neonatal mortality are preterm delivery, low birth weight, and inappropriate transport. Neonatal infection, anoxo-ischemic encephalopathy (EAI), and congenital malformations are the most observed neonatal pathologies.

In our series, the first day of life is the deadliest of the neonatal period with a proportion of 85.15% (n = 367); obeying the two-thirds rule of deaths occurring within 24 hours of birth, reported by several authors [10] [11] [36]. Considering the risk factors of early lethality, prematurity, being the primary goal of antenatal consultations, has been shown to be the first direct cause of early neonatal mortality. This does not seem surprising, taking into account many factors—providers of prematurity and its consequences—present in the Central African Republic and described elsewhere linked to the low socio-economic level, insufficient medical follow-up of pregnancy, early motherhood, childbearing, long journeys, and inappropriate means of transport [37] [38] [39]. But this predominance of prematurity is not particular to developing countries [40] [41]. Regarding selection bias for prematurity and hypotrophic infants, there are often difficulties in estimating gestational age (ignorance of the date of the last menstruation, absence of early ultrasound) [42]. But, a careful clinical examination (Finnstrom score) allowed us most often to differentiate between the true premature and the hypotrophic newborn. Anyway, newborns with low birth weight have 22.59 times more risk of dying than those with normal birth weight. Several authors in Africa [24] [25] [43] [44] [45] [46] [47] and in Asia [48] [49] have reported the same findings. The main thing is to observe that most children with low birth weight are not preterm—that they have in common problems of growth in utero, generally due to the poor health of their mother [50] in order to intervene upstream on the health problems of women of childbearing age.

Regarding the pathologies found in early deaths newborns in our series, malformations are major contributors, followed by anoxo-ischemic encephalopathy, infections, and respiratory distress. Infections, prematurity, and brain injury are frequently cited causes of neonatal mortality in Africa, varying in their proportion from one site to another [51] [52]. According to Lawn [53], worldwide in 2012, the clinical situations frequently associated with neonatal mortality are complications of prematurity (0.99 million, 34%), perinatal asphyxia (0.72 million, 25%), and infections (including sepsis, meningitis, and pneumonia; 0.64 million, 22%). It is also reported in Lawn's systematic review that complications of preterm delivery have similar proportions in countries with low mortality and high mortality. However, poor management of preterm newborns is observed in most countries with high mortality. Yenan [54] pointed out the limits of human and material resources in newborn care management in Bouaké. Azaria [40] underlines that "in addition to the organization of societies around access to care and the influence of modes of solidarity on the national health of people in precarious situations, also include ethnic differences or geographical, educational level and territorial inequalities" and proposes to take into account while analyzing. Thus, we have to recognize that national solidarity, through free health

care offered to children in the Central African Republic, is far from solving the problems of neonatal morbidity and mortality. It seems like this system generates the inadequacy between need and offer as human and material resources are lacking, given the realities revealed by Yenan *et al.* [54]. If we refer to the study on the nurse's workload carried out in 2002 by Aitken, the patient/nurse ratio is not blamed [55]. The workload of the pediatrician likely remains to be blamed at the pediatric hospital. Indeed, the standards of practice in the neonatal hospitalization unit require the presence of a pediatrician 24 hours 7 days skilled in neonatal resuscitation [56]; whereas in our case, the pediatrician—with this skill—provides care in the unit for 8 hours out of the 24 required.

Our observation concerning the strong implication of congenital malformations is supported by the assertions that a gradient between the risks of congenital anomaly increase as the precariousness index increases [57].

5. Conclusions

This study, limited to the only referral neonatal unit in the Central African Republic, showed determinants of early neonatal mortality often observed in countries with high mortality is related to the young age of the mother, the poor antenatal care, rural area, cesarean section, gestational age < 37 weeks, weight < 2500 g, external transfer, infections, perinatal asphyxia, congenital abnormalities, and respiratory distress.

The literature review has shown us that beyond national solidarity targeting the most vulnerable in the form of free healthcare implementation at the neonatal unit in Bangui, it would be necessary to decentralize the care of pregnant women and newborns, facilitate access to education for mothers and improve the offer/need ratio in response strategies aiming to increase newborn survival in the Central African Republic.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

References

[1] OMS (2011) La mortalité néonatale baisse trop lentement, surtout en Afrique. 12 p.

[2] Amorissani-Folquet, M., Dainguy, E., Kouakou, C., Benie, B.V.J. and Houenou, Y. (2007) Facteurs de risque de mortalité néonatale précoce du nouveau-né à terme au service de pédiatrie du chu de cocody. *Revue International des Sciences Médicales*, **9**, 28-33.

[3] Lawn, J.E., Blencowe, H., Waiswa, P., *et al.* (2016) For the Lancet Ending Preventable Stillbirths Series Study Group with the Lancet Stillbirth Epidemiology Investigator Group. Stillbirths: Rates, Risk Factors, and Acceleration towards 2030. *Lancet*.

[4] Hoan, P.T., Bao, T.V., Huong, N.T., Manirankunda, L. and Boelaert, M. (2000) Mortalité Néonatale précoce à l'Hôpital de gynécologie-obstétrique de Hanoï, Vietnam. *Bulletin de la Société de Pathologie Exotique*, **93**, 62-65.

[5] Taylor, G., Devine, S., Carvajal-Aguirre, L., Hug, L., Porth, T., You, D.Z., Arts, M., Begin, F., Chaiban, T., Chandy, L., Hayashi, C., Hereward, M., Mehra, V., Mshvidobadze, A., Pearson, L., Peterson, S., Rogers, K., Sharrow, D., Taqi, I., Zaka, N. and Zeck, W. (2018) Pour chaque enfant, une chance de vivre. L'urgence de mettre fin à la mortalité néonatale. UNICEF, Palais des Nations, 44 p.

[6] Balaka, B., Agbere, A.D., Kpemissi, E., *et al.* (1998) Évolution de la mortalité néonatale précoce en dix ans (1981-1982et1991-1992) au CHU de Lomé: Quelle politique de santé néonatale pour demain ? *Médecine d'Afrique Noire*, **45**, 430-434.

[7] Kedy Koum, D.C., Essomba, N.E., Ngaba, G.P., Sintat, S., Koki Ndombo, P. and Coppieters, Y. (2015) Morbidité et facteurs de risque de mortalité néonatale dans un hôpital de référence de Douala. *Pan African Medical Journal*, **20**, Article No. 258.

[8] OMS (2018) Recommandations de l'OMS concernant les soins prénatals pour que la grossesse soit une expérience positive https://apps.who.int/iris/bitstream/handle/10665/259584/9789242549911-fre.pdf;sequence=1

[9] Bobossi Serengbe, G., Serdouma, E., Gody, J.C., Habarugira, R. and Gresenguet, G. (2002) La réanimation néonatale en milieu pédiatrique à l'hôpital communautaire de Bangui. *Revue Internationale des Sciences Médicales*, **4**, 89-95.

[10] Bobossi, S.G., Deyamissi-Sana, T.S., Diemerh, C. and Gauduelle, A.G. (1994) Mortalité Néonatale en République centrafricaine. *Médecine d'Afrique Noire*, **51**, 159-163.

[11] Lawn, J.E., McCarthy, B. and Ross, S.R. (2001) The Healthy Newborn: A Reference Manual for Program Managers. CDC et CARE, Atlanta.

[12] Kedy Koum, D., Exhenry, C., Penda, C.I., Nzima Nzima, V. and Pfister, R.E. (2014) Morbidité et mortalité néonatale dans un hopital de district urbain à ressources limitées à Douala, Cameroun. *Archives de Pediatrie*, **21**, 147-156. https://doi.org/10.1016/j.arcped.2013.11.014

[13] Garba, M., Kamaye, M., Alido, S., Zoubeirou, H., Oumarou, Z. and Amadou, A. (2017) Les déterminants de la mortalité néonatale précoce à la maternité Issaka-Gazobi de Niamey. *Journal de Pediatrie et de Puériculture*, **30**, 156-161. https://doi.org/10.1016/j.jpp.2017.01.005

[14] Manzar, N., Manzar, B., Yaqoob, A., Ahmed, M. and Kumar, J. (2012) The Study of Etiological and Demographic Characteristics of Neonatal Mortality and Morbidity—A Consecutive Case Series Study from Pakistan. *BMC Pediatrics*, **12**, Article No. 131. https://doi.org/10.1186/1471-2431-12-131

[15] Baker, L.C., Afendulis, C.C., Chandra, A., McConville, S., Phibbs, C.S. and Fuentes-Afflick, E. (2007) Differences in Neonatal Mortality among Whites and Asian-American Subgroups: Evidence from California. *Archives of Pediatrics and Adolescent Medicine*, **161**, 69-76. https://doi.org/10.1001/archpedi.161.1.69

[16] Kramer, M.S., Liu, S., Luo, Z., Yuan, H., Platt, R.W. and Joseph, K.S. (2002) Analyse de la mortalité périnatale et de ses composantes: Il est temps de changer? *American Journal of Epidemiology*, **156**, 493-497.

[17] WHO Regional Office for Europe (2005) Base de données européenne sur la santé pour tous. Organisation mondiale de la santé, Bureau Régional Européen, Copenhague. http://www.euro.who.int/InformationSources/Data/20010827_1

[18] Nguyen Ngoc, N.T., Merialdi, M., Abdel-Aleem, H., Carroli, G., Purwar, M., Zavaleta, N., Campódonico, L., Ali, M., Hofmeyr, G.J., Mathai, M., Lincetto, O. and Villar, J. (2006) Causes of Stillbirths and Early Neonatal Deaths: Data from 7993 Pregnancies in Six Developing Countries. *Bulletin of the World Health Organization*, **84**, 699-705. https://doi.org/10.2471/BLT.05.027300

[19] Ministère de la Santé et de la Population (2006) Plan National de Développement Sanitaire 2006-2015. 87 p.

[20] Chelo, D., Monebenimp, F., Romyale, F., Npanguepko, T. and Tietche, F. (2012) Mortalité néonatale précoce et ses déterminants dans une maternité de niveau I à Yaoundé, Cameroun. *Pan African Medical Journal*, **13**, Article No. 67.

[21] Akinyemi, J.O., Bamgboye, E.A. and Ayeni, O. (2015) Trends in Neonatal Mortality in Nigeria and Effects of Bio-Demographic and Maternal Characteristics. *BMC Pediatrics*, **15**, Article No. 36. https://doi.org/10.1186/s12887-015-0349-0

[22] Blondel, B., Eb, M., Matet, N., Bréart, G. and Jougla, E. (2005) La mortalité Néonatale en France: Bilan et apport du certificat de décès néonatal. *Archives de Pédiatrie*, **12**, 1448-1455. https://doi.org/10.1016/j.arcped.2005.05.009

[23] OMS, Bureau régional de l'Afrique (2014) Plan Stratégique Régional pour la Vaccination 2014-2020.

[24] Adetola, A.O., Tongo, O.O., Orimadegun, A.E. and Osinusi, K. (2011) Neonatal Mortality in an Urban Population in Ibadan Nigeria. *Pediatrics & Neonatology*, **52**, 243-250. https://doi.org/10.1016/j.pedneo.2011.06.001

[25] Mengesha, H.G., Wuneh, A.D., Lerebo, W.T. and Tekle, T.H. (2016) Survival of Neonates and Predictors of Their Mortality in Tigray Region, Northern Ethiopia: Prospective Cohort Study. *BMC Pregnancy and Childbirth*, **16**, Article No. 202. https://doi.org/10.1186/s12884-016-0994-9

[26] Mekonnen, Y., Tensou, B., Telake, D.S., Degefie, T. and Bekele, A. (2013) Neonatal Mortality in Ethiopia: Trends and Determinants. *BMC Public Health*, **13**, Article No. 483. https://doi.org/10.1186/1471-2458-13-483

[27] Sidibé, T., Sangho, H., Doumbia, S., Sylla, M., Keita, M., Keita, H.D., *et al.* (2006) Mortalité néonatale dans le district sanitaire de Kolokani (Mali). *Journal de Pédiatrie et de Puériculture*, **19**, 272-276. https://doi.org/10.1016/j.jpp.2006.08.004

[28] Lukonga, E. and Michelo, C. (2015) Factors Associated with Neonatal Mortality in the General Population: Evidence from the 2007 Zambia Demographic and Health Survey (ZDHS); A Cross Sectional Study. *Pan African Medical Journal*, **20**, Article No. 64.

[29] Lassi, Z.S., Middleton, P.F., Bhutta, Z.A. and Crowther, C. (2016) Strategies for Improving Health Care Seeking for Maternal and Newborn Illnesses in Low and Middle-Income Countries: A Systematic Review and Meta-Analysis. *Global Health Action*, **9**, Article ID: 31408. https://doi.org/10.3402/gha.v9.31408

[30] Labie, D. (2005) Le scandale des 4 millions de morts néonatales chaque année: Bilan et actions possibles. *Médecine/Sciences*, **21**, 768-771.

[31] Muluken, G., Mitike, M. and Wubegzier, M. (2014) Trends and Risk Factors for Neonatal Mortality in Butajira District, South Central Ethiopia, (1987-2008): A Prospective Cohort Study. *BMC Pregnancy Childbirth*, **14**, Article No. 64. https://doi.org/10.1186/1471-2393-14-64

[32] Singh, K., Brodish, P. and Suchindran, C. (2014) A Regional Multilevel Analysis: Can Skilled Birth Attendants Uniformly Decrease Neonatal Mortality. *Maternal and Child Health Journal*, **18**, 242-249.

[33] Lee, H.Y., Do, D.V., Choi, S., Trinh, O.H. and To, K.G. (2016) Trends and Determinants of Infant and Under-Five Childhood Mortality in Vietnam, 1986-2011. *Global Health Action*, **9**, Article ID: 29312. https://doi.org/10.3402/gha.v9.29312

[34] Musafili, A., Essén, B., Baribwira, C., Binagwaho, A., Persson, L.A. and Selling, K.E.

(2015) Trends and Social Differentials in Child Mortality in Rwanda 1990-2010: Results from Three Demographic and Health Surveys. *Journal of Epidemiology and Community Health*, **69**, 834-840. https://doi.org/10.1136/jech-2014-204657

[35] Kimani-Murage, E.W., Fotso, J.C., Egondi, T., Abuya, B., Elungata, P., Ziraba, A.K., *et al.* (2014) Trends in Childhood Mortality in Kenya: The Pour Citer Urban Advantage Has Seemingly Been Wiped out. *Health & Place*, **29**, 95-103. https://doi.org/10.1016/j.healthplace.2014.06.003

[36] Sanogo, C.T. (2008) Etude épidémio-clinique d l'accouchement prématuré au centre de santé de référence de la commune V de 2002 à 2003 à propos de 238 cas. Université de Bamako, Bamako, 19 p.

[37] Agbere, A.D., Bayilabou, K., Tatagan, K., Assimadi, K. and Kessie, K. (1998) Mortalité néonatale précoce dans le service de pédiatrie du CHR de Kara. *Publications Médicales Africaines*, **126**, 9-14.

[38] Ayivi, B., Alihonou, E., Dan, V. and Koumakpai, S. (1994) Médecine néonatale au Bénin: Etat actuel et perspectives d'avenir. *Médecine d'Afrique Noire*, **41**, 491-495.

[39] Alihonou, E., Dan, V., Ayivi, B., Sossou, E.C., Gandaho, T. and Koumakpai, S. (1991) Mortalité néonatale au centre national hospitalier et universitaire de Cotonou: Incidence, causes et moyens de lutte. *Médecine d'Afrique Noire*, **38**, 746-751.

[40] Azria, E. (2015) Inégalités sociales en santé périnatale. *Archives de Pédiatrie*, **22**, 1078-1085. https://doi.org/10.1016/j.arcped.2015.07.006

[41] Villar, J. and Belizan, J.M. (1982) The Relative Contribution of Prematurity and Fetal Growth Retardation to Low Birth Weight in Developing and Developed Societies. *American Journal of Obstetrics & Gynecology*, **143**, 793-798. https://doi.org/10.1016/0002-9378(82)90012-6

[42] Bégué, P. and Capochichi, D. (1979) Les nouveau-nés de petits poids de naissance au Togo. Classification en fonction de l'âge gestationnel à partir de 888 cas. *Annals of Pediatrics*, **26**, 639-645.

[43] Diallo, A.H., Meda, N., Oue'draogo, W.T., Cousens, S. and Tylleskar, T. (2011) A Prospective Study on Neonatal Mortality and Its Predictors in a Rural Area in Burkina Faso: Can MDG-4 Be Met by 2015? *Journal of Perinatology*, **31**, 656-663. https://doi.org/10.1038/jp.2011.6

[44] Shrimpton, R. (2003) Preventing Low Birthweight and Reduction of Child Mortality. *Transactions of the Royal Society of Tropical Medicine and Hygiene*, **97**, 39-42.

[45] Shankaran, S., Fanaroff, A.A., Wright, L.L. and Stevenson, D.K. (2002) Risk Factors for Early Death among Extremely Low-Birth-Weight Infants. *American Journal of Obstetrics & Gynecology*, **186**, 796-802. https://doi.org/10.1067/mob.2002.121652

[46] Cisse, C.T., Yacoubou, Y., Ndiaye, O., Diop-Mbengue, R. and Moreau, J.C. (2006) Évolution de la mortalité néonatale précoce entre 1994 et 2003 au CHU de Dakar. *Journal de Gynécologie Obstétrique et Biologique de la Reproduction*, **35**, 46-52. https://doi.org/10.1016/S0368-2315(06)76371-2

[47] Kabore, P., Potvliege, C., Sanou, H., Bawhere, P. and Dramaix, M. (2004) Croissance pondérale et survie des enfants de petit poids de naissance nés à terme en milieu rural africain (Burkina Faso). *Archives de Pédiatrie*, **11**, 807-814. https://doi.org/10.1016/j.arcped.2004.03.034

[48] Jehan, I., Harris, H., Salat, S., *et al.* (2009) Neonatal Mortality, Risk Factors and Causes: A Prospective Population-Based Cohort Study in urban Pakistan. *Bulletin of the World Health Organization*, **87**, 130-138. https://doi.org/10.2471/BLT.08.050963

[49] Titaley, C.R., Dibley, M.J. and Roberts, C.L. (2012) Type of Delivery Attendant,

Place of Delivery and Risk of Early Neonatal Mortality: Analyses of the 1994-2007 Indonesia Demographic and Health Surveys. *Health Policy and Planning*, **27**, 405-416.

[50] Beck, L. (2009) La santé des nouveau-nés au Rwanda. Évolution des facteurs associés aux tendances de la mortalité néonatale. *Santé Publique*, **2**, 159-172.

[51] Ratovoarisoa, N.M., Randriamanantena, S.N.C., Raveloharimino, N.H. and Rabesandratana, H.N. (2020) Morbidité néonatale sur 10 ans dans un complexe mère enfant de Madagascar. *Revue Malgache de Pédiatrie*, **3**, 70-77.

[52] Ben Hamida Nouaili, E., Chaouachi, S., Ben Said, A. and Marrakchi, Z. (2010) Déterminants de la mortalité néonatale, dans une population tunisienne. *La Tunisie Médicale*, **88**, 42-45

[53] Lawn, J.E., Blencowe, H., Oza, S., You, D., Lee, A.C.C., Waiswa, P., Lalli, M., Bhutta, Z., Barros, A.J.D., Christian, P., Mathers, C. and Cousens, S.N. (2014) Every Newborn: Progress, Priorities, and Potential beyond Survival. *The Lancet*, **384**, 189-205. https://doi.org/10.1016/S0140-6736(14)60496-7

[54] Yenan, J.P., Plo, K.J. and Asse, K.V. (2014) Morbidité et mortalité néonatales au service de pédiatrie du CHU de Bouaké. *RAMUR*, **18**, 2-12.

[55] Aiken, L., Clarke, S., Sloane, D., *et al.* (2012) Patient Safety, Satisfaction, and Quality of Hospital Care: Cross Sectional Surveys of Nurses and Patients in 12 Countries in Europe and the United States. *British Medical Journal*, **344**, e1717. https://doi.org/10.1136/bmj.e1717

[56] Code la santé publique. Article D6124-61. https://www.legifrance.gouv.fr/

[57] Vrijheid, M., Dolk, H., Stone, D., *et al.* (2000) Socioeconomic Inequalities in Risk of Congenital Anomaly. *Archives of Disease in Childhood*, **82**, 349-352. https://doi.org/10.1136/adc.82.5.349

Estimating the impact on obstetric complication care: comparison between Met Need for Emergency Obstetric Care and Unmet Obstetric Need

POSTER PRESENTATIONS

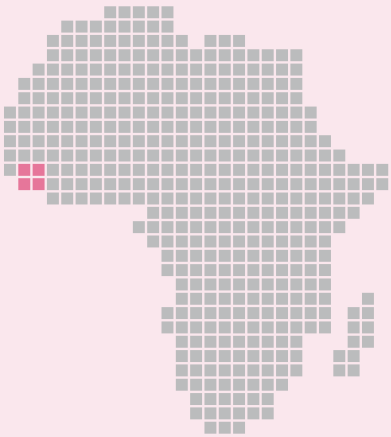
Conference
12th European Congress on Tropical Medicine and International Health (ECTMIH)

Location
Virtual from Bergen, Norway

Presentation date
28 September – 1 October 2021

Authors
Valente N.

Focus country
Sierra Leone



The 10 Group Classification System (TGCS) applied in a urban referral hospital in Sierra Leone: an observational study

POSTER PRESENTATIONS

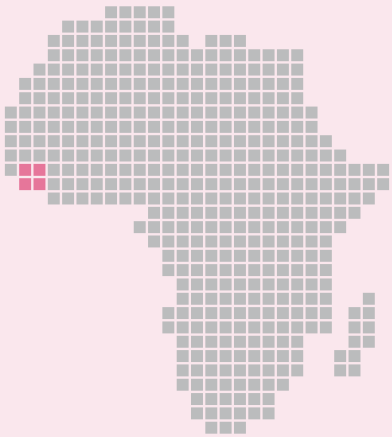
Conference
12th European Congress on Tropical Medicine and International Health (ECTMIH)

Location
Virtual from Bergen, Norway

Presentation date
28 September – 1 October 2021

Authors
Arata M.

Focus country
Sierra Leone



Chronic diseases

A survey on a rural in-hospital population diagnosed with Atrial Fibrillation in west Shewa region, Ethiopia

PAPER

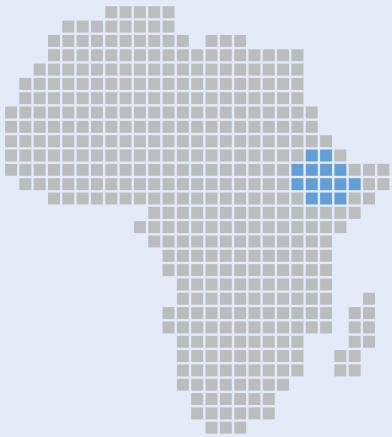
Authors
Bregani E. R., Valcarenghi C., Conti M.

Published in
Journal of Public Health,
June 2021

Link
10.1093/pubmed/fdz140

Topic
Chronic diseases

Focus country
Ethiopia



This paper is not available as open access, which is why only an abstract is posted.
If you would like to read the entire paper, please go to the web page given and follow the instructions.

An Integrated Management System for Noncommunicable Diseases Program Implementation in a Sub-Saharan Setting

PAPER

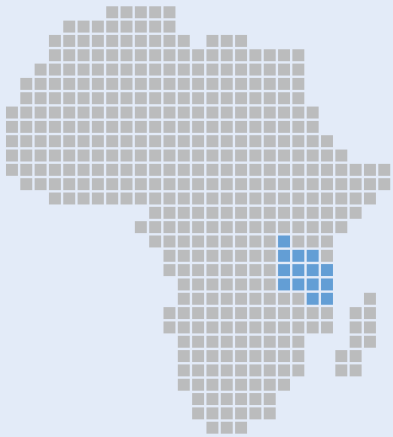
Authors
Miselli M.A., Cavallin F., Marwa S., Ndunguru B., Itambu R.J., Mutalemwa K., Rizzi M., Ciccarelli G., Conte S.,Taddei S., Azzimonti G., Putoto G., Torelli G.F.

Published in
International Journal of Environmental Research and Public Health, November 2021

Link
https://doi.org/10.3390/ijerph182111619

Topic
Chronic diseases

Focus country
Tanzania



International Journal of
Environmental Research and Public Health

MDPI

Article

An Integrated Management System for Noncommunicable Diseases Program Implementation in a Sub-Saharan Setting

Maria Agata Miselli [1,2], Francesco Cavallin [3], Samwel Marwa [4], Bruno Ndunguru [4], Rehema John Itambu [1,2], Katunzi Mutalemwa [1,2], Monica Rizzi [1,2], Giulia Ciccarelli [1,2], Simone Conte [1,2], Stefano Taddei [5], Gaetano Azzimonti [1,2], Giovanni Putoto [6] and Giovanni Fernando Torelli [7,8,*]

1 Doctors with Africa CUAMM, Tosamaganga, Iringa P.O. Box 11, Tanzania; a.miselli@cuamm.org (M.A.M.); r.itambu@cuamm.org (R.J.I.); mutalemwa6@gmail.com (K.M.); monica.rizzi2@aovr.veneto.it (M.R.); cuamm@cuamm.org (G.C.); simone.conte@aovr.veneto.it (S.C.); g.azzimonti@cuamm.org (G.A.)
2 Department of Medicine, Tosamaganga District Designated Hospital, Tosamaganga, Iringa P.O. Box 11, Tanzania
3 Independent Statistician, 36020 Solagna, Italy; cescocava@libero.it
4 District Medical Office, Iringa District Council, Iringa P.O. Box 162, Tanzania; ded@iringadc.go.tz (S.M.); brnndunguru@gmail.com (B.N.)
5 Department of Internal Medicine, University of Pisa, 56122 Pisa, Italy; stefano.taddei@med.unipi.it
6 Doctors with Africa CUAMM, 35121 Padua, Italy; g.putoto@cuamm.org
7 Doctors with Africa CUAMM, Dar es Salaam P.O. Box 23447, Tanzania
8 Department of Hematology, Oncology and Dermatology, Policlinico Umberto 1, 00161 Rome, Italy
* Correspondence: g.torelli@cuamm.org

check for updates

Citation: Miselli, M.A.; Cavallin, F.; Marwa, S.; Ndunguru, B.; Itambu, R.J.; Mutalemwa, K.; Rizzi, M.; Ciccarelli, G.; Conte, S.; Taddei, S.; et al. An Integrated Management System for Noncommunicable Diseases Program Implementation in a Sub-Saharan Setting. *Int. J. Environ. Res. Public Health* **2021**, *18*, 11619. https://doi.org/10.3390/ijerph182111619

Academic Editors: Shinichi Tokuno and Paul B. Tchounwou

Received: 4 August 2021
Accepted: 30 October 2021
Published: 4 November 2021

Publisher's Note: MDPI stays neutral with regard to jurisdictional claims in published maps and institutional affiliations.

Copyright: © 2021 by the authors. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (https://creativecommons.org/licenses/by/4.0/).

Abstract: Morbidity and mortality due to noncommunicable diseases (NCDs) are growing exponentially across Tanzania. The limited availability of dedicated services and the disparity between rural and urban areas represent key factors for the increased burden of NCDs in the country. From March 2019, an integrated management system was started in the Iringa District Council. The system implements an integrated management of hypertension and diabetes between the hospital and the peripheral health centers and introduces the use of paper-based treatment cards. The aim of the study was to present the results of the first 6 months' roll-out of the system, which included 542 patients. Data showed that 46.1% of patients returned for the reassessment visit (±1 month), more than 98.4% of patients had blood pressure measured and were checked for complication, more than 88.6% of patients had blood sugar tested during follow-up visit, and blood pressure was at target in 42.8% of patients with hypertension and blood sugar in 37.3% of diabetic patients. Most patients who were lost to follow-up or did not reach the targets were those without medical insurance or living in remote peripheries. Our findings suggest that integrated management systems connecting primary health facilities and referral hospitals may be useful in care and follow-up of patients with hypertension and diabetes.

Keywords: Sub-Saharan Africa; noncommunicable diseases; hypertension; diabetes

1. Introduction

Noncommunicable diseases (NCDs) represent a group of chronic conditions, including cardiovascular diseases, cancer, chronic respiratory diseases, and diabetes, which account for 71% of all deaths worldwide, equivalent to 41 million people each year [1,2]. A large proportion of these deaths occur in low- and middle-income countries (LMICs), where about 700 million people still experience extreme levels of poverty [2,3]. The link between illness and poverty is well documented, as it is the role played by NCDs and injuries (NCDIs) in the suffering and death of the poorest populations [4–6].

In Tanzania, the burden of NCDIs has doubled in the past 25 years and accounts for 41% of all disability-adjusted life years (DALYs) [7]. While 80% of the global NCDIs burden

Int. J. Environ. Res. Public Health **2021**, *18*, 11619

is generally associated with lifestyle components (smoking habits, alcohol abuse, sedentary lifestyle, poor diet), the majority of NCDIs DALYs occurring in Tanzania cannot be explained by behavioral or metabolic risk factors [7,8]. The lack of treatment of conditions leading to chronic diseases, the linkage between infectious diseases and NCDs, and the limited availability of NCDIs services (which are mainly concentrated in hospitals and urban settings) may play crucial roles in this setting [9–12]. The Tanzania NCDI Poverty Commission reached the conclusion that the response to NCDIs among the poorest should consider socioeconomic indices, address material poverty, integrate models of health service delivery strategy that connect rural and urban areas, and complement the existing agenda focused on the prevention of emerging behavioral risk factors [13–16].

Similar to other sub-Saharan countries, hypertension is the most common NCD in Tanzania and impacts approximately 25% of the adult population [7,17–20], representing the leading cause of death after HIV and the leading cause of death due to NCDs [7,21]. Diagnosed individuals often are neither in blood pressure treatment nor seeking for care, and people living in rural areas are more likely to be unaware of their hypertension and therefore are less likely to be on treatment [7]. A major role is also played by diabetes, with a prevalence of 9% among adults 25–64 years old [7,15], and very high incidence of complications [22,23]. The STEPs survey of the World Health Organization (WHO) performed in 2012 revealed that three-quarters of participants with hypertension or diabetes were never previously diagnosed, and less than half of those with a previous diagnosis were receiving treatment [7,17]. Of note, individuals in the lower wealth quintile, those less educated, and those from rural areas were less likely to have prior blood glucose or blood pressure tested. Moreover, it is well known that treatment adherence and clinical follow-up play a crucial role in the management of NCDs, but health systems in many sub-Saharan countries have limited capacity of long-term continuous management of such patients [7].

Since 2016, Doctors with Africa CUAMM [24], in partnership with local authorities, has been running a dedicated clinical program at Tosamaganga District Designated Hospital (DDH), Iringa District Council (DC), Iringa Region. As the health system could not regularly engage patients for follow-up, there was the need to implement a new management system based on the systematic link between the hospital and the peripheral health units of the district. The experience conducted in Tanzania in HIV care [25], as well as old [26] and newly [27] released WHO packages for NCDs care implementation, represents key models of inspiration.

In March 2019, an integrated management system of hypertension and diabetes has started in collaboration with the local authorities of Iringa DC and Tosamaganga DDH. The purpose of this study was to present the results of the first 6 months' roll-out of the system.

2. Materials and Methods

2.1. Study Design

This prospective cohort study presents the results of the first 6 months' roll-out of an integrated management system for patients with hypertension and/or diabetes in Iringa DC (Tanzania). All patients who were enrolled in the new model between March and September 2019 were included in the study. Data on follow-up were retrieved in June 2020. The study was approved by the National Institute for Medical Research (NIMR/HQ/R.8a/Vol. IX/3294). The study was conducted in accordance with the principles of the Declaration of Helsinki, and all participants gave their written informed consent to have their anonymized data used for scientific purpose.

2.2. Setting

According to the World Health Organization (WHO), diabetes and hypertension affect a large proportion of Tanzanian adults; adult population includes 14% of tobacco users, 9% alcohol abusers, and 7% obese [18].

Iringa DC is located in a rural area 500 km southwest of Dar es Salaam, has a population of about 358,000 inhabitants, distributed in a surface area of 20,414 km^2, and the health

care system includes a District Hospital (Tosamaganga DDH), 10 health centers (HCs), and 67 dispensaries. The Tanzanian health system has a hierarchical and decentralized structure [28]. Each district has a designated hospital (primary level) which is the referral hospital for health centers and dispensaries within the district. District hospitals refer to a regional hospital (secondary level), and all regional hospitals to zonal and national hospitals (tertiary level). Administrative data include 336 hospitals, 907 health centers, and 7247 dispensaries, distributed in 26 regions for a population of more than 56 million inhabitants. Since October 2016, Doctors with Africa CUAMM and the Iringa DC have set up an outpatient service exclusively dedicated to patients suffering from NCDs at the outpatient department (OPD) of Tosamaganga DDH. People attending the NCDs clinic arrive from all over Iringa DC, coming from 134 different villages, and are referred from all 10 HCs of the district.

2.3. Participants

Eligible subjects were adults (age $\geq$ 18 years) with hypertension and/or diabetes who were followed-up at Tosamaganga DDH and in all 10 district HCs. Patients with both new and known diagnosis of hypertension and/or diabetes were invited to attend the Tosamaganga DDH NCDs clinic for the registration visit. Patients with all types of diabetes were included in the study. Pregnant women were excluded.

2.4. The Integrated Management System

The implementation of an integrated management system of hypertension and diabetes (Figure 1) was started at the beginning of March 2019, after the finalization of the Protocol of Cooperation Agreement among Iringa DC, Tosamaganga DDH, and Doctors with Africa CUAMM. The Protocol of Cooperation Agreement was conceived to reinforce and improve the health system of Iringa DC; in particular, regarding the prevention and treatment of NCDs at hospital and HC levels, with the purpose of warranting access, quality, and equitable health care for the population of the district.

Before the implementation, blood pressure and blood sugar were measured randomly (according to patient's request or health care staff decision, equipment availability, and patient's willingness to cover the costs) and follow-up was not systematically offered. In addition, patients were referred from HCs to the hospital, without any back-referral or information feedback to HCs.

The integrated system included the creation of pathways for patients and the implementation of the use of paper-based treatment cards (TCs) (Figure 2). Each patient (with either a new diagnosis or a previous diagnosis) underwent the initial assessment at Tosamaganga DDH, and all enrolled patients were supplied with personal TCs. Monthly follow-up visits were conducted at the hospital or the HCs, where clinical records and treatment information were regularly recorded in the TCs. The patient returned to the hospital for a reassessment visit every six months ($\pm$1 month). The reassessment visit was set at 6 months after registration because such a time span would have provided useful feedback on the roll-out of the integrated system with a reasonable frequency for the patient (monthly visit at the closest health center and travel to the referral hospital only twice a year). This cut-off time was inspired by the WHO dedicated package [27]. The implementation is fully described in Supplementary Table S1.

Screening and diagnosis of hypertension and diabetes were conducted according to national guidelines [29]. Lifestyle counselling and pharmacological treatment, as well as criteria for referral to higher level of care during follow-up, were provided according to national NCDs guidelines [30]. TC and treatment targets were directly inspired by WHO HEARTS technical package [27].

Int. J. Environ. Res. Public Health **2021**, *18*, 11619

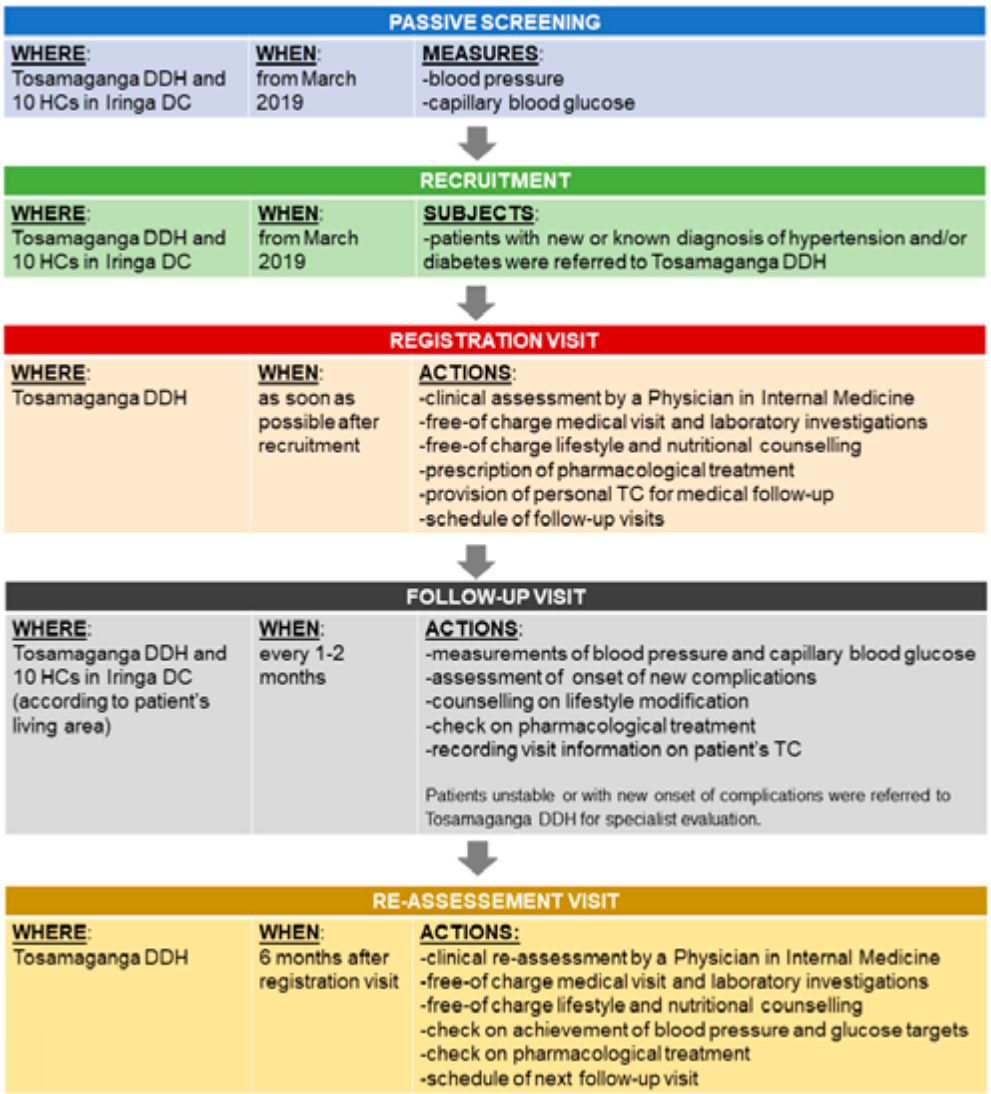


Figure 1. Scheme of the integrated management system (full description in Supplementary Table S1).

Patients' registration and enrolment started on 18 March 2019, and the system is currently ongoing.

2.5. Outcome Measures

The outcome measures included (i) adherence to reassessment visit (±1 month) at Tosamaganga DDH, (ii) patient attendance and quality of data collection during follow-up visits, (iii) achievement of treatment target at reassessment visit (±1 month), and (iv) occurrence of complications (stroke, diabetic foot, vision impairment, heart failure, and heart ischemia) during follow-up.

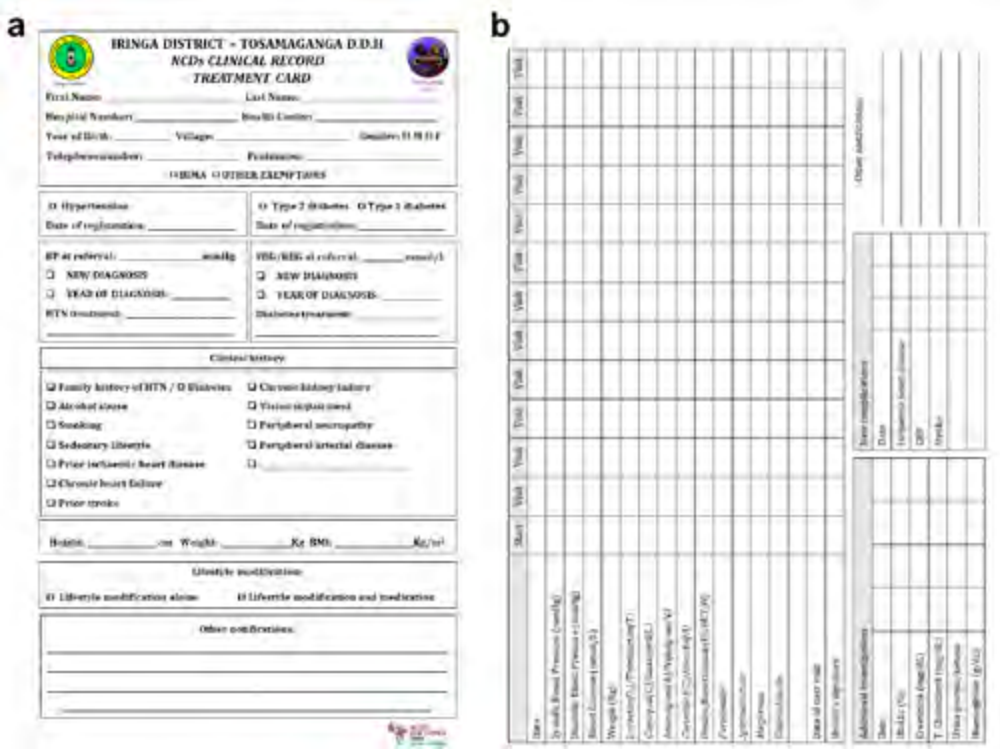


Figure 2. Template of the paper-based treatment cards. (**a**) Front of treatment card. (**b**) Back of treatment card.

2.6. Data Collection

The records of patients who were enrolled between 18 March 2019 and 18 September 2019 were used for this study. Data were retrieved from medical records noted on patients' TCs and entered in an anonymized database for the analysis. The health care staff on duty was responsible for data collection on patients' TC, which was checked by the medical doctor before data entry in the study database. Available data included demographics, and information from registration visit, follow-up visits, and reassessment visit. Data on follow-up were retrieved on 18 June 2020, to ensure an adequate follow-up for patients included in the study.

2.7. Statistical Analysis

Data were summarized as median and interquartile range (continuous data) or frequency and percentage (categorical data). Categorical data were compared between groups using chi square test or Fisher's exact test, while continuous data were compared using Mann–Whitney test or Kruskal–Wallis test. Correlation between continuous data was assessed using Spearman rank correlation coefficient. The change (from baseline to the six-month reassessment visit (±1 month)) in the proportion of hypertensive patients with target blood pressure and of diabetic patients with target fasting blood glucose was evaluated using McNemar test. All tests were two-sided, and a p-value less than 0.05 was considered statistically significant. Statistical analysis was performed using R 4.0 (R Foundation for Statistical Computing, Vienna, Austria) [31].

3. Results

3.1. Patients

The study included 542 patients (134 males and 408 females; median age 61 years) who were enrolled between March and September 2019. Patient characteristics are shown in Table 1.

Table 1. Characteristics of 542 patients who were enrolled between March and September 2019.

Variable	All Patients	Hypertensive Patients	Diabetic Patients	Hypertensive and Diabetic Patients
No. of subjects	542	403	67	72
Age, years [a,b]	61 (53–69)	62 (55–70)	52 (44–60)	61 (54–65)
Males:females	134:408	92:311	21:46	21:51
Personal insurance holders [b]	190 (35.1)	129 (32.1)	27 (40.3)	34 (47.2)
Referred from district health centers [b]	312 (57.7)	249 (61.9)	37 (55.2)	26 (36.1)
Job:				
Peasant	312 (57.6)	253 (62.8)	29 (43.3)	30 (41.7)
Employed	70 (12.9)	39 (9.7)	15 (22.4)	16 (22.2)
Unemployed [c]	16 (3.0)	7 (1.7)	6 (9.0)	3 (4.2)
Retired	100 (18.4)	77 (19.1)	9 (13.4)	14 (19.4)
Other/no response	44 (8.1)	27 (6.7)	8 (11.9)	9 (12.5)
Family history of hypertension [b]	159 (29.4)	125 (31.0)	15 (22.7)	19 (26.4)
Family history of diabetes	67 (12.4)	30 (7.4)	17 (25.4)	20 (27.8)
Regular daily alcohol consumption	177 (32.7)	144 (35.7)	15 (22.4)	18 (25.0)
Regular daily smoking habits	26 (4.8)	22 (5.4)	2 (3.0)	2 (2.8)
Sedentary lifestyle (>5 h spent seated daily)	140 (25.8)	100 (24.8)	20 (29.9)	20 (27.8)
Prior heart attack	7 (1.3)	7 (1.7)	0 (0.0)	0 (0.0)
Chronic heart failure	59 (10.9)	53 (13.1)	0 (0.0)	6 (8.3)
Prior stroke	38 (7.0)	28 (6.9)	2 (3.0)	8 (11.1)
Vision impairment	25 (4.6)	12 (3.0)	7 (10.4)	6 (8.3)
Diabetic foot	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)

Data expressed as no. (%) or [a] median (IQR). Data not available in [b] 1 patient. [c] Including students and housewives.

Hypertension was found in 475 patients (Figure 3A): 132 of them (27.8%) were new diagnoses, 304 (64.0%) were already in treatment for hypertension, and 39 (8.2%) had already a diagnosis of hypertension but were not receiving any treatment. Blood pressure (BP) was within the target range (systolic BP < 140 mmHg and diastolic BP < 90 mmHg) in 88/335 patients with previous hypertension diagnosis (26.3%).

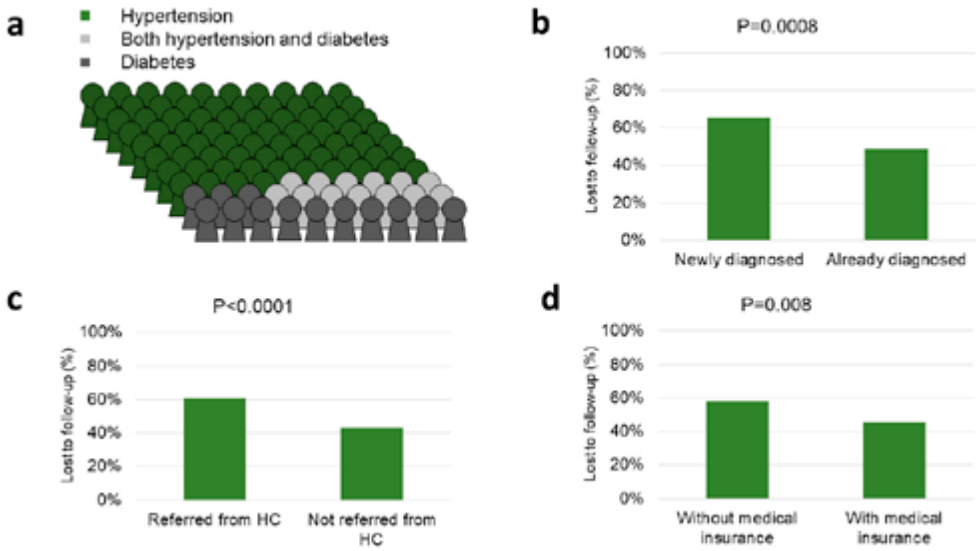


Figure 3. Diagnosis in 542 patients who were enrolled between March and September 2019 (**a**); lost to follow-up was more frequent in newly diagnosed patients (**b**); lost to follow-up was more frequent in patients referred from district health centers (**c**); lost to follow-up was more frequent in patients without medical insurance (**d**).

Diabetes was found in 139 patients (Figure 3A): 33 of them (23.7%) were new diagnoses, 94 (67.6%) were already in treatment for diabetes, and 12 (8.6%) had already a diagnosis of diabetes but were not receiving any treatment. Fasting blood glucose was (<7 mmol/L) in 30/106 patient with previous diabetes diagnosis (28.3%).

3.2. Adherence to Follow-Up

At the time of the analysis, 250 patients (46.1%) returned for follow-up visits, while three patients (0.6%) died, and 289 patients (53.3%) were lost to follow-up (i.e., never returned for follow-up visits). Loss to follow-up was 54.1% among hypertensive patients (218/403), 59.7% among diabetic patients (40/67), and 43.1% among patients with hypertension and diabetes (31/82). Median number of visits was five (IQR 4–6) in patients who returned for reassessment visit (±1 month) at Tosamaganga DDH after six months.

Loss to follow-up was more frequent in newly diagnosed patients (95/145, 65.5% vs. 194/397, 48.9%, $p = 0.0008$; Figure 3B), patients referred from health centers (189/312, 60.6% vs. 99/229, 43.2%, $p < 0.0001$; Figure 3C), and in those without medical insurance (202/351, 57.5% vs. 86/190, 45.3%, $p = 0.008$; Figure 3D). Of note, new diagnoses were more frequent among patients referred from health centers (107/312, 34.3% vs. 37/229, 16.1%; $p < 0.0001$). Loss to follow-up visits was not associated with diagnosis ($p = 0.12$), age ($p = 0.92$), sex ($p = 0.11$), family history of hypertension ($p = 0.69$), or family history of diabetes ($p = 0.84$) (Supplementary Table S2).

In patients who returned for follow-up reassessment visit (±1 month) at Tosamaganga DDH, the number of visits was not associated with diagnosis ($p = 0.41$), being referred from health centers ($p = 0.39$), medical insurance ($p = 0.83$), age ($p = 0.80$), sex ($p = 0.29$), family history of hypertension ($p = 0.60$), or family history of diabetes ($p = 0.65$) (Supplementary Table S3).

3.3. Data Collection during Follow-Up Visits

During follow-up visits #1 to #7, patient attendance ranged between 149 and 188 patients (Supplementary Table S4). Almost all patients had their BP measured (98.9–100%) and were

checked for complications (98.4–100%), while FBG was measured in 88.6–95.8% of diabetic patients (Figure 4).

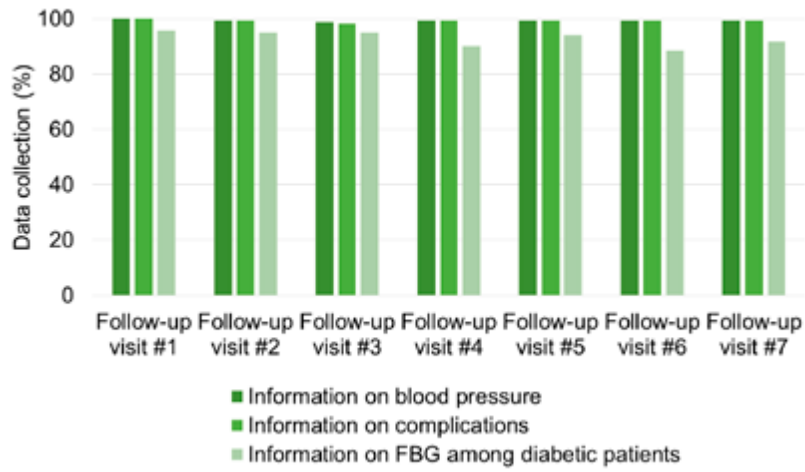


Figure 4. Data collection during follow-up visits.

4. Achievement of Treatment Target after Six Months of Follow-Up

Reassessment visit (±1 month) at Tosamaganga DDH was attended by 231 patients (42.6%). Target BP (systolic BP < 140 mmHg and diastolic BP < 90 mmHg) was achieved in 89/208 hypertensive patients (42.8%), with an increase of the proportion of those achieving target BP from 53/202 (25.5%) at baseline to 87/202 (41.8%) at reassessment visit (±1 month) ($p = 0.0001$) (Figure 5A). Achieving target BP was more frequent in patients with medical insurance (46/84, 54.8% vs. 43/124, 34.7%, $p = 0.006$; Figure 5C) or younger age (median 60 vs. 63 years, $p = 0.03$; Figure 5D), while it was not associated with new diagnosis ($p = 0.61$), being referred from health centers ($p = 0.07$), sex ($p = 0.95$), or family history of hypertension ($p = 0.15$) (Supplementary Table S5).

Target FBG (FBG < 7 mmol/L) was achieved in 22/59 diabetic patients (37.3%), without statistically significant change in the proportion of those target FBG from baseline (19/57, 33.3%) to reassessment visit (22/57, 38.6%) ($p = 0.68$) (Figure 5B). Achieving target FBG was not associated with new diagnosis ($p = 0.51$), being referred from health centers ($p = 0.32$), medical insurance ($p = 0.76$), age ($p = 0.17$), sex ($p = 0.35$), or family history of diabetes ($p = 0.99$) (Supplementary Table S6).

Complications during Follow-Up

During the first six months of follow-up, stroke occurred in two patients, diabetic foot in four patients, vision impairment in two patients, heart failure in five patients, and heart ischemia in none. Further description of these patients is reported in Supplementary Table S7.

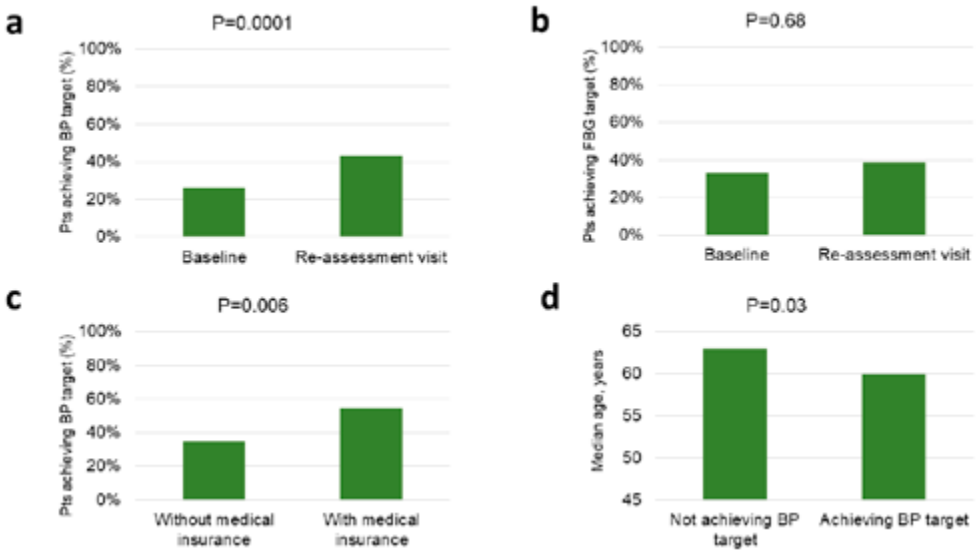


Figure 5. Patients with hypertension achieving blood pressure target at baseline and reassessment visit (±1 month) (**a**); patients with diabetes achieving fasting blood glucose target at baseline and reassessment visit (±1 month) (**b**); association between achieving blood pressure target at reassessment visit (±1 month) and medical insurance (**c**); association between achieving blood pressure target at reassessment visit (±1 month) and age (**d**).

5. Discussion

The current study aimed to present the results of the first 6 months' roll-out of an integrated management system of hypertension and diabetes in Tanzania, based on the use of paper-based treatment cards belonging to the patient, the tight connection between primary health facilities and referral hospitals, and the ownership of the program to local authorities (district/regional medical officers).

The study confirmed that in Tanzania, many patients affected by hypertension and diabetes do not receive any treatment and only about one fourth of those actually in treatment reach the target [17,32]. During the first six months of enrolment, approximately five new cases of hypertension and one new case of diabetes were registered each week. This represents a consistent number of chronic patients to deal with for the type of health services actually present in rural areas of Tanzania.

Participant characteristics were typical of rural areas, with 57.6% peasants and the rest mainly retired. The old age of the study group is not surprising as chronic diseases are common in adults, although it appears quite high, taking into consideration that life expectancy in Tanzania is 64 years [33]. Finally, we believe that the higher female presence in the program could probably reflect the higher attendance of health facilities by the female population.

A large group of patients enrolled in the study were lost to follow-up (53.3%); the majority of them were those without medical insurance or who were referred from health centers, suggesting that poverty and distance were the most relevant contributing factors preventing patients to return to the hospital. Of note, loss to follow-up was also more common in newly diagnosed patients, which were more frequently referred from health centers. While no data are available in the literature concerning attendance and follow-up visit for NCDs in Tanzania, we believe that this issue is probably one of the most relevant in the management and care of chronic diseases. In light of the specific setting of our intervention, it is noteworthy that almost half of the patients returned for the reassessment

visit (±1 month) during follow-up; additionally, patients not returning to the District Hospital for the reassessment visit ±1 month may be still receiving the necessary care and treatment at their health center of origin, confirming the importance of decentralizing the health program in the context of chronic care in order to reduce distance and improve accessibility to health care.

Health insurance coverage is still low in Tanzania; as of 2019, only 32% of Tanzanians had health insurance coverage, of which 8% have subscribed to National Health Insurance Fund (NHIF), 23% are members of Community Health Fund, and 1% are members of private health insurance companies [34]. Low insurance coverage leads to overreliance on direct payment, which is among the fundamental problems that restrain the move towards universal health coverage in many developing countries [35]. Direct payment leads to high levels of inequity, in most cases denying the poorest to access the needed health care [36]. The NHIF was established in 1999 and a steady increase in coverage, from 2% of the total population in 2001 to 8% in 2019, has been observed [34]; nevertheless, the study results underline the need to continue reforming the health care system and improve health insurance coverage with the intention of increasing universal access to health services to the poor and those living in marginalized rural areas.

For those patients that had successfully performed reassessment (±1 month), general satisfactory implementation of the system was observed, especially concerning attendance to follow-up visits and correct documentation on treatment cards. In fact, the mean number of visits per patient in the 6-month period was five, and almost all patients had their blood pressure measured (98.9–100%) during follow-up visits, while fasting blood glucose was measured in 88.6–95.8% of diabetic patients. This difference was probably due to glucose test strips availability. The high percentage of patients who had blood pressure and fasting blood sugar measured and were checked for complications during follow-up visit (including those performed at health centers), indicates that the availability of simple instruments, the tight connection between central hospital and peripheral health facilities, and the provision of adequate training can improve the management of NCDs in Tanzania.

At last, when evaluating the clinical outcomes through the achievement of guidelines targets for hypertension and diabetes, it became evident that only a minority of patients enrolled in the study succeeded to achieve the targets after six months of follow-up. This is a well-known challenge which is already documented in other studies; in the 2012 Tanzania STEPS Survey, for example, only 42.4% of patients treated for hypertension had systolic blood pressure <140 mmHg and diastolic blood pressure <90 mmHg [15], while in other studies, the percentage of patients at target was significantly lower [32]. When exploring the potential contributors to the achievement of these goals, once again it was shown that health insurance holders, together with younger patients, were more likely to satisfy clinical targets for hypertension. Moreover, the provenance from health centers seemed to play a negative role on clinical target achievement, probably due to drugs availability at the peripheral level that was still uncertain and limited to few drugs categories. From baseline to reassessment visit (±1 month), the proportion of hypertensive patients who achieved target blood pressure increased significantly, while a small nonsignificant increment was observed in the proportion of diabetic patients who achieved target fasting blood glucose. Nevertheless, the management of patients with diabetes is still challenging due to the great economic burden and the need for an acceptable level of education to self-manage insulin therapy.

Finally, we observed very low prevalence of complications during follow-up, though the short period of observation suggests caution and a need for long-term assessment. However, the integrated system favored the connection between the hospital and the health centers, and patients with new onset of complications were promptly referred to Tosamaganga DDH for specialist evaluation.

This study has some limitations that should be considered by the reader. First, the limited duration of the follow-up in the study (6 months) suggests caution in the interpretation of the adherence to follow-up and the occurrence of complications. However,

the six-monthly control was suggested by the WHO HEARTS technical package (hypertensive subjects) [27] and the Tanzanian Desk Guide (diabetic subjects) [30]. In addition, information on the reasons for loss to follow-up was not available but would have been useful to plan adequate actions for improving follow-up adherence. Second, the generalizability of the findings should be restricted to similar settings. Third, the study would have benefited from the comparison of pre- and post-implementation periods to emphasize the importance of the change. Unfortunately, previous data were not available because systematic data collection was not performed before program implementation. Future developments of the integrated system will include the contacting of patients skipping follow-up visits (to remind them of scheduled visits, to understand the reasons for unattendance, and to plan adequate actions for improving the follow-up adherence) and the systematic check on medication adherence and pharmacovigilance during follow-up visits. Of note, the implementation of an electronic database system linking the referral hospital and the health centers would notably improve the management of NCD patients living in remote areas. In addition, an update of the study over a longer time span is warranted to provide more reliable data on follow-up and complications, and to assess the effect of further developments.

6. Conclusions

These results confirm that gaps in the control of noncommunicable diseases are still large in Tanzania. Nevertheless, the analysis performed on this integrated management system suggests that health system interventions are possible and should be properly designed, taking into consideration socioeconomic indicators and proposed models of health delivery strategy owned by local authorities tightly connecting primary health facilities and referral hospitals. Should these positive results be confirmed after long-term assessment, similar programs might be taken into consideration for implementation on a larger scale in Tanzania.

Supplementary Materials: The following are available online at https://www.mdpi.com/article/10.3390/ijerph182111619/s1, Table S1: Scheme of model implementation, Table S2: Factors associated with lost to follow-up (i.e., not returning for re-assessment visit at Tosamaganga DDH), Table S3: Factors associated with number of visits among patients who returned for follow-up, Table S4: Data collection during follow-up visits, Table S5: Factors associated with achieving target blood pressure in hypertensive patients, Table S6: Factors associated with achieving target Fasting Blood Glucose in diabetic patients, Table S7: Characteristics of patients who experience a complication during the first six-months of follow-up.

Author Contributions: All authors contributed to the study conception and design, to the acquisition, analysis, or interpretation of data, have drafted the work or substantively revised it, and have approved the submitted version. The individual contribution of the authors is described as follows: conceptualization: M.A.M., S.M., S.T., G.P. and G.F.T.; methodology: M.A.M., F.C., G.P. and G.F.T.; formal analysis and data curation: M.A.M. and F.C.; investigation: M.A.M., B.N., R.J.I., K.M., M.R., G.C. and S.C.; writing—original draft preparation: M.A.M., F.C. and G.F.T.; writing—review and editing: M.A.M., F.C., S.T., G.A., G.P. and G.F.T.; supervision: M.A.M., F.C. and G.F.T. All authors have read and agreed to the published version of the manuscript.

Funding: The authors received no specific funding for this work.

Institutional Review Board Statement: The study was approved by the National Institute for Medical Research (NIMR/HQ/R.8a/Vol. IX/3294).

Informed Consent Statement: The study was conducted in accordance with the principles of the Declaration of Helsinki, and all participants gave their written informed consent to have their anonymized data used for scientific purpose.

Data Availability Statement: All data are fully available without restriction. All relevant data are within the manuscript and its Supporting Information files.

Conflicts of Interest: The authors declare no conflict of interest.

References

1. WHO. *Global Action Plan for the Prevention and Control of NCDs 2013-2020*; WHO: Geneva, Switzerland, 2013.
2. WHO. *Noncommunicable Diseases*; WHO: Geneva, Switzerland, 2018.
3. The World Bank. *Poverty*; The World Bank: Washington, DC, USA, 2020.
4. *The 17 Sustainable Development Goals*; The United Nations: New York, NY, USA, 2015. Available online: Sdgs.un.org/goals (accessed on 4 August 2021).
5. Bukhman, G.; Mocumbi, A.O.; Horton, R. Reframing NCDs and injuries for the poorest billion: A Lancet Commission. *Lancet* **2015**, *386*, 1221–1222. [CrossRef]
6. Bukhman, G.; Mocumbi, A.O.; Atun, R.; Becker, A.E.; Bhutta, Z.; Binagwaho, A. The Lancet NCDI Poverty Commission: Bridging a gap in universal health coverage for the poorest billion. *Lancet* **2020**, *396*, 991–1044. [CrossRef]
7. The Tanzania NCDI Poverty Commission. Tanzania non-Communicable Diseases and Injuries Poverty Commission: Findings and Recommendations. August 2020. Available online: https://www.ncdipoverty.org/national-commission-reports (accessed on 4 August 2021).
8. Institute for Health Metrics and Evaluation (IHME). *Findings from the Global Burden of Disease Study 2017*; IHME: Seattle, WA, USA, 2018.
9. *Tanzania Service Provision Assessment Survey 2014–2015*; Ministry of Health and Social Welfare: Dar es Salaam, Tanzania, 2014.
10. The DHS Program—Tanzania: Standard DHS. Available online: http://dhsprogram.com/what-we-do/survey2015-16 (accessed on 4 August 2021).
11. Bintabara, D.; Mpondo, B.C.T. Preparedness of lower-level health facilities and the associated factors for the outpatient primary care of hypertension: Evidence from Tanzanian National survey. *PLoS ONE* **2018**, *12*, e0192942. [CrossRef] [PubMed]
12. Peck, R.; Mghamba, J.; Vanobberghen, F.; Kavishe, B.; Rugarabamu, V.; Smeeth, L. Preparedness of Tanzania Health Facilities for outpatient primary care of hypertension and diabetes: A cross sectional survey. *Lancet Glob. Health* **2014**, *2*, 285–292. [CrossRef]
13. WHO. *Making Fair Choices on the Path to Universal Health Coverage*; WHO: Geneva, Switzerland. Available online: http://www.who.int/choice/documents (accessed on 4 August 2021).
14. Watkins, D.; Qi, J.; Horton, S. Costing Universal Health Coverage: The DCP3 Model | DCP3. Available online: http://dcp-3.org/resources/costs-and-affordability-essential-universalhealth-coverage-low-and-middle-income (accessed on 4 August 2021).
15. *Tanzania Health Sector Strategic Plan 2015-2020 (HSSP IV)*; Ministry of Health and Social Welfare: Dar es Salaam, Tanzania, 2015.
16. *Strategic and Action Plan for the Prevention and Control of Non Communicable Diseases in Tanzania 2016–2020*; Ministry of Health, Community Development, Gender, Elderly and Children: Dar es Salaam, Tanzania, 2016.
17. *Tanzania STEPs Survey Report 2012*; Ministry of Health and Social Welfare: Dar es Salaam, Tanzania, 2012.
18. WHO. *Noncommunicable Diseases (NCDs) Country Profile United Republic of Tanzania*; WHO: Geneva, Switzerland, 2018.
19. Edward, A.; Hoffmann, L.; Manase, F.; Matsushita, K.; Pariyo, G.W.; Brady, T.M. An exploratory study on the quality of patient screening and counseling for hypertension management in Tanzania. *PLoS ONE* **2020**, *15*, e0227439. [CrossRef] [PubMed]
20. NCD Risk Factor Collaboration (NCD-RisC). Worldwide trends in blood pressure from 1975 to 2015: A pooled analysis of 1479 population-based measurement studies with 19.1 million participants. *Lancet* **2017**, *389*, 37–55. [CrossRef]
21. Peck, R.N.; Green, E.; Mtabaji, J.; Majinge, C.; Smart, L.R.; Downs, J.A. Hypertension-related diseases as a common cause of hospital mortality in Tanzania: A 3-year prospective study. *J. Hypertens.* **2013**, *31*, 1806–1811. [CrossRef]
22. Cleland, C.R.; Burton, M.J.; Hall, C.; Hall, A.; Courtright, P.; Makupa, W.U.; Philippin, H. Diabetic retinopathy in Tanzania: Prevalence and risk factors at entry into a regional screening programme. *Trop. Med. Int. Health* **2016**, *21*, 417–426. [CrossRef]
23. Abbas, Z.G.; Lutale, J.K.; Bakker, K.; Baker, N.; Archibald, L.K. The "Step by Step" Diabetic Foot projectin Tanzania: A model for improving patient outcomes in less-developed countries. *Int. Wound J.* **2011**, *8*, 169–175. [CrossRef] [PubMed]
24. Doctors with Africa CUAMM. Available online: www.doctorswithafrica.org (accessed on 4 August 2021).
25. *Impementation of HIV/AIDS Care and Treatment Services in Tanzania*; Ministry of Health, Community Development, Gender, Elderly and Children: Dar es Salaam, Tanzania, 2016.
26. WHO. *Package of Essential Noncommunicable (PEN) Disease Interventions for Primary Health Care in Low-Resource Settings*; WHO: Geneva, Switzerland, 2010.
27. WHO. *HEARTS Technical Package for Cardiovascular Diseases Managment in Primary Health Care*; WHO: Geneva, Switzerland, 2018.
28. Global Health Workforce Alliance. Tanzania annex 5. Available online: https://www.who.int/workforcealliance/knowledge/resources/MLHWCountryCaseStudies_annex5_Tanzania.pdf (accessed on 4 August 2021).
29. *Standard Treatment Guidelines and National Essential Medicines List Tanzania Mainland*; Ministry of Health, Community Development, Gender, Elderly and Children: Dar es Salaam, Tanzania, 2017.
30. *Cardiovascular Disease, Type 2 diabetes, Cancer and COPD in Adults, Case Management Desk Guide*; Ministry of Health, Community Development, Gender, Elderly and Children: Dar es Salaam, Tanzania, 2013.
31. R Core Team. *R: A Language and Environment for Statistical Computing*; R Foundation for Statistical Computing: Vienna, Austria, 2020; Available online: https://www.R-project.org/ (accessed on 4 August 2021).
32. Mills, K.T.; Bundy, J.D.; Kelly, T.N.; Reed, J.E.; Kearney, P.M.; Reynolds, K. Global disparities of hypertension prevalence and control: A systematic analysis of population-based studies from 90 countries. *Circulation* **2016**, *134*, 441–450. [CrossRef]
33. The World Bank Data. Life Expectancy at Birth, Total (Years), Tanzania. Available online: https://data.worldbank.org/indicator/SP.DYN.LE00.IN?locations=TZ (accessed on 4 August 2021).

34. Odunga, M. Tanzania: NHIF to Roll Out New Insurance Packages. 2019. Available online: Allafrica.com (accessed on 4 August 2021).
35. WHO. *Health Systems Financing: The Path to Universal Coverage*; WHO: Geneva, Switzerland, 2010.
36. Mtei, G.; Makawia, S.; Ally, M.; Kuwawenaruwa, A.; Meheus, F.; Borghi, J. Who pays and who benefits from health care? An assessment of equity in health care financing and benefit distribution in Tanzania. *Health Policy Plan.* **2012**, *27* (Suppl. S1), i23–i34. [CrossRef] [PubMed]

Universal coverage and equity

Financial protection and coping strategies in rural Uganda: an impact evaluation of community-based zero-interest healthcare loans

PAPER

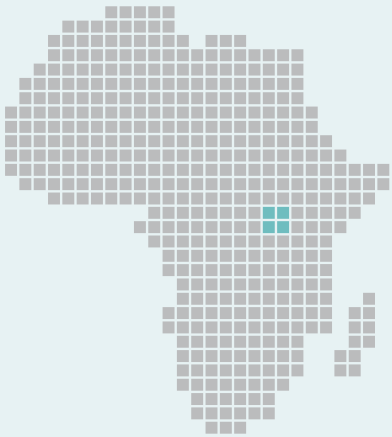
Authors
Nannini M., Biggeri M., Putoto G.

Published in
Health Policy and Planning,
June 2021

Link
https://doi.org/10.1093/heapol/czab073

Topic
Universal coverage and equity

Focus country
Uganda



This paper is not available as open access, which is why only an abstract is posted.
If you would like to read the entire paper, please go to the web page given and follow the instructions.

Work with the community or go home: local engagement in Mozambique

PAPER

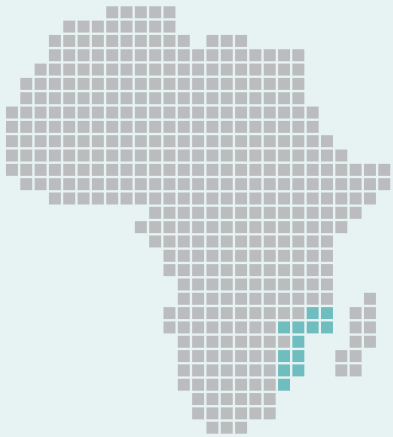
Authors
Cardona-Fox G., De Meneghi G., Occa E., Atzori A.

Published in
Forced Migration Review,
July 2021

Link
tinyurl.com/forcedmigrationreview

Topic
Universal coverage and equity

Focus country
Mozambique



20 Public Health and WASH FMR 67
www.fmreview.org/issue67 July 2021

Work with the community or go home: local engagement in Mozambique

Gabriel Cardona-Fox, Giovanna De Meneghi, Edoardo Occa and Andrea Atzori

A health intervention in a complex crisis, such as in Cabo Delgado, Mozambique, can only succeed if the community is effectively engaged and actively participates in the response.

Providing basic health services in complex humanitarian situations during a pandemic presents significant challenges. Our experience working with internally displaced people (IDPs) in the Cabo Delgado province of Mozambique has taught us that a health intervention can only be successful with effective community engagement strategies. In other words, we either work with the community or we go home.

Engaging with the community is often the only way to guarantee acceptance of an intervention, allowing humanitarian workers to make the most efficient use of limited resources. Without community engagement, the deployment of effective communication strategies to influence perceptions and affect behaviours is almost impossible. In situations where a large inflow of forced migrants intensifies competition over limited resources and upsets the local equilibrium, community engagement is also essential in order to address conflict in a culturally sensitive manner.

The Cabo Delgado province of Mozambique is currently the site of one of the most urgent IDP crises in the world. Violent attacks by non-state armed groups in the north-east of the country and devastation by cyclone Kenneth in 2019 have displaced approximately 732,000 people. This population is now living in precarious conditions with limited access to basic health services. Approximately 36% of the health facilities in the hardest-hit districts have been destroyed and the northern section of the province is an effective 'no-go zone', outside the reach of humanitarian actors.[1] The economic effects of the COVID-19 pandemic and limitations on travel and gatherings have also greatly complicated the humanitarian response.

Doctors with Africa CUAMM, an Italian NGO, has been collaborating with local institutions in setting up systems for prevention, identification, referral and follow-up relating to COVID-19, cholera, acute watery diarrhoea, HIV-AIDS and other infectious diseases (as well as in reproductive, maternal and child health issues, and malnutrition). We have learned that providing medical expertise and support to the national health system alone are not enough. Cultural awareness and effective engagement of the local population and institutions are essential to success.

Community advocacy and monitoring

Community activists (CAs) are the core of CUAMM's work. These people are appointed by the local authorities but are supervised and paid by CUAMM, and can include IDPs. CAs understand the local context and the languages spoken by the forced migrants. They are part of the local health system and serve as a link with the local population. Their training includes early detection and reporting of outbreaks within the community as well as the promotion of preventive behaviours such as social distancing, handwashing and wearing masks. They also undertake advocacy to prevent marginalisation of people suffering from HIV-AIDS, cholera and COVID-19.

CUAMM also works closely with village health committees, community elders, traditional healers, midwives, and formal and informal health practitioners. Village health committees are particularly important; they are composed of medical and non-medical professionals, village elders, religious leaders and other individuals respected within the community, and derive their credibility from the collective authority of their members. With the active participation of the village

A CUAMM worker engages with a community member in Cabo Delgado.

health committees we have been setting up an epidemiological surveillance system to detect the outbreak of COVID-19 and other communicable diseases, using detection mechanisms (such as private screenings conducted during household visits) that would otherwise be considered too sensitive or intrusive. The engagement of CAs and local health committees is critical to ensuring that the system works, the community is kept informed, and those who abandon their treatment are found and brought back.

We have also learned how essential it is to enlist the participation of village elders, birth attendants, and traditional healers (*feticeiros*), who, although not formal health-care professionals, are respected in their communities and often accredited by government authorities. These local actors play an important role in raising health awareness and encouraging compliance with preventive measures. In the district of Montepuez, for example, traditional healers were instrumental in convincing reluctant families to adopt handwashing practices in their households and to forgo traditional burial ceremonies. Using more modest alternative rites, where a few selected representatives of the community performed the ceremony, minimised the risk of contagion. *Feticeiros* also play a key role in discouraging the stigmatisation of people who are infected with COVID-19, thus ensuring that they receive the proper treatment.

Mediating conflict between IDPs and host communities is an integral part of a larger strategy to contain the spread of communicable diseases, as conflict in the community promotes distrust, disrupting the necessary channels of communication for monitoring, referrals and medical attention. To this end, we have found it useful to work with community courts, providing them with medical training and supporting their work; we also complemented their functions by including in our work a) mediating in conflicts over water and other resources and b) advocating on behalf of victims of gender-based violence and accompanying them through the health and court systems.

Integration of displaced health-care practitioners

Among the people displaced by the conflict in northern Mozambique, we identified nearly 600 state-employed health-care workers. While obviously a loss to the populations that stayed behind, these workers presented an opportunity to reinforce the health response in areas where IDPs first arrive. In partnership with the national health authorities, we have begun negotiating

the reassignment of these professionals to the fragile state health facilities that have been stretched beyond capacity.

Displaced health-care workers are helping to set up Temporary Advanced Medical Posts in locations where many IDPs are registered and local health authorities are under stress. These posts are accessible to both the migrant and local populations and operate a basic triage system to screen patients and refer them when necessary to government health centres. We have noted that the inclusion of IDP health workers has greatly facilitated communication with the displaced communities and has encouraged trust. Integrating IDP professionals in the health response has also provided them with a source of livelihood and a sense of purpose.

Communication strategy

The engagement of community leaders, including village elders and religious leaders, has been crucial in our attempts to develop an effective communication strategy to disseminate culturally appropriate medical information to remote communities in compliance with the social distancing and travel restrictions imposed by the COVID pandemic. Because of the geographic isolation of many of the IDP resettlement sites and the constraints imposed by the pandemic, many of the methods and mobile technologies traditionally used to raise health awareness are not available. We were able to develop an innovative communication strategy, however, with the engagement of the community.

One approach that proved effective was to enlist a troupe of local actors to help broadcast a series of *radionovelas* – radio soap operas – in Portuguese and six local languages; these transmitted important COVID-19 mitigation information through storytelling. *Radionovelas* are very popular in Mozambique, particularly in areas with low literacy rates. In the districts of Montepuez, Balama and Chiure, our radio programmes reach approximately 380,000 people – just over half of the total population of 750,000.[2] CUAMM was also able to engage with religious authorities at the national and local level to help disseminate key public health announcements through religious communities.

One of the principle challenges we faced at the onset of the pandemic was how to convey epidemiological risks in a manner that the community would understand and take seriously. During the first months of the pandemic, we needed to dispel several myths about COVID-19 causes and cures that had been proliferating rapidly within the community. To do so, we engaged respected religious leaders to deliver correct information in a manner that was easily understood. The majority Muslim community of Cabo Delgado allowed their mosques' loudspeaker system to be used to disseminate accurate information, and CUAMM worked with these religious groups both to insert health information into religious services and to devise alternative religious ceremonies that were meaningful yet limited the risk of contagion.

As the migration crisis moves beyond the emergency phase, the community needs to own and be committed to the continuing success of the health programme, for the sake of sustainability. Ultimately, we are merely facilitators. We must either engage with the community or prepare to go home.

Gabriel Cardona-Fox
gcardonafox@johnshopkins.it
Associate Fellow, Bologna Institute for Policy Research, Johns Hopkins University; Senior Research Associate, Internal Displacement Research Programme, University of London

Giovanna De Meneghi
g.demeneghi@cuamm.org
Country Manager, Mozambique, Doctors with Africa CUAMM

Edoardo Occa *e.occa@cuamm.org*
Head of Community Health Programmes, Mozambique, Doctors with Africa CUAMM; researcher, University of Milan

Andrea Atzori *a.atzori@cuamm.org*
Head of International Relations, Doctors with Africa CUAMM, Italy

1. *Humanitarian Response Plan, Mozambique* (Abridged Version), December 2020 bit.ly/Mozambique-HRP-2021

2. Source: Radio Comunitaria Mpharama de Balama; Radio Comunitaria Girimba de Montepuez; Radio e Televisao Comunitaria de Chiure; Instituto de Comunicação Social.

Health Coverage and Financial Protection in Uganda: A Political Economy Perspective

PAPER

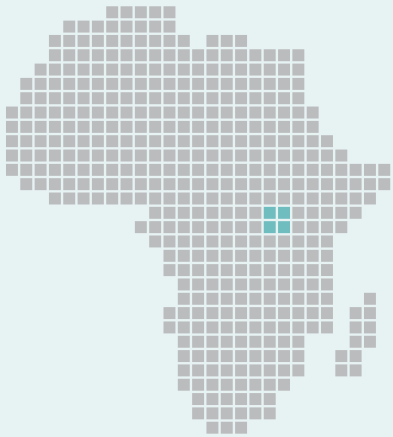
Authors
Nannini M., Biggeri M., Putoto G.

Published in
International journal of Health Policy and Management,
August 2021

Link
https://dx.doi.org/10.34172/ijhpm.2021.116

Topic
Universal coverage and equity

Focus country
Uganda



http://ijhpm.com
Int J Health Policy Manag 2021, x(x), 1–11

doi 10.34172/ijhpm.2021.116

IJHPM International Journal of Health Policy and Management

Original Article

Health Coverage and Financial Protection in Uganda: A Political Economy Perspective

Maria Nannini[1*], **Mario Biggeri**[1], **Giovanni Putoto**[2]

Abstract

Background: As countries health financing policies are expected to support progress towards universal health coverage (UHC), an analysis of these policies is particularly relevant in low- and middle-income countries (LMICs). In 2001, the government of Uganda abolished user-fees to improve accessibility to health services for the population. However, after almost 20 years, the incidence of catastrophic health expenditures is still very high, and the health financing system does not provide a pooled prepayment scheme at national level such as an integrated health insurance scheme. This article aims at analysing the Ugandan experience of health financing reforms with a specific focus on financial protection. Financial protection represents a key pillar of UHC and has been central to health systems reforms even before the launch of the UHC definition.

Methods: The qualitative study adopts a political economy perspective and it is based on a desk review of relevant documents and a multi-level stakeholder analysis based on 60 key informant interviews (KIIs) in the health sector.

Results: We find that the current political situation is not yet conducive for implementing a UHC system with widespread financial protection: dominant interests and ideologies do not create a net incentive to implement a comprehensive scheme for this purpose. The health financing landscape remains extremely fragmented, and community-based initiatives to improve health coverage are not supported by a clear government stewardship.

Conclusion: By examining the negotiation process for health financing reforms through a political economy perspective, this article intends to advance the debate about politically-tenable strategies for achieving UHC and widespread financial protection for the population in LMICs.

Keywords: Universal Health Coverage, Political Economy, Health Financing, Financial Protection, Uganda

Copyright: © 2021 The Author(s); Published by Kerman University of Medical Sciences. This is an open-access article distributed under the terms of the Creative Commons Attribution License (https://creativecommons.org/licenses/by/4.0), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Citation: Nannini M, Biggeri M, Putoto G. Health coverage and financial protection in Uganda: a political economy perspective. *Int J Health Policy Manag.* 2021;x(x):x–x. doi:10.34172/ijhpm.2021.116

Article History:
Received: 6 August 2020
Accepted: 23 August 2021
ePublished: 29 August 2021

***Correspondence to:**
Maria Nannini
Email: maria.nannini@unifi.it

Key Messages

Implications for policy makers

- A political economy perspective is relevant to explain the evolution of health financing reforms and needs to be taken into account when pursuing universal health coverage (UHC).
- In Uganda political economy conditions are not yet favourable for universal coverage; in particular, interests and ideas are not conducive for expanding financial protection.
- Stewardship from the central government is essential to improve financial protection and more efforts are needed to ensure a major commitment for public health financing.

Implications for the public

Considering the influence of political economy on health financing reforms allows to disentangle the country-specific experience related to financial protection for universal health coverage (UHC). In Uganda, the role played by the central government and other stakeholders determines the current level of financial protection for the population. This research helps to identify the major obstacles against the implementation of health financing reforms towards UHC; furthermore, potential opportunities to improve the population coverage and financial protection are indicated. The adoption of a political economy perspective is relevant to enhance the understanding on the main processes shaping progress towards UHC and the usefulness of applying this analytical lens goes beyond the single case study of Uganda. It will be important, thus, to utilise political economy frameworks such as the one presented here as key to interpret the experiences of different low- and middle-income countries (LMICs).

Full list of authors' affiliations is available at the end of the article.

Background

Forty years after the Alma Ata declaration, the international community reaffirmed its commitment to ensure access to quality healthcare for the population of all countries. Universal health coverage (UHC), defined as a situation where people who need health services receive them without undue financial hardship, received renewed attention at the global level and was embraced in the Sustainable Development Goals.[1] The objective of UHC is informed by a horizontal approach for system-level interventions and, thus, brings about important implications for low- and middle-income countries (LMICs).[2,3] As part of the 2030 Agenda, international institutions strongly support the implementation of efficient and equitable health sector reforms for quality care, claiming, in particular, to ensure adequate financial protection for the population against the risk of financial catastrophe due to health expenditures.[4]

An extensive literature[5-7] investigates the main technical factors enabling LMICs to move towards UHC by enhancing health financing systems. Many studies[1,8-10] argue for more systematic reforms to overcome the excessive fragmentation of health systems in LMICs. They point to the importance of a general growth in health spending and claim that the increase in health expenditure should be financed domestically.[1,5,11] To address demand-side barriers to the utilization of health services, pre-payment financing strategies that avoid catastrophic expenditures for the population are strongly recommended.[12,13] Although the discussion of the major technical approaches facilitating the expansion of health coverage is relevant, political determinants driving these improvements deserve more attention.[14] Several authors indicate that a political economy perspective can contribute to understanding contingent paths to UHC.[15-17] Health system analyses need to be supplemented with approaches that focus on the political dynamics surrounding reforms, as reflected in many studies.[2,18-25]

Following this strand of literature, the present investigation advances the debate on the political economy of UHC by considering the case of Uganda and the country's experience of health financing reforms. Our analysis identifies the effects of stakeholders' interests and ideas on the negotiation process behind these reforms, and the resulting implications in terms of financial protection enjoyed by the population. A political economy framework is developed and tested in order to disentangle the Ugandan experience. The framework represents a preliminary output of the research, and it is functional to examine the different spheres which play a role in the political economy process. The investigation follows the line of reasoning presented in the framework and it is informed by a desk review, and 60 key informant interviews (KIIs) with major stakeholders in the health sector (32 at the national level and 28 in one district). The analysis focuses on the last two decades (starting from 2000) and investigates, in particular, the abolition of user-fees in public health facilities and the debate on National Health Insurance as two important cases of health financing reforms with relevant implications for financial protection.

Conceptual Framework

Making progress towards UHC requires the convergence of several factors.[19] In order to develop a coherent analysis of the Uganda's experience of health financing reforms, we adopt a political economy framework inspired by existing knowledge about the politics sphere and UHC.[23] Since many different theories have been used to interpret health reforms and underlying political processes, we draw on contributions from several authors in political economy and public health analysis. As noted by Fox and Reich,[14] progress or delay in achieving positive health coverage outcomes strongly depends on the political economy discourse affecting the health system. Indeed, "countries moving towards UHC face a number of choices, from policy negotiations and decisions to financing and implementation, that are inherently political."[7] In this article, we refer to health policy as a public strategic plan of action to make progress towards the goal of UHC.[25] Practical difficulties of implementing health policy within a specific national context reflect the complexity of politics, that here is related to "managing actors, organizations and institutions that have a stake in health reform."[25]

The processes driving policy design and policy-making for health financing reforms in LMICs is conceptualized in Figure. The circular and dynamic feature of the framework indicates the incremental nature of the process: the spheres of politics and policy are animated by stakeholders' interactions and result in health coverage outcomes when policies are effectively implemented after the negotiation.[26] In this sense, policy is a product of, and constructed through, political processes of negotiation where ideas, knowledge, interests, power and institutions are influential.[14]

The main actors behind the negotiation process on health reforms ("a" in Figure) refer to political institutions and public bureaucracies as well as non-state actors[15] such as private sector, international agencies, civil society organisations and the academia. A country's experience of reforms for UHC and, specifically, for health financing, is largely affected by the role played by the central government[12]; in this respect, the degree of consensus governments manage to build for the reform process is crucial,[26] as well as the political commitment to allocate considerable resources to the health system.[27] Within the public sector, visions on policy-making are often plural: finance ministries and health ministries who discuss the design of reforms may have conflicting priorities.[14] Furthermore, external donors can greatly influence health system infrastructure; in case where they bypass the public sector, they may end up creating an unregulated private market for health services.[16] Finally, active engagement of academia and civil society can contribute to policy-making, implementation, and monitoring for health reforms: collaboration among these actors has the potential to exert collective pressure on governments and other stakeholders for promoting universality and equity in health policy.[27]

The way these stakeholders inform the politics of reforms ("b" in Figure) depends on their specific interests and ideas: here interests refer to how the benefits of reforms are distributed among actors, whilst ideas concern the main values and ideologies inspiring their vision about policies.

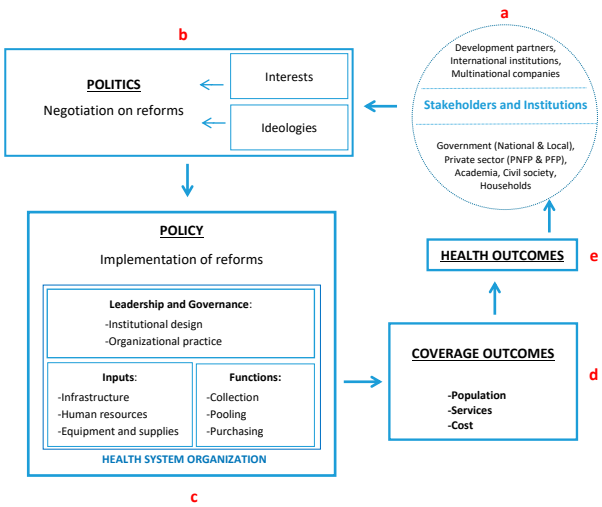


Figure. The Political Economy of Health Financing Reforms.

Interests and power distribution are traditionally intended as key factors in the sphere of politics. According to a more recent literature,[17,20] ideological values are also important to consider in order to obtain a broader understanding of social protection reforms and the political discourse supporting these policies, which include also reforms to expand financial protection for health expenses.

If we consider political negotiations about health financing in LMICs, both interests and ideas have considerable influence on the ensuing reforms. Ruling parties can expand social policies for financial protection against health expenditures as a means of legitimation to prevent the emergence of political opposition. Experiences in China,[19] Rwanda,[17] and Ethiopia[20] are examples of regime legitimacy creation through the expansion of social insurance policies. The development of a comprehensive health insurance system can also be motivated by a desire to reduce financial dependency on donor contributions while increasing domestic resources, as in the case of Malawi.[28] The incentive of political elections often underlies the decision to implement universalistic reforms in the health sector, or to revise agenda setting and policy formulation for this purpose. This has been the case for Thailand in 2001, Ghana in 2008, and Sierra Leone in 2010.[29] In contrast, commercial interests and lobbying from multi-national companies boost policies in favour of the private health sub-sector.[30]

Policy-making in the health system ("c" in Figure) requires coordinated action in multiple areas to be conducive for UHC.[19] Health financing is key to ensure the system functions adequately.[6,31] Mathauer and Carrin[32] argue that two aspects of leadership and governance greatly affect achievements in terms of health coverage: first, the institutional design of rules for resources collection, resource pooling, and the purchasing of services; second, the organizational practice and capacity of the system to implement and comply with formal regulation. Moreover, leadership and governance aspects interact with health system inputs (such as infrastructure, human resources, equipment and supplies) to determine the policy outcomes. These aspects need to be interpreted through institutional lens: while "organisations" represent those actors who interact to influence health system and relevant reforms, "institutions" are the "rules of engagement between stakeholders" which crucially affect governance within health systems.[11] In this sense, health system leadership is a key aspect to determine formal and informal institutions enabling organisations to learn, adapt, and interact in a constructive way to strengthen the health system.[13] However, too often the institutional setting may foster inefficient behaviours among national stakeholders and, in turn, may alter patterns of engagement with international agencies.[11]

This framework helps to disentangle the complexity of the political economy discourse about health financing reforms. To verify whether health reforms bring about advancement towards UHC ("d" in Figure), changes in the coverage dimensions of population, services, and costs are usually measured. These refer, respectively, to the proportion of the population that has financial protection, the range of services that are available, and the proportion of the costs of those services that are covered. Finally, it is expected that UHC, while increasing access to essential health services and improving financial protection, ultimately lead to better health outcomes for the population[12] ("e" in Figure).

Historical Overview of Health Financing and Reforms

Uganda presents a pluralistic system where service provision is divided among public and private sub-sectors.[33] Within a decentralized architecture, districts are responsible for healthcare delivery, whilst the central government formulates policies and is responsible for supervision.[34] The country constitutes a valid case study to examine the issue of healthcare financing; government expenditure as percentage of total health expenditure (THE) has been uneven over time[35] and

lower than that of neighbour countries such as Kenya and Tanzania.[36] Currently, health spending indicators and the public budget for health are well below the recommended international targets, while sector financing is highly dependent on donor funding and direct payments[1]. The insurance sector is under-developed and contributes little to health financing[2].[37] As in many LMICs, impoverishing effects due to health costs are critical: for the 12% of the population, health expenditures represent more than 10% of total income.[38] Out-of-pocket expenses still represent 42% of THE, and occurrence of financial catastrophes have not declined over the last two decades.[39,40]

Over the last period of political stability, social protection policies in Uganda have exhibited specific features of political economy. As we focus on the last two decades, a recent analysis considers the year 2008 to distinguish among two distinct periods with respect to expenditure allocation criteria.[41] The first period was characterised by high priority spending on social services in accordance with a national poverty reduction strategy. In the health sector, the principles of decentralisation, primary healthcare, health system strengthening, community participation and a sector wide approach constituted the chief reforms.[42] At the global level, the increase in health funding was also encouraged by important initiatives such as the Heavily Indebted Poor Country Initiative for debt relief and Global Health Initiatives. Moreover, the international framework of the Millennium Development Goals provided further stimulus to the decision of regarding healthcare as a strategic priority for development.

During the 2001 pre-elections phase, the President launched the "free healthcare" policy by abolishing user-fees in public facilities, thus helping to improve access to health services for the poor.[33]

The second period of expenditure allocation began in 2010 and reflects a new development strategy firmly centred on the goal of achieving higher economic growth. The government's decision to favour growth-enhancing sectors has involved a significant shift away from social spending and a greater support for infrastructure spending.[43] At the same time, international actors emphasised the need to strengthen social policies.[44] Public expenditure on health began to stagnate and efforts for decentralization, primary healthcare reforms, and public-private partnerships in health declined.[45]

Over the last decade, efforts by the central government have not been adequate to strengthening the system for service delivery.[33] Geographic accessibility continued to improve[3],[46] but low domestic revenue flows and modest public budget allocations were not sufficient to meet demand for services.[39] As a result, the quality of care in government facilities deteriorated, with frequent shortages of essential medicines and poor availability of human resources lowering effective coverage[4].[46-48] Given the evident financial weaknesses affecting the health system in recent years, the design of a public health insurance program has been a recurring theme of debate among national stakeholders.[49,50] However, discussion of a possible National Health Insurance (NHI) scheme has been inconclusive for a long time,[51] and the NHI Bill passed by Parliament only in March 2021.

Methods

The analysis draws on two main qualitative research methods, namely a desk review and KIIs with major players in the health sector both at the national and at the district level[5]. The review covers academic writings, policy documents, technical reports, and government policy briefs. We reviewed all available policy documents on the health sector produced in the sector by the central public authority for planning and policy-making going back to 1999, when the country started to develop guidelines for national health policy. Indeed, the position of the central government for health financing reforms is expressed in the core documents for planning and policy-making in the sector[6]. We consulted academic articles and books, as well as technical reports and background papers by other major stakeholders operating in the health system. Table 1 describes the main documents covered by the desk review (see Supplementary file 1 for the full list of consulted documents).

Individual interviews targeted firstly major stakeholders involved in health reforms and policy-making at the central level: KII participants were purposively selected based on their current or previous roles in the Ugandan health system. In total, we conducted 32 KIIs with national representatives of central government (including both technical and political leaders at the Ministry of Health), private sector and medical bureaus, academia, health development partners from bilateral cooperation and United Nations agencies, and civil society organisations. Furthermore, we performed 28 interviews in the district of Oyam[7] with technical and political leaders, health providers of public and private facilities, Village Health Workers, and community leaders at the district level. Table 2 provides a summary list of the main stakeholders involved in the interviews[8]. Whilst most of these actors are the ones driving policy-making for reforms, the position of the general population is represented by the civil society and community leaders at the district level.

Ethical issues were set using a protocol on high-level ethical standards and approved by the authors institutes. All respondents were asked to provide informed consent to participate in the study in respect of anonymity, and no ethical concerns arose during the research. Specifically, the informed consent presented assumptions and interests in the research topics by the investigators, as well as modalities of participation and treatment of data and contacts of investigators in case of questions or additional comments. Data collection took place during three missions in Uganda between November 2018 and January 2020, and interviews were performed in Kampala and in Oyam district within safe places (mainly offices and workplaces of participants) with no presence of external people.

Interviews were conducted using semi-structured questionnaires that had been previously tested by the investigators to verify whether the contents of the political economy framework were clearly understood by participants. The topics covered by the national stakeholders' questionnaire are the following: stakeholders' function within the health system; major reforms and policies affecting health financing; the role of ideology and power differences in driving change;

Table 1. Summary List of Consulted Documents for Desk Review

Type of Document	Authors' Category as Stakeholders	Organisation Represented	No. of Documents (Total = 82)
Official government documents	Government	Ministry of Finance Planning and Economic Development, Ministry of Health, Uganda Bureau of Statistics	25
Academic article, chapter or book	Development partners	World Health Organisation, Belgian Development Agency, Doctors with Africa CUAMM	23
	Academia	Academicians from Ugandan universities and foreign academic organisations, independent experts	
Working or discussion paper	Development partners	World Bank, WHO, UNICEF	18
	Academia	Makerere University, New York University, Manchester University, Ghent University	
	Civil society	Advocates Coalition for Development and Environment	
Report	Private sector	Ugandan Catholic Medical Bureau	16
	Development partners	International Monetary Fund, World Health Organisation, Belgian Development Agency, UK Department for International Development, US Agency for International Development	
	Academia	Makerere University, Economic Policy Research Centre, Birmingham University, Overseas Development Institute	
	Civil society	CORDAID, Global Network for Health Equity, Save for Health Uganda	

Abbreviations: WHO, World Health Organization; UNICEF, United Nations Children's Fund.

Table 2. Summary List of KIIs

Level	Stakeholders	Organisations Represented	No. of Participants
National	Government	Ministry of Health, National Planning Authority	6
	Private sector	Ugandan Catholic Medical Bureau, Pharmaceutical companies	4
	Development partners	World Bank, WHO, Belgian Development Agency, UK Department for International Development, US Agency for International Development, Doctors with Africa CUAMM	9
	Academia	Universities and independent experts	9
	Civil society	Save the Children, CORDAID, Save for Health Uganda	4
			Total: 32
District	Government	District Health Office, District Local Government	13
	Private sector	Ugandan Catholic Medical Bureau	2
	Development partners	Doctors with Africa CUAMM	1
	Civil society	Community leaders, village health workers	12
			Total: 28

Abbreviations: WHO, World Health Organization; KIIs, key informant interviews.

results in terms of health coverage; the current debates about UHC; and the main challenges and opportunities for enhancing financial coverage. These topics echo domains in our conceptual framework and enrich the discourse on political economy. The questionnaire used with district-level stakeholders was adapted to investigate access to health services and financial coverage for the population, thus focusing mainly on the sphere of coverage outcomes in the political economy framework. Interviews were conducted in English by one of the investigators[9], audio recorded (with permission from participants), and then transcribed verbatim. Average duration of each interview was around 40 minutes. Documents and interview transcriptions were coded manually employing selective coding by identifying the central issue of healthcare financing as the core category of analysis; then we categorized other topics according to domains associated with our conceptual framework. The data relevant to each category was identified and analysed using a constant comparative method, in which single items are systematically checked with the rest of available information in order to triangulate findings and establish sound connections between categories.[52] Moreover, the reporting of qualitative data collected through interviews follows consolidated criteria from the COREQ (COnsolidated criteria for REporting Qualitative research) checklist.[53] While the desk review has been initially functional to inform the early stages of the investigation, depicting the historical overview of reforms, it was then used throughout the following phases of the investigation. Indeed, after concluding data collection, we systematically integrated evidence from the KIIs with the findings from the desk review.

We acknowledge some methodological limitations to this study. First, given the great diversity of actors underlying the political economy negotiation some categories of stakeholders may be underrepresented in the sample of respondents. Second, although this does not hinder generalisability of the

main findings, interviews at the local level were performed in one single district. Third, the historical path affecting the political discourse is analysed considering only the last two decades, since we decided to focus on the current implications of health financing reforms.

Results

The political discourse surrounding health financing in Uganda is animated by multiple actors and we analysed their position and role with respect to key reforms for improving financial protection such as the abolition of user-fees and the potential implementation of a NHI scheme. Following the line of reasoning illustrated in our conceptual framework, we present the main findings by referring to the domains of "stakeholder and institutions," "politics," and "policy" for health financing reforms as depicted in Figure ("a," "b," and "c" spheres). Findings from interviews at the district level shed more lights on the domain of "health coverage outcomes" ("d" sphere) and, specifically, financial protection for the general public.

Stakeholders' Position in the Health Sector

As we refer to the domain of stakeholders in Figure ("a"), five main categories of actors can be identified with respect to their role for health financing, namely government, private sector, development partners, academia, and civil society.

The government, after user-fees abolition in 2001, only increased per capita health expenditure marginally, while public investments to enhance healthcare delivery have been inadequate.[33,36] Starting from the second decade, according to several KIIs, central government did not provide clear guidance about health system reforms and services provision, although it is responsible for policy formulation.

In recent years, the private for profit (PFP) sub-sector has expanded substantially. Low quality healthcare in public hospital and health centres has partly contributed to the higher utilization of PFP facilities by the population.[50] However, the lack of common regulation of quality standards and pricing raises concerns about the fragmentation of the healthcare landscape.[33] The collaboration between private and public organisations was less vibrant over the last decade, and financial contributions from the government to the private not for profit (PNFP) sector experienced a decline.[54] In percentage terms, "the health budget provided to the PNFP sector increased slightly between 2000 (5.3%) and 2005 (8.5%) but gradually reduced to 2% in 2014."[55]

Considering the position of development partners with respect to health financing, poor accountability for large sums of money involving the Ministry of Health has led to important changes in the form of support for health initiatives.[56] During the late 2000s, a shift occurred from budget support to vertical programs with poor coordination and weak system strengthening.[42] Nonetheless, programmes and initiatives driven by development partners continue to play a central role for healthcare financing and services provision.[57]

Looking at the role of other stakeholders, there is a consensus among many KIIs that the available evidence produced by academia does not currently influence the process of policy-making in the health sector to any real extent. Some informants argue that, in the foreseeable future, the development of strategic plans within the Sustainable Development Goals framework will make the role of academia more relevant[10].

KIIs indicated that civil society organisations also contribute to the evidence base on health sector practices and have repeatedly called for additional investment and effort to be directed towards healthcare. Although actors from the civil society often create partnerships with donors, governments and local communities,[58] many respondents argue that support for specific initiatives do not translate into influential negotiation power to affect the overall process of decision making at the national level.

Finally, we focus on the position of the community within the health financing system. A significant proportion of the population continues to bear a large financial burden for out-of-pocket health expenditures, which are likely to lead to disparities in access to quality health services.[36,59] While involving the local community is vital for primary healthcare effectiveness and the achievement of UHC,[60] several informants believe that the dominant approach is still oriented towards curative services and considers households as mere recipients of healthcare. As pointed out by a recent study,[58] the general public is largely excluded from policy design and decision making at the district level.

Politics for Health Financing

Table 3 summarizes the main findings related to the politics sphere ("b" in Figure) for health financing reforms, highlighting differences in influence among actors and their respective contributions in terms of interests and values that shape policy outcomes.

The commitment of central government to the health sector has declined over the last decade, as demonstrated by the stagnant pattern of public health expenditure as a percentage of gross domestic product.[57] A significant increase in competition within the political landscape and the change in leadership at the Ministry of Health may have contributed to a shift of national priorities from social services to productive sectors during the second decade.[54,61] Most representatives of the central government expressed the idea that devoting efforts to infrastructure (such as roads and railway, but also physical infrastructures for healthcare provision) will lead to positive spill-over effects on health, since expansion of infrastructures is considered as an enabling condition to progress towards UHC[11]. In this sense, different priorities are not conceived as mere alternatives. A stakeholder from the Ministry of Health argues[12]:

> *"The Ministry of Health is not the only responsible for health: social determinants of health are beyond this sector, and if we do not address social determinants many causes of diseases such as safe water, housing, personal behaviours are neglected. We believe that promoting a multisectoral approach will allow the country to record faster progress towards UHC."*

According to most respondents, there is a lack of consistent political commitment at central level to enforce and strengthen

Table 3. Stakeholders and Politics

Stakeholders	Influence	Interests And Ideologies	Implications for Policy-Making
Central government	Weak guidance for reforms and lack of political will to be the first player in the sector	Productive sectors and market expansion as strategic priorities	Poor leadership in the sector; expansion of health facilities infrastructures without proper functionality
Private sector	Strong economic power	Market supremacy	Development of PFP sub-sector without effective regulation
Development partners	Important financial contribution and influence	Fragmented preferences of single donors	Vertical programs without harmonization
Academia	Potential increasing influence in the negotiation process	Evidence-based approach	Not yet systematic use of evidence for policy design and policy-making
Civil society and population	Low influence in the negotiation process	Participatory bottom-up approach	No systematic engagement of civil society and population

Abbreviation: PFP, private for profit.

public health service delivery and, specifically, tension exists between the Ministry of Finance and the Ministry of Health concerning strategic policy-making for healthcare. Moreover, the Ministry of Gender Labour and Social Protection has the mandate to ensure social protection which is closely connected with the objective of enlarging financial protection for health expenses; according to several respondents, however, this ministry has much less contracting power than the other two. A representative of development partners explicitly states that the government has currently no interest in being the first player for the provision of health services and, thus, for healthcare financing. Consequently, development partners unanimously believe that health services have deliberately been delegated to them, who heavily finance the sector.

Many key informants reiterate the common opinion that, over the last decade, much more scope than before has been given to market forces on the one hand, and to development partners on the other. Accordingly, a recent analysis of healthcare financing in the country attributes the drop in public funds to the crowding out effect of external subsidies.[36] As expressed by a national academic, the presence of external donors creates a disincentive for central government to invest in the health sector[13]:

"Maybe there is a side effect: as donors' funds increase, government responsibility for health reduces, so you don't see sufficient increase in the public budget as [it might be] expected."

Several participants affirm that the presence of international donors is particularly important in specific areas, such as tackling Malaria, HIV and TB. The vulnerability of Uganda to fluctuations in development partners' contributions is recognized in some studies.[36,50,62] In this regard, a participant from a development partner organisation argues[14]:

"Much of the budget for basic services is donors dependent [and] this means that the State is very vulnerable. If […] the Americans decide to leave the country, it would be a disaster. [This] is a risky situation."

The private sector is also expanding its influence over services delivery. The strategic goal of promoting national economic growth is reflected in the health sector through renewed emphasis on market expansion.[35] As a result, inequalities in access to services are increasing,[36] while market forces tend to advantage those who are better placed to afford health. One independent expert declares[15]:

"The shift […] is towards those who are economically powerful: the rich now have a greater voice in policies. […] Responding to investors in the sector, [and] responding to those who have money has become more important than having service coverage for those who need it most."

Whilst the influence of the PFP and development partners for health financing and policy design is increasing, the relevance of civil society and general public for policy design is still minimal, as confirmed by a district-level stakeholder analysis.[58] Similarly, many respondents observe that the current involvement of academia in the negotiation process does not translate into systematic use of evidence to inform reform processes. However, the SPEED (Supporting Policy Engagement for Evidence-Based Decisions) initiative which directly involves the universities into the definition of a roadmap for UHC in the country represents a factor of optimism for the future.

Implications for Policy Reforms

Values and interests of the most influential stakeholders have driven the negotiation process concerning policy design and implementation for healthcare financing ("c" in Figure) and, in particular, for the case of user-fees abolition and NHI discussion.

In 2001, the President launched the "free healthcare" initiative as part of political discourse regarding key reforms. According to several analyses, the vision of universal access to basic healthcare was intended to legitimise the government during a period of transition to a multi-party system of governance.[54,63] Similarly, many respondents argue that the ideological position of "free healthcare" was motivated by political gain of the elite who had interest to maintain the status quo in a landscape of increasing political competition.

After the change in the government strategic vision, the dominant ideology became the supremacy of market forces. Meanwhile, discussions on the reform of NHI remained inconclusive for a long time with members of parliament who did not achieved agreement on the design of a possible scheme. A prepayment mechanism involving financial contributions from users would contradict the promise of

"free healthcare" and, according to many KIIs, the President is apparently reluctant to implement this reform. The ambiguity between the "free healthcare" slogan from the government and the design of NHI remains thus crucial for health financing reforms and heavily influences the political decision-making process.

Most informants from the central government suggest that the negotiations process for NHI is delayed due to the conflicting commercial interests of private companies, fearing a reduction of their market power, and basic misunderstandings of insurance principles by formal sector employees, who interpret membership to insurance as a reduction in their salary. In general, public policies designed by the ruling party in the country are often designed to retain support from prominent factions.[61] In the case of NHI, political incentives are provided by private companies and trade unions to refrain from implementing a comprehensive scheme covering the whole population.[49] On one side, the private sector fears competition between social health insurance and commercial schemes; on the other side, trade unions are concerned about payroll deduction from workers' pay. Furthermore, after corruption scandals in the public sector, these actors have doubt about the government capacity and transparency in implementing a unique national scheme. The process to design the NHI scheme failed to create ownership among the main players in the private sectors and the lack of backing from these stakeholders protracted the discussion.[49] In other words, poor stakeholder's engagement appears to be a critical factor both for the decision of user-fees abolition, which has not been discussed within a health secotr forum, and for the ongoing debate about NHI.

Overall, conflicting interests, ideas, and perceptions about insurance do not create favourable ground for cultivating a consensus on the design and implementation of a national insurance to improve financial protection. Including the informal sector within the health financing system represents a relevant issue. Although participants from civil society and the PNFP sub-sector have less voice than other stakeholders, they advocate active involvement of the community within the health system. The idea of financing healthcare in a sustainable way and, meanwhile, empowering the demand side is reflected in the design of Community Based Health Insurance.[64] This model aims to provide financial protection to individuals in the informal sector. Interest in Community Based Health Insurance is increasing in Uganda, but the implementation of single schemes remains highly fragmented in the absence of an overall public insurance programme at the national level.[65]

In conclusion, the current political negotiation process for health financing reforms is failing to harmonize interventions driven by individual stakeholders: development partners are mainly financing vertical programs, whilst the public sector, PNFP and PFP sub-sectors are not yet coordinated to contribute to a unique system for resource collection, pooling and services provision. In other words, both institutional design and organizational practices to guarantee the adequate functioning of the system are not yet favourable for expanding financial coverage in an equitable manner.

Consequences for Coverage Outcomes and Financial Protection

Given the lack of comprehensive and equitable health financing reforms at the national level, outcomes in terms of population, services and costs coverage ("d" in Figure) are not improving. As we consider a rural and informal setting (Oyam district), the political economy discourse results into a generally low level of financial protection at the local level The vast majority of the population lacks adequate protection for health expenses. Most interviewees in the district argue that impoverishing effects due to health expenditures are becoming more frequent over recent years as the private sector expands without adequate regulation and the public sector is not able to offer adequate quality of care[16]:

> *"The main concerns about accessing healthcare are, on one side, the poor availability of drugs and medicines in public health centres and, on the other side, the [lack of] affordability of services in private clinics."*

Indeed, most services which are supposed to be guaranteed at the public facilities are not provided in practice, whilst private health facilities are not affordable to many families. Given such difficulties, some community representatives observe that the spirit of solidarity among the population in rural area is high, and the practice of risk-sharing for health expenditures is quite widespread[17]:

> *"Community members use to support each other during illness, providing in-kind and monetary gifts. This spirit is stronger in remote areas where utilising health services is really challenging."*

Health providers stated that sometimes community groups bring their pooled contributions to pay user-fees for admitted members. However, evidence from a specific study in Uganda[66] shows that the absence of a coherent policy framework prevents these informal mechanisms from operating as a functional scheme of social protection. Furthermore, some authors[65] pointed out that the poorest remain excluded from this informal safety-net since they cannot afford to join community groups. The fact that solidarity regards only members of defined groups implies an important equity concern, since risk-sharing practices bring advantages only for those who share a common identity. Consequently, caution is needed when considering the potential role of these informal practices for health financing: spontaneous initiatives by the population require to be channelled through a solid legislative framework in order to effectively contribute towards a comprehensive scheme of financial protection.

We can interpret the rationale to rely on informal networks for coping with health expenditures as partly due to the delay to implement effective national reforms for financial protection. Indeed, the population is not supported neither by the government nor by the private sector to improve coverage outcomes.

Discussion and Conclusion

The interpretation of the main findings through the developed framework allows us to disentangle the dynamic and incremental processes of political economy for health financing reforms in Uganda, and to interpret the current level of financial protection for the population. Whilst transition

towards UHC requires "*several essential forces […] to mature and come together,*"[19] we contend that political conditions are currently delaying an effective expansion of financial protection coverage for the population.

The negotiation process for health financing reforms is characterised by divergent ideologies concerning healthcare as well as conflicting interests for the main stakeholders' categories. In recent years, central government has not regarded social services and, in particular, healthcare, as a strategic priority, and the ensuing public budget remained stagnant. On the other hand, development partners and private organisations are gaining influence within the sector, but they lack coordination. In contrast, academics and civil society have at the moment weaker voices within the national debate on health financing.

The dominant ideology of market supremacy and the regime's strategic vision to transform Uganda into a middle-income economy has added to an unfavourable background for designing and implementing a comprehensive insurance scheme. The dichotomy between the slogan of "free healthcare" and the planned reform of NHI has not been totally solved, and engagement of important stakeholders into the process of reform design has been low. Consequently, a broad consensus about a comprehensive scheme for financial protection has not yet been reached, and an extremely fragmented and inequitable landscape for health financing remains in place with weaknesses in terms of service delivery and harmonization of interventions undermining the capacity of the system to improve coverage outcomes.

Further to delaying conditions, the political economy analysis permitted to identify two enabling factors that provide positive stimulus for advancing the negotiation process behind health financing reforms. Whilst the scope of this political process is national, the two factors originate, respectively, from the international arena and from the local community background. First, the 2030 Agenda is creating strong momentum towards UHC that can be exploited at the national level to unlock the negotiation process for a comprehensive scheme of financial protection. The mission to promote a broad access to essential health services without suffering financial hardship needs to be translated into national-level reforms for health financing: in this sense, the global community can exert pressure on the central government in order to clarify the ambiguity between the "free healthcare" policy and the debate on NHI. The political process to define the national strategy for the goal of UHC also constitutes the opportunity to create an effective platform of dialogue and discussion between national partners from different sectors (such as the private sector and the academia). Second, another stimulus comes from bottom-up leverage involving the population and, in particular, the informal sector through community-based initiatives aimed to expand the practice of risk-sharing for health expenditures. Increasing collection and pooling of prepayment contributions and promoting an active role in the health system for linking the demand and supply-side of healthcare represents a promising opportunity to expand financial coverage; however, this architecture for health financing can be sustainable and efficient only if coordinated by a multi-level governance.[67] In other words, if efforts by the community represent an important boost, poor stewardship by the government does not permit to effectively advance towards UHC. Engagement of the civil society and the general public can bring important advantages to health system strengthening, but this requires a clear political will and does not imply a shift of responsibility away from the central government.

To conclude, this analysis contributes to the emerging literature on the political economy of health sector reforms in LMICs. The study highlights key political factors that influence the context-dependent trajectory of Uganda for health financing reforms aimed at improving financial protection for the population. On one side, at the national level, poor stewardship of the central government into the health sector and lack of effective platforms of dialogue involving different stakeholders prevent to achieve the effective implementation of a comprehensive scheme for financial protection. On the other side, both the global agenda focused on the overarching goal of UHC and spontaneous bottom-up initiatives at the local level to improve health coverage can constitute opportunities to weight on the reactivity of the system to develop a clear policy agenda for health financing and financial protection. The adoption of a political economy perspective is relevant to enhance the understanding on the main processes shaping progress towards UHC and the usefulness of applying this analytical lens goes beyond the single case study of Uganda. It will be important, thus, to utilise political economy frameworks such as the one presented here as key to interpret the experiences of different LMICs.

Acknowledgements

We are grateful for the logistical support of Doctors with Africa CUAMM in Uganda. Earlier drafts of the paper strongly benefitted from comments by David A. Clark and Gavino Maciocco. We wish to thank all the participants to KIIs for their precious contribution to the research.

Ethical issues

Ethical issues were set using a protocol on high-level ethical standards and approved the Ethic Committee for Research of the University of Florence and by Doctors with Africa CUAMM. All respondents were asked to provide informed consent to participate in the study, and no ethical concerns arose during the research.

Competing interests

Authors declare that they have no competing interests.

Authors' contributions

MN and MB conceived and designed the study, analysed the data, wrote the draft manuscript, and participated in the interpretation of the findings and revision of the manuscript. GP contributed to the implementation of the study, participated in the data analysis, interpretation of the findings and revision of the manuscript. All authors read and approved the final version of the manuscript.

Funding

Doctors with Africa CUAMM provided us with logistical support during the field research in Uganda. No other forms of support/funding were received.

Authors' affiliations

[1]Department of Economics and Management, University of Florence, Florence, Italy. [2]Doctors with Africa CUAMM, Padova, Italy.

Supplementary files

Supplementary file 1. List of Consulted Documents for the Desk Analysis.

Endnotes

[1] On average, about 8% of public spending was devoted to the health sector between 2012/2013 and 2016/2017. This is well below the Abuja declaration target of 15.[57] During the same period, the total health budget as a percentage of gross domestic product has remained about 1% compared to a regional average of 1.9 for Sub-Saharan African countries and the international target of 5% for LMICs.[36] On a per capita basis, between 2012/2013 and 2016/2017 the government spent US $8 on health, against the WHO target of $34.[36]

[2] Figures from the Ministry of Health[57] show that 42% and 43% of THE respectively were covered by development partners and private funds in 2015/2016. In contrast, the public sector contribution only accounted for 15% of THE. Overall, health expenditure per capita in 2017 was US $51, against the minimum of US $84 recommended by the WHO.[57]

[3] The proportion of households living within a radius of 5 km from health facilities raised from 72 in 2010/2011 to 86% in 2016/2017.[68,46]

[4] In 2013/2014, only 45% of health centres of fourth level (IV) have been found to be functional in terms of availability of Comprehensive Emergency Obstetric Care services.[69] The density of health workforce, which increased from 0.498 in 2011/2012 to 0.710 in 2014, remains well below the WHO recommended target of 2.28 health workers per 1000 people.[47]

[5] In order to identify the scope of priority setting for healthcare, finalize the list of key informants and design interview questions, we performed a preliminary research phase by participating to eight workshops with health sector stakeholders at the district level and to two national conferences on UHC.

[6] National Health Policy I and II, National Budget Framework Papers, Health Sector Strategic Plans, Health Sector Development Plans, and National Health Accounts.

[7] The regional health system in Oyam is similar to the rest of Uganda, featuring a wide variety of health providers. Due to a long post-conflict period, this district records lower coverage outcomes for health services than those at the national level,[70] and financial obstacles to healthcare utilisation are still critical for the local population.[67] Therefore, the district constitutes a solid case study with analytical relevance regarding financial protection for the population.

[8] Such categorization does not reflect uniform ideological positions and influence in the negotiation process.

[9] This person, with a PhD in Development Economics, had already previous experience of research work in Uganda and a basis of knowledge about the national context.

[10] Indeed, several universities and research entities have been engaged in producing a country-specific roadmap towards UHC to orient policies for the health system.[71]

[11] For example, geographic accessibility to health services improved after great efforts to build new health facilities.

[12] KII, Kampala, February 25, 2019.

[13] KII, Kampala, February 22, 2019.

[14] KII, Kampala, January 30, 2019.

[15] KII, Kampala, February 27, 2019.

[16] KII, Oyam, January 21, 2020.

[17] KII, Oyam, January 23, 2020.

References

1. Cotlear D, Rosemberg N. *Going Universal in Africa: How 46 African Countries Reformed User Fees and Implemented Health Care Priorities*. Universal Health Coverage Studies Series No. 26. Washington, DC: World Bank; 2018.
2. Agyepong IA. Universal health coverage: breakthrough or great white elephant? *Lancet*. 2018;392(10160):2229-2236. doi:10.1016/s0140-6736(18)32402-4
3. Kutzin J. Anything goes on the path to universal health coverage? No. *Bull World Health Organ*. 2012;90(11):867-868. doi:10.2471/blt.12.113654
4. Dye C, Reeder JC, Terry RF. Research for universal health coverage. *Sci Transl Med*. 2013;5(199):199ed113. doi:10.1126/scitranslmed.3006971
5. Barroy H, Kutzin J, Tandon A, et al. Assessing fiscal space for health in the SDG era: a different story. *Health Syst Reform*. 2018;4(1):4-7. doi:10.1080/23288604.2017.1395503
6. McIntyre D, Meheus F, Røttingen JA. What level of domestic government health expenditure should we aspire to for universal health coverage? *Health Econ Policy Law*. 2017;12(2):125-137. doi:10.1017/s1744133116000414
7. The Lancet Global Health. Gravitating towards universal health coverage in the new WHO era. *Lancet Glob Health*. 2017;5(7):e633. doi:10.1016/s2214-109x(17)30224-3
8. Yates R. Universal health care and the removal of user fees. *Lancet*. 2009;373(9680):2078-2081. doi:10.1016/s0140-6736(09)60258-0
9. Xu K, Soucat A, Kutzin J, Brindley C, et al. *Public Spending on Health: A Closer Look at Global Trends*. Geneva: World Health Organisation; 2018.
10. Kutzin J. Health financing for universal coverage and health system performance: concepts and implications for policy. *Bull World Health Organ*. 2013;91(8):602-611. doi:10.2471/blt.12.113985
11. Swanson RC, Atun R, Best A, et al. Strengthening health systems in low-income countries by enhancing organizational capacities and improving institutions. *Global Health*. 2015;11:5. doi:10.1186/s12992-015-0090-3
12. Savedoff WD, de Ferranti D, Smith AL, Fan V. Political and economic aspects of the transition to universal health coverage. *Lancet*. 2012;380(9845):924-932. doi:10.1016/s0140-6736(12)61083-6
13. North D. *Institutions, Institutional Change and Economic Performance*. Cambridge: Cambridge University Press; 1990:1-36.
14. Fox AM, Reich MR. The politics of universal health coverage in low- and middle-income countries: a framework for evaluation and action. *J Health Polit Policy Law*. 2015;40(5):1023-1060. doi:10.1215/03616878-3161198
15. Gilson L, Raphaely N. The terrain of health policy analysis in low and middle-income countries: a review of published literature 1994-2007. *Health Policy Plan*. 2008;23(5):294-307. doi:10.1093/heapol/czn019
16. Stuckler D, Feigl AB, Basu S, McKee M. *The Political Economy of Universal Health Coverage*. Background Paper for the Global Symposium on Health Systems Research. Geneva: WHO; 2010.
17. Chemouni B. The political path to universal health coverage: power, ideas and community-based health insurance in Rwanda. *World Dev*. 2018;106:87-98. doi:10.1016/j.worlddev.2018.01.023
18. Croke K, Mohd Yusoff MB, Abdullah Z, et al. The political economy of health financing reform in Malaysia. *Health Policy Plan*. 2019;34(10):732-739. doi:10.1093/heapol/czz089
19. Hsiao WC, Li M, Zhang S. Universal Health Coverage: The Case of China. Working Paper 2014-15. Unrisd. 2014. http://www.unrisd.org/80256B3C005BCCF9/%28httpAuxPages%29/E15A4915BFDBEE8AC1257D9E0033BACE/$file/Hsiao et al.pdf.
20. Lavers T. Towards universal health coverage in Ethiopia's 'developmental state'? the political drivers of health insurance. *Soc Sci Med*. 2019;228:60-67. doi:10.1016/j.socscimed.2019.03.007
21. Pisani E, Olivier Kok M, Nugroho K. Indonesia's road to universal health coverage: a political journey. *Health Policy Plan*. 2017;32(2):267-276. doi:10.1093/heapol/czw120
22. Reich MR, Harris J, Ikegami N, et al. Moving towards universal health coverage: lessons from 11 country studies. *Lancet*. 2016;387(10020):811-816. doi:10.1016/s0140-6736(15)60002-2
23. Shiffman J. Political context and health financing reform. *Health Syst Reform*. 2019;5(3):257-259. doi:10.1080/23288604.2019.1633894
24. Sparkes SP, Bump JB, Özçelik EA, Kutzin J, Reich MR. Political economy analysis for health financing reform. *Health Syst Reform*. 2019;5(3):183-194. doi:10.1080/23288604.2019.1633874
25. Campos PA, Reich MR. Political analysis for health policy implementation. *Health Syst Reform*. 2019;5(3):224-235. doi:10.1080/23288604.2019.1625251
26. Schmidt VA. Does discourse matter in the politics of welfare state adjustment? *Comp Polit Stud*. 2002;35(2):168-193.
27. Averill C, Marriott A. Universal Health Coverage: Why Health Insurance Schemes Are Leaving the Poor Behind. Oxfam International; 2013.
28. Gheorghe A, Straehler-Pohl K, Nkhoma D, et al. Assessing the feasibility and appropriateness of introducing a national health insurance scheme in Malawi. *Glob Health Res Policy*. 2019;4:13. doi:10.1186/s41256-019-0103-5
29. World Health Organization (WHO). Arguing for Universal Health Coverage. WHO; 2013.
30. Reich MR. Reshaping the state from above, from within, from below: implications for public health. *Soc Sci Med*. 2002;54(11):1669-1675. doi:10.1016/s0277-9536(01)00334-3
31. Kutzin J. Health financing for universal coverage and health system performance: concepts and implications for policy. *Bull World Health Organ*. 2013;91(8):602-611. doi:10.2471/blt.12.113985
32. Mathauer I, Carrin G. The role of institutional design and organizational practice for health financing performance and universal coverage. *Health*

Policy. 2011;99(3):183-192. doi:10.1016/j.healthpol.2010.09.013
33. Nabyonga Orem J, Mugisha F, Kirunga C, Macq J, Criel B. Abolition of user fees: the Uganda paradox. *Health Policy Plan*. 2011;26 Suppl 2:ii41-51. doi:10.1093/heapol/czr065
34. Ministry of Health Uganda. Health Sector Strategic & Investment Plan. 2010. http://ec.europa.eu/priorities/jobs-growth-and-investment/investment-plan_en#actions.
35. Zikusooka CM, Kyomuhang R, Orem JN, Tumwine M. Is health care financing in Uganda equitable? *Afr Health Sci*. 2009;9 Suppl 2:S52-58.
36. USAID, Ministry of Health Uganda. Financing for Inclusive and Sustainable Health Services Uganda Health Public Expenditure Review 2013/14-2016/17. USAID, Ministry of Health Uganda; 2016.
37. Ministry of Health Uganda. Health Financing Strategy 2015/16-2024/25. Ministry of Health Uganda; 2016.
38. WHO. Uganda Statistical Profile. WHO; 2015.
39. Xu K, Evans DB, Kadama P, et al. Understanding the impact of eliminating user fees: utilization and catastrophic health expenditures in Uganda. *Soc Sci Med*. 2006;62(4):866-876. doi:10.1016/j.socscimed.2005.07.004
40. Wagstaff A, Flores G, Hsu J, et al. Progress on catastrophic health spending in 133 countries: a retrospective observational study. *Lancet Glob Health*. 2018;6(2):e169-e179. doi:10.1016/s2214-109x(17)30429-1
41. Kjær AM, Ulriksen MS, Kangave J, Katusiimeh M. A Political Economy Analysis of Domestic Resource Mobilization in Uganda. UNRISD; 2017.
42. Habraken R, Schulpen L, Hoebink P. Putting promises into practice: the new aid architecture in Uganda. *Dev Policy Rev*. 2017;35(6):779-795. doi:10.1111/dpr.12294
43. Ministry of Finance, Planning and Economic Development (MoFPED). National Budget Framework Paper FY 2019/20-FY 2023/24. MoFPED; 2018.
44. International Monetary Fund (IMF). *Uganda Selected Issue*. Washington, DC: IMF; 2017:1-86.
45. Williamson T, Davies F, Aziz I, Hedger E. Budget Support to Uganda 1998-2012. Overseas Development Institute; 2016.
46. Ministry of Health Uganda. Annual Health Sector Performance Report 2017/18. Ministry of Health Uganda; 2018.
47. Odokonyero T, Mwesigye F, Adong A, Mbowa S. Universal Health Coverage in Uganda: The Critical Health Infrastructure, Healthcare Coverage and Equity. 2017. http://www.eprcug.org/research/research-series?task=document.viewdoc&id=521.
48. Uganda Bureau of Statistics (UBOS). National Service Delivery Survey: 2015 Report. UBOS; 2015.
49. Basaza RK, O'Connell TS, Chapčáková I. Players and processes behind the national health insurance scheme: a case study of Uganda. *BMC Health Serv Res*. 2013;13:357. doi:10.1186/1472-6963-13-357
50. Zikusooka CM, Kwesiga B, Lagony S, Abewe C. Universal Health Coverage Assessment Uganda. Global Network for Health Equity; 2014. doi:10.13140/RG.2.1.1174.7683
51. Ministry of Health Uganda. Booklet on the Planned National Health Insurance Scheme. Ministry of Health Uganda; 2019.
52. Pope C, Ziebland S, Mays N. Qualitative research in health care. Analysing qualitative data. *BMJ*. 2000;320(7227):114-116. doi:10.1136/bmj.320.7227.114
53. Tong A, Sainsbury P, Craig J. Consolidated criteria for reporting qualitative research (COREQ): a 32-item checklist for interviews and focus groups. *Int J Qual Health Care*. 2007;19(6):349-357. doi:10.1093/intqhc/mzm042
54. Ssennyonjo A, Namakula J, Kasyaba R, Orach S, Bennett S, Ssengooba F. Government resource contributions to the private-not-for-profit sector in Uganda: evolution, adaptations and implications for universal health coverage. *Int J Equity Health*. 2018;17(1):130. doi:10.1186/s12939-018-0843-8
55. Awor P, Bisase H, Lochoro P, Curtale F. How is the Partnership between the Public and Non-Public Sector Evolving to Strengthen Universal Health Coverage? Universal Health Coverage in Uganda; 2018:1-17.
56. Steurs L. European aid and health system strengthening: an analysis of donor approaches in the DRC, Ethiopia, Uganda, Mozambique and the global fund. *Glob Health Action*. 2019;12(1):1614371. doi:10.1080/16549716.2019.1614371
57. Ministry of Health Uganda. Uganda National Health Accounts. Ministry of Health Uganda; 2017.
58. Razavi SD, Kapiriri L, Abelson J, Wilson M. Who is in and who is out? a qualitative analysis of stakeholder participation in priority setting for health in three districts in Uganda. *Health Policy Plan*. 2019;34(5):358-369. doi:10.1093/heapol/czz049
59. Kwesiga B, Zikusooka CM, Ataguba JE. Assessing catastrophic and impoverishing effects of health care payments in Uganda. *BMC Health Serv Res*. 2015;15:30. doi:10.1186/s12913-015-0682-x
60. Allotey P, Tan DT, Kirby T, Tan LH. Community engagement in support of moving toward universal health coverage. *Health Syst Reform*. 2019;5(1):66-77. doi:10.1080/23288604.2018.1541497
61. Kjær AM. Political settlements and productive sector policies: understanding sector differences in Uganda. *World Dev*. 2015;68:230-241. doi:10.1016/j.worlddev.2014.12.004
62. CORDAID. Aid and Health Sector Performance in Uganda. Cordaid; 2011.
63. UNICEF. Uganda: Political Economy Analysis. UNICEF; 2018.
64. Soors W, Devadasan N, Durairaj V, Criel B. Community Health Insurance and Universal Coverage: Multiple Paths, Many Rivers to Cross. World Health Organization; 2010.
65. Nshakira-Rukundo E, Mussa EC, Gerber N, von Braun J. Impact of voluntary community-based health insurance on child stunting: evidence from rural Uganda. *Soc Sci Med*. 2020;245:112738. doi:10.1016/j.socscimed.2019.112738
66. Basaza R, Criel B, Van der Stuyft P. Low enrollment in Ugandan Community Health Insurance schemes: underlying causes and policy implications. *BMC Health Serv Res*. 2007;7:105. doi:10.1186/1472-6963-7-105
67. Biggeri M, Nannini M, Putoto G. Assessing the feasibility of community health insurance in Uganda: a mixed-methods exploratory analysis. *Soc Sci Med*. 2018;200:145-155. doi:10.1016/j.socscimed.2018.01.027
68. Ministry of Health Uganda. Annual Health Sector Performance Report. Ministry of Health Uganda; 2012.
69. Ministry of Health Uganda. Health Sector Development Plan 2015/16-2019/20. Ministry of Health Uganda; 2015.
70. Wilunda C, Putoto G, Dalla Riva D, et al. Assessing coverage, equity and quality gaps in maternal and neonatal care in sub-Saharan Africa: an integrated approach. *PLoS One*. 2015;10(5):e0127827. doi:10.1371/journal.pone.0127827
71. SPEED. Symposium on Health Financing for UHC in LMICs proceedings report. 2017.

Improving Access to Healthcare in Sierra Leone: The Role of the Newly Developed National Emergency Medical Service

PAPER

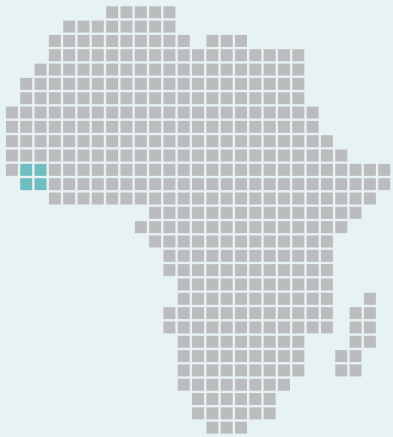
Authors
Caviglia M., Dell'Aringa M., Putoto G., Buson R., Pini S., Youkee D., Jambai A., Vandy M. J., Rosi P., Hubloue I., Della Corte F., Ragazzoni L., Barone-Adesi F.

Published in
International Journal of Environmental Research and Public Health, September 2021

Link
https://doi.org/10.3390/ijerph18189546

Topic
Universal coverage and equity

Focus country
Sierra Leone



International Journal of
Environmental Research and Public Health

MDPI

Article

Improving Access to Healthcare in Sierra Leone: The Role of the Newly Developed National Emergency Medical Service

Marta Caviglia [1,*], Marcelo Dell'Aringa [1], Giovanni Putoto [2], Riccardo Buson [2], Sara Pini [2], Daniel Youkee [3], Amara Jambai [4], Matthew Jusu Vandy [4], Paolo Rosi [5], Ives Hubloue [6], Francesco Della Corte [1], Luca Ragazzoni [1,†] and Francesco Barone-Adesi [1,†]

1 CRIMEDIM—Center for Research and Training in Disaster Medicine, Humanitarian Aid, and Global Health, Università del Piemonte Orientale, 28100 Novara, Italy; marcelo.dellaringa@uniupo.it (M.D.); francesco.dellacorte@med.uniupo.it (F.D.C.); luca.ragazzoni@med.uniupo.it (L.R.); francesco.baroneadesi@uniupo.it (F.B.-A.)
2 Research Section, Doctors with Africa CUAMM, 35121 Padua, Italy; g.putoto@cuamm.org (G.P.); r.buson@cuamm.org (R.B.); sarapini89@gmail.com (S.P.)
3 School of Population Health and Environmental Sciences, King's College London, London SE5 9NU, UK; daniel.youkee@kcl.ac.uk
4 Ministry of Health and Sanitation, Government of Sierra Leone, Freetown, Sierra Leone; amarajambai@yahoo.com (A.J.); matthewjusuvandy@yahoo.co.uk (M.J.V.)
5 SUEM 118 Venezia, Azienda ULSS 3 Serenissima, 30174 Mestre, Italy; paolo.rosi@aulss3.veneto.it
6 Research Group on Emergency and Disaster Medicine, Vrije Universiteit Brussels, 1050 Brussels, Belgium; Ives.Hubloue@vub.be
* Correspondence: marta.caviglia@med.uniupo.it
† Luca Ragazzoni and Francesco Barone-Adesi contributed equally to this work.

check for updates

Citation: Caviglia, M.; Dell'Aringa, M.; Putoto, G.; Buson, R.; Pini, S.; Youkee, D.; Jambai, A.; Vandy, M.J.; Rosi, P.; Hubloue, I.; et al. Improving Access to Healthcare in Sierra Leone: The Role of the Newly Developed National Emergency Medical Service. *Int. J. Environ. Res. Public Health* **2021**, *18*, 9546. https://doi.org/10.3390/ijerph18189546

Academic Editor: Paul B. Tchounwou

Received: 13 August 2021
Accepted: 7 September 2021
Published: 10 September 2021

Publisher's Note: MDPI stays neutral with regard to jurisdictional claims in published maps and institutional affiliations.

Copyright: © 2021 by the authors. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (https://creativecommons.org/licenses/by/4.0/).

Abstract: We aim to evaluate whether the first National Emergency Medical Service (NEMS) improved access to hospital care for the people of Sierra Leone. We performed an interrupted time-series analysis to assess the effects of NEMS implementation on hospital admissions in 25 facilities. The analysis was also replicated separately for the area of Freetown and the rest of the country. The study population was stratified by the main Free Health Care Initiative (FHCI) categories of pregnant women, children under 5 years of age, and populations excluded from the FHCI. Finally, we calculated direct costs of the service. We report a 43% overall increase in hospital admissions immediately after NEMS inception (RR 1.43; 95% CI 1.2–1.61). Analyses stratified by FHCI categories showed a significant increase among pregnant women (RR 1.54; 95% CI 1.33–1.77) and among individuals excluded from the FHCI (RR 2.95; 95% CI 2.47–3.53). The observed effect was mainly due to the impact of NEMS on the rural districts. The estimated recurrent cost per ambulance ride and NEMS yearly cost per inhabitant were 124 and 0.45 USD, respectively. To our knowledge, this is the first nationwide study documenting the increase in access to healthcare services following the implementation of an ambulance-based medical service in a low-income country. Based on our results, NEMS was able to overcome the existing barriers of geographical accessibility and transport availability, especially in the rural areas of Sierra Leone.

Keywords: Free Health Care Initiative (FHCI); National Emergency Medical Service (NEMS); emergency medical service (EMS); primary health units (PHUs); operation center (OC)

1. Introduction

Multiple barriers prevent an equitable access to healthcare services in low-income countries (LICs), leading to higher morbidity and mortality rates for both acute and chronic diseases, especially in rural communities [1–3].

Sierra Leone is one of the least developed countries worldwide, where access to healthcare is mostly constrained by geographical barriers, extremely high out-of-pocket expenditures, lack of skilled medical staff, and poor service quality [4,5]. Furthermore,

Int. J. Environ. Res. Public Health **2021**, *18*, 9546

the country's health resources are unevenly distributed, with the vast majority of referral hospitals and more than half of the entire workforce concentrated in the urban area of Freetown, the nation's capital [5].

To tackle the high rates of maternal and neonatal mortality reported in its territory, in 2010, the Sierra Leone government launched the Free Health Care Initiative (FHCI), which waived all medical-related fees for pregnant and breastfeeding women, children under the age of 5 years, and Ebola survivors [6]. Although the FHCI was effective in curbing financial barriers to accessing care, leading to an overall improvement in the utilization rates of healthcare services, wealth-related health inequalities remained prevalent, and people residing in rural areas, accounting for 59% of the total population, were still left underserved [7,8].

Similar to most of the other African countries, Sierra Leone has been long devoid of any formalized prehospital care system [9]. Since the limited number of ambulances available in the country were associated with high transport-related fees, the majority of patients used to reach hospital facilities either using private vehicles or public services, therefore bearing the costs of transport fare and often being subjected to delays in care [10].

In line with recommendations issued by the World Health Organization (WHO), in 2013, the African Federation of Emergency Medicine advocated for the development of prehospital care systems to reduce the high morbidity and mortality rates reported in African countries [11,12]. Thus, in keeping with both WHO guidelines and national health security policies, in 2016, a government-backed joint venture comprising Doctors with Africa (CUAMM, Padua, Italy), the Regional Government of Veneto (Italy), the Research Center in Emergency and Disaster Medicine (CRIMEDIM, Università del Piemonte Orientale, Italy), and the Sierra Leone Ministry of Health and Sanitation (MOHS), designed the first National Emergency Medical Service (NEMS) in Sierra Leone, one of the very few coordinated, structured, and fully equipped prehospital emergency medical services (EMS) in the African continent [5,13,14]. The goal of this newly developed entity is to provide a free-of-charge prehospital service coordinated by a centralized operation center (OC), using part of the ambulances donated to the country during the Ebola outbreak [14]. With seed funding from the World Bank (Washington, DC USA), the service started in October 2018 and reached the full operativity countrywide on the 27th of May 2019, after a gradual process of training sessions and subsequent activation in all the 14 districts of Sierra Leone [14]. After a 26-month work plan, the joint venture released a fully staffed and functional NEMS working all over Sierra Leone, managed by the local MOHS staff and funded through the governmental budget.

The aim of the present study was to evaluate the impact of this initiative on access to hospital care for the general population, with a special emphasis on underserved rural communities. We also provided an overview of the direct costs of the service.

2. Materials and Methods

2.1. Study Setting and Design

This was a retrospective study using monthly aggregated data on hospital admissions across Sierra Leone, recorded between October 2017 and November 2019. The study encompassed 25 hospital facilities distributed across the 14 districts of Sierra Leone, including government district hospitals, faith-based clinics, and health centers managed by non-governmental organizations. As the NEMS was introduced in the various districts at different times (from the 15 October 2018 to the 27 May 2019; Figure 1), we analyzed data collected 12 months before and 6 months after NEMS inception for each district.

The NEMS ambulance referral system has been designed as a tiered system of care, comprising peripheral health units (PHUs), in charge of the primary assessment and care of patients, a fleet of 81 ambulance units, and healthcare facilities at different levels [14]. It recognizes two main categories of interventions: "red" codes, which are clinically defined as "immediately life threatening", and "yellow" codes, which are clinically defined as "not life threatening but still serious." At the time of this research, NEMS activation was

initiated by a registered nurse, midwife, or healthcare worker at the PHU level, and all referred cases were appropriately evaluated and managed by trained nurses allocated to the NEMS OC through codes and scripted questions adapted from the Medical Priority Dispatch system [15], available on request from the authors. Triage accuracy and adherence to protocols were overseen by the OC Supervisor [14], and a post-hoc cross-check was performed in the category of pregnant women to confirm that the severity of the diagnosis reported coincided with the triage category assigned.

Figure 1. Time of implementation of the National Emergency Medical Service (NEMS) in the 14 districts of Sierra Leone.

Ambulances were staffed by a paramedic and an ambulance care driver, trained in the basic principles of prehospital emergency care, including management of medical emergencies, trauma, obstetrics and gynecologic and pediatric emergencies [14]. Treatments performed in the ambulances included oxygen delivery, continuation of fluid administration after peripheral intravenous cannulation performed by nurses at the PHU level, assistance during labor and delivery, administration of rectal misoprostol for the prevention of postpartum hemorrhage, and basic life support and resuscitation maneuvers without the support of automated external defibrillator.

2.2. Data Collection

Data were retrieved from the national referral coordinators' database, storing information on all incoming referrals collected at each hospital facility [16]. After initial notification of the incoming referral via telephone call from the sending PHU, patients were identified upon arrival by referral coordinators, and information regarding patient demographics, clinical condition, mode, and time of transport to the referral facility were collected through a paper report form, which was then transcribed into an Epi Info™ datasheet (Centers for Disease Control and Prevention, Atlanta, GA, USA). Data entry integrity and accuracy was monitored with monthly inspection by data collector supervisors.

Referral and in-hospital data have been recorded nationwide by the network of local referral coordinators since September 2017, before the implementation of NEMS, when the vast majority of patients used either private or public means of transport to reach

the hospital from the peripheral health units. This structured data collection system has been incorporated in the NEMS system upon its inception, and scans of patient referral forms filled by ambulance teams have been used to crosscheck data collected by referral coordinators at the hospital level.

Data extracted for this research included age, gender, FHCI category, priority ("urgent" or "non-urgent"), date and time of arrival at the hospital, and transport mode ("NEMS ambulance" or "other").

Data on the population of Sierra Leone and its districts were extracted from the 2015 Sierra Leone Census, as reported on the Sierra Leone Statistics website [8]. Additional data on costs were retrieved from the NEMS monthly financial and management internal reports from the 1 June 2019 until the 31 March 2020, during which NEMS worked at full capacity. Data included the recurrent cost of personnel, the fuel for ambulance referral (based on kilometers covered as recorded through the global positioning system (GPS) and mean consumption per kilometer), and the fuel for the generator at the NEMS OC, maintenance, insurance, GPS, medical material and personal protective equipment, and mobile phone expenses.

2.3. Statistical Analysis

We adopted standard methods for interrupted time-series to assess the effects of the introduction of the NEMS [17,18]. We carried out negative binomial regression models to account for the possible overdispersion of data. In all considered models, the dependent variable was the monthly number of hospital admissions and the population size was included as the offset. Among the independent variables of the model, the immediate effect of the intervention was modeled as a step function, using an indicator variable and taking a value of 1 at the time of implementation of NEMS in each district, whereas the gradual effects were investigated considering an interaction term between the introduction of NEMS and time [17]. To explore the effect of the introduction of NEMS on the different FHCI categories, the study population was classified according to the following groups: pregnant women, children under 5 years of age, and populations without access to free healthcare. We excluded from the analysis the remaining FHCI categories of Ebola survivors and breastfeeding women, as they included a very small number of subjects (less than 5% of the total). We performed the main analysis for the whole country, but we also carried out separate analyses for the area of Freetown and the rest of the country. We performed the analysis using Stata15 (StataCorp. 2017, College Station, TX, USA). All tests were two-sided and performed at the 5% level of statistical significance.

Calculation of the cost included recurrent costs of the intervention, while capital costs have been excluded from the analysis as the implementation phase of the project was entirely funded by the World Bank and relied on vehicles donated from around the world during the 2014–2016 Ebola crisis.

3. Results

A total of 28,574 hospital admissions in the 14 districts of Sierra Leone were included in the analysis. Table 1 shows the demographic characteristics of the analyzed population.

Both in the period before and after the implementation of the NEMS, women's access to hospital facilities was much higher compared to men. The majority of hospital admissions were represented by patients included in the FHCI, namely pregnant women and children under 5 years of age (Table 1).

An overview of the obstetric diagnosis associated with "red" codes assigned in the category of pregnant women is presented in the supplementary Table S1. After NEMS inception, 80.1% of the patient arrived at hospitals using NEMS ambulances, and in 97.8% of the cases, the mission priority was deemed as "urgent" upon arrival at the health facilities. A 43% increase in hospital admissions was observed in Sierra Leone immediately after the introduction of the NEMS (RR 1.43; 95% CI 1.26–1.61) (Table 2 and Figure 2).

Int. J. Environ. Res. Public Health **2021**, *18*, 9546

Table 1. Demographic characteristics of admitted patients before and after the introduction of the National Emergency Medical System (NEMS).

	Pre NEMS (12-Months Timeframe)	Post NEMS (6-Months Timeframe)
Gender, *n* (%)		
Female	10,741 (72.1)	9805 (71.7)
Male	4150 (27.9)	3878 (28.3)
FHCI category, *n* (%)		
Pregnant	6799 (45.6)	6104 (44.6)
Lactating	533 (3.6)	573 (4.2)
Under 5	5865 (39.4)	4398 (32.1)
Ebola Survivors	71 (0.5)	0 (0)
Non-Free Healthcare	1623 (10.9)	2608 (19)
Districts, *n* (%)		
Bo	692 (4.6)	1129 (8.2)
Bombali	658 (4.4)	941 (6.9)
Bonthe	335 (2.2)	341 (2.5)
Kailahun	574 (3.8)	668 (4.9)
Kambia	574 (3.8)	678 (4.9)
Kenema	837 (5.6)	1000 (7.3)
Koinadugu	531 (3.6)	480 (3.5)
Kono	450 (3.0)	902 (6.6)
Moyamba	417 (2.8)	457 (3.3)
Port Loko	882 (5.9)	833 (6.0)
Pujehun	2019 (13.6)	1643 (12.0)
Tonkolili	270 (1.8)	1501 (10.9)
Western Area	6652 (44.7)	3100 (22.6)
Total, *n*	14,891	13,683

Table 2. Effect of the introduction of the NEMS on hospital admission rates in Sierra Leone. The results are presented as immediate and gradual (monthly) change in the rates of hospital admissions after the introduction of the intervention.

Group	Effect of the Intervention	Rate Ratio (RR)	95% CI	*p*-Value
All	Immediate	1.43	1.26 to 1.61	<0.001
	Gradual	1.02	0.99 to 1.05	0.103
Pregnant	Immediate	1.54	1.33 to 1.77	<0.001
	Gradual	1.01	0.98 to 1.04	0.505
Under 5	Immediate	0.90	0.72 to 1.13	0.362
	Gradual	1.05	0.99 to 1.10	0.062
Non-FHCI [1]	Immediate	2.95	2.47 to 3.53	<0.001
	Gradual	1.01	0.97 to 1.05	0.603

[1] Non-FHCI = not included in the Free Health Care Initiative.

In the different subgroups, a statistically significant increase was reported among pregnant women (RR 1.54; 95% CI 1.33–1.77) and those exempted from the FHCI (RR 2.95; 95% CI 2.47–3.53), but not for children under 5 years of age (RR 0.90; 95% CI 0.72–1.13). We did not find evidence of an additional gradual effect of the intervention over time, as there was no statistically significant change in the underlying trend in admissions after the implementation of the NEMS. Analyses stratified by area showed a very different pattern in Freetown compared to the rest of the country (Table 3). Overall, there was no increase in hospital admissions in Freetown. Pregnant women reported a 39% (RR 1.37; 95% CI 1.05–1.84) immediate increase and a monthly 6% (RR 1.06; 95% CI 1.02–1.11) gradual increase following the activation of the NEMS, while a substantial drop (RR 0.36 95% CI 0.27–0.47) in hospital admissions was observed among children under 5 years of age (Figure 3). Access to a hospital for subjects not included in the FHCI remained stable over time.

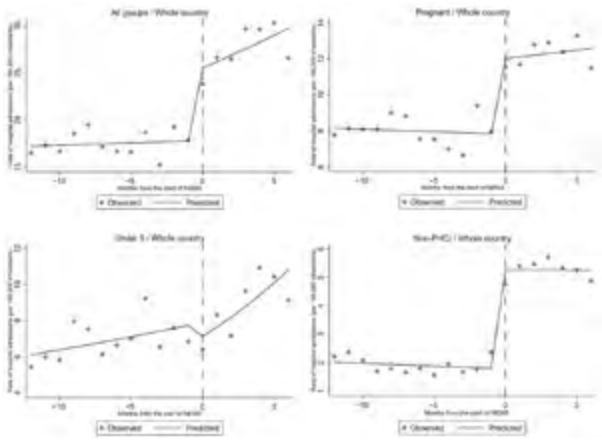


Figure 2. Observed and predicted hospital admission rates in Sierra Leone before and after the introduction of the NEMS. The results are also stratified by categories of the Free Health Care Initiative.

Table 3. Effect of the introduction of the NEMS on hospital admission rates in Freetown. The results are presented as immediate and gradual (monthly) change in the rates of hospital admissions after the introduction of the intervention.

Group	Effect of the Intervention	Rate Ratio (RR)	95% CI	*p*-Value
All	Immediate	0.80	0.65 to 0.99	0.041
	Gradual	1.05	1.02 to 1.09	<0.001
Pregnant	Immediate	1.39	1.05 to 1.84	0.021
	Gradual	1.06	1.02 to 1.11	0.001
Under 5	Immediate	0.36	0.27 to 0.47	<0.001
	Gradual	1.03	0.99 to 1.07	0.090
Non-FHCI	Immediate	0.95	0.63 to 1.44	0.825
	Gradual	1.09	1.04 to 1.16	0.001

Non-FHCI = not included in the Free Health Care Initiative.

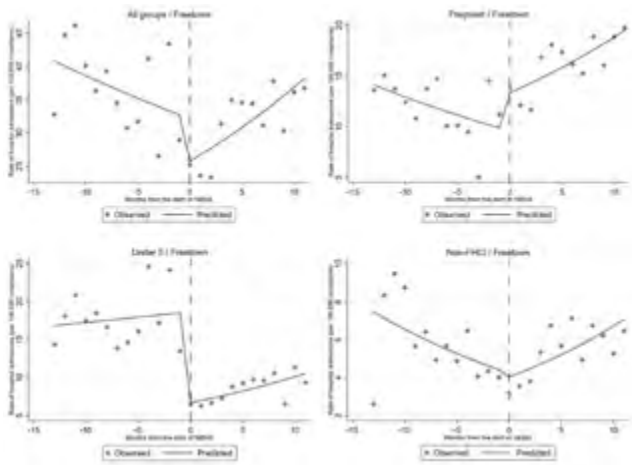


Figure 3. Observed and predicted hospital admission rates in Freetown before and after the introduction of the NEMS. The results are also stratified by categories of the Free Health Care.

Int. J. Environ. Res. Public Health **2021**, *18*, 9546

Conversely, in the rest of the country an immediate increase in the number of hospital admissions was evident both overall and for all considered subgroups, except for children under 5 years of age (Table 4 and Figure 4).

Table 4. Effect of the introduction of NEMS on hospital admission rates in Freetown. The results are presented as immediate and gradual (monthly) change in the rates of hospital admissions after the introduction of the intervention.

Group	Effect of the Intervention	Rate Ratio (RR)	95% CI	*p*-Value
All	Immediate	1.77	1.49 to 2.11	<0.001
	Gradual	0.98	0.94 to 1.02	0.358
Pregnant	Immediate	1.59	1.40 to 1.82	<0.001
	Gradual	0.98	0.95 to 1.00	0.179
Under 5	Immediate	1.36	0.88 to 2.11	0.154
	Gradual	1.01	0.92 to 1.12	0.751
Non-FHCI	Immediate	3.82	2.96 to 4.92	<0.001
	Gradual	0.85	0.81 to 0.90	<0.001

Non-FHCI = not included in the Free Health Care Initiative.

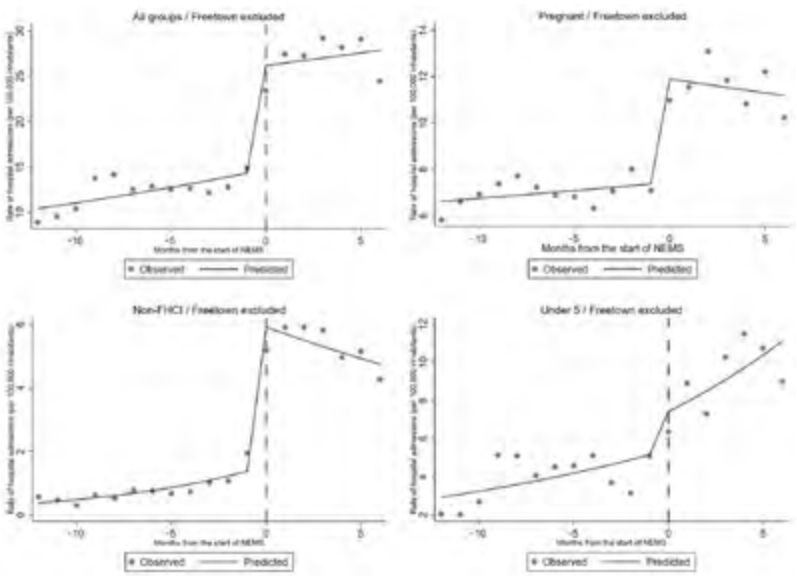


Figure 4. Observed and predicted hospital admission rates in Sierra Leone, with the exclusion of Freetown, before and after the introduction of NEMS. The results are also stratified by categories of the Free Health Care Initiative.

Table 5 shows the estimated costs of the intervention. The majority of expenses were composed of personnel costs. The estimated recurrent cost per ambulance ride was 124 USD, based on an average monthly number of 2366 NEMS missions. The NEMS' yearly cost per inhabitant was 0.45 USD.

Table 5. Estimated recurrent cost of the intervention.

Title 1	Title 2	Title 3
NEMS Generator Fuel	7	561
Ambulance Fuel	439	35,567
Ambulance Maintenance	336	27,207
GPS	23	1903
Mobile Phones Air-time [1]	32	2626
Medical Material and PPEs [2]	94	7574
Insurance	16	1296
Paramedics salary [3]	1406	113,850
OC [4] operators' salary	94	7590
Drivers' salary	1178	95,400
Total	3624	293,574

Costs are expressed in US dollars, with an exchange rate of 1 USD = 10235 Sierra Leone Leones; [1] Mobile phones were provided to all the ambulances (n = 81); [2] Personal Protective Equipment; [3] Salary of personnel includes health insurance and involves 450 paramedics, 450 ambulance drivers, and 30 OC operators; [4] Operation Center.

4. Discussion

The results of our study show that the implementation of NEMS in Sierra Leone was associated with an overall increase in access to hospitals. The rise in hospital admissions was observed not only among individuals with free access to healthcare services, but also among those not exempted from payment, suggesting that prior to NEMS inception, geographical and transportation barriers played an important role in limiting the access to the country's healthcare services, irrespective of the possible financial constraints of subjects. This aspect corroborates findings from studies performed in other LICs, where distance or travel time to health facilities was inversely related to the healthcare seeking behavior of the population [19,20].

Moreover, the observation that underserved rural communities benefited the most from the activation of the free ambulance service in terms of ability to reach hospital care suggests that NEMS was effective in reducing health inequalities between urban and rural areas in Sierra Leone. Fittingly, we did not observe any major increment in hospital admission rates in the Freetown area, the most heavily populated district in the country, characterized by a higher concentration of healthcare facilities and better road conditions. Indeed, it is well established that urban residents of LICs have a much better prospect of accessing healthcare services compared to that of people living in rural communities, inevitably affected by structural constraints and health inequities [21–23].

The results stratified by FHCI categories show an increase in the number of hospital admissions of pregnant women upon NEMS inception. Although healthcare service utilization rates among pregnant women increased after the implementation of FHCI, this improvement was deemed not adequate enough to meet the sustainable development goals of the country [7,24,25]. Indeed, the FHCI had to face a number of issues hampering its effectiveness, first and foremost the non-affordability of transport-related indirect costs for people residing in rural areas [7,26,27] Moreover, the decision to seek care in health facilities during childbirth in rural Sierra Leone is also affected by a number of cultural and sociodemographic factors that often limit the impact of public health initiatives [26,28]. Although it is argued that the sole availability of EMS does not equal access to care when barriers related to the social acceptability of the initiatives are not fully addressed [29], our findings suggest that the development of a nationwide referral system (e.g., NEMS) may be a key strategy to boost the effects of other healthcare interventions already in place. Notwithstanding the countrywide support through awareness and public sensitization campaigns [14], future studies will be useful to assess the current acceptability of NEMS among the population of Sierra Leone and to inform public health initiatives.

Another interesting finding of our study is the decreased number of hospital admissions among "children under 5" in the Freetown area, which was evident immediately after

the implementation of the NEMS. This observation may be explained by the presence of a big referral facility in Freetown, the Ola During Children's Hospital, which used to treat a substantial number of pediatric cases from other districts before NEMS inception. Our results suggest that the NEMS allowed a better distribution of pediatric patients among the districts surrounding the capital, with a possible improvement in the use of available healthcare services.

To our knowledge, this is the first nationwide study documenting the impact of a newly developed EMS on health service utilization rates in a LIC. Although previous studies performed in low- and lower middle-income African countries attempted to evaluate the few existing referral systems, analyses were restricted to the local, district, or regional level [30–35].

A relevant aspect that arose from the implementation of NEMS in Sierra Leone was the importance of developing a robust and reliable patient referral network, featuring an efficient communication network and well-defined standard operating procedures [14]. Referral systems in LICs are often compromised by systemic inefficiencies, including a lack of coordination between the different healthcare facilities levels, which either cause a delay in access to care or lead to over congestion of referral hospitals [36]. In Ghana, for example, poor communication between referrers and receivers has been shown to undermine the entire referral process [33,37]. Additionally, despite being key to assess the status and the performance of the entire EMS system, monitoring and quality assurance programs are frequently either absent or only partially developed among African LICs [9,34]. Our results indicate that almost all patients transported to hospital facilities met the priority criteria identified for NEMS interventions, suggesting a high compliance with the NEMS standard operating procedures for referrals and effective communication at different levels. Furthermore, the integration of the national referral coordinators' database into the NEMS information system, which allowed for continuous monitoring of NEMS operations at the national level, represented an additional point of strength of the project, allowing to understand the demand of emergency services and to adopt corrective and preventive measures. In this regard, we believe that processes of continuous oversight, supervisory actions, and monitoring efforts contributed greatly to achieve such a level of efficiency.

Of note, the vast majority of hospital admissions recorded after the implementation of NEMS involved the use of NEMS ambulances. This high utilization rate is associated with an average cost of the service that is slightly higher compared to other African countries, where, however, referral systems are only regionally developed and less structured than NEMS [38,39]. It is also worth mentioning that a significant share of the total expenditure is related to wage expenses, as NEMS fleet accounts for 930 ground personnel, and the monthly remuneration of 250 USD offered to NEMS paramedics is higher than the average salary of nurses working in public hospitals, in order to attract and retain trained personnel [40].

The findings of this study should be interpreted considering some limitations. First, although the systematic collection of data was deemed accurate, information regarding admission and discharge diagnoses of patients was recorded as free text and were often either unreliable or missing. Additionally, information regarding in-hospital treatment was missing. For this reason, it was not possible to evaluate whether the implementation of the NEMS effectively translated in better clinical outcomes for patients nor if hospital admission had any detrimental effect on patients excluded from the FHCI who had to bear out of pocket expenditures to receive treatments. To overcome these technical limitations, we plan to perform additional studies on selected healthcare facilities, where more accurate clinical information might be available. Moreover, as the data analyzed did not include patients' follow-up after hospital discharge, we were unable to provide information on how patients returned home from hospital facilities, and patients' perspectives were not investigated in a qualitative manner.

As in any observational study, the role of possible confounders cannot be definitely ruled out. However, confounding in time series studies is usually limited to factors that are

related to the outcome of interest and change at the time of the intervention [41]. In contrast, temporal changes in the prevalence of individual risk factors shape the underlying long-term trends and are, thus, inherently considered in this kind of analysis. To our knowledge, with the exclusion of NEMS, no other nation-wide intervention potentially able to cause a sharp increase in rates of hospital admissions took place in Sierra Leone during the study period. Moreover, NEMS was implemented at different times in the different districts, over an 8-month timespan, and the effect appeared almost immediately after the intervention. These two facts make it unlikely that unmeasured confounding played a major role in the observed results.

5. Conclusions

In conclusion, the present study demonstrates that the implementation of NEMS in Sierra Leone enhanced access to hospital care among vulnerable populations by overcoming existing barriers, such as geographical accessibility and transport availability, especially in the rural areas of the country. Our findings suggest that NEMS was able to boost the effects of the FHCI, therefore building on the existing governmental strategy to improve maternal and child health indicators and to achieve the sustainable development goals of Sierra Leone. Altogether, our findings may serve as the basis for the development and evaluation of prehospital emergency and referral services in other LICs.

Supplementary Materials: The following are available online at https://www.mdpi.com/article/10.3390/ijerph18189546/s1, Table S1: Classification of NEMS obstetric emergencies triaged as "red" codes.

Author Contributions: Conceptualization, M.C., L.R. and F.B.-A.; Data curation, M.C. and S.P.; Formal analysis, M.C., M.D. and F.B.-A.; Investigation, M.C., G.P., L.R. and F.B.-A.; Methodology, M.C., M.D. and F.B.-A.; Project administration, G.P., R.B., S.P. and P.R.; Resources, M.C., R.B., D.Y., A.J., M.J.V. and P.R.; Supervision, I.H., F.D.C., L.R. and F.B.-A.; Validation, F.B.-A.; Visualization, M.C.; Writing—original draft, M.C.; Writing—review and editing, M.D., G.P., R.B., S.P., D.Y., A.J., M.J.V., P.R., I.H., F.D.C., L.R. and F.B.-A. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Institutional Review Board Statement: This study was conducted according to the guidelines of the Declaration of Helsinki and approved by the Office of Sierra Leone Ethics and Scientific Review Committee (23 June 2020) and by the Ethics Committee of the Maggiore Hospital, Novara, Italy (28 July 2020, CE/203).

Informed Consent Statement: Not applicable.

Data Availability Statement: Restrictions apply to the availability of these data. Data were obtained from the National Referral Coordinators Database and are available from the authors with the permission of the Ministry of Health and Sanitation of Sierra Leone.

Acknowledgments: The study was conducted in the framework of the International PhD in Global Health, Humanitarian Aid and Disaster Medicine jointly organized by the Università del Piemonte Orientale (UPO) and the Vrije Universiteit Brussel (VUB).

Conflicts of Interest: The authors declare no conflict of interest.

References

1. Ouma, P.O.; Maina, J.; Thuranira, P.N.; Macharia, P.M.; Alegana, V.A.; English, M.; Okiro, E.A.; Snow, R.W. Access to emergency hospital care provided by the public sector in sub-Saharan Africa in 2015: A geocoded inventory and spatial analysis. *Lancet Glob. Health* **2018**, *6*, e342–e350. [CrossRef]
2. Strasser, R.; Kam, S.M.; Regalado, S.M. Rural Health Care Access and Policy in Developing Countries. *Ann. Rev. Public Health* **2016**, *37*, 395–412. [CrossRef] [PubMed]
3. Rutherford, M.E.; Mulholland, K.; Hill, P.C. How access to health care relates to under-five mortality in sub-Saharan Africa: Systematic review. *Trop. Med. Int. Health* **2010**, *15*, 508–519. [CrossRef]

4. Human Development Reports. Sierra Leone. 2020. Available online: http://hdr.undp.org/en/countries/profiles/SLE (accessed on 22 July 2021).
5. Ministry of Health and Sanitation, Republic of Sierra Leone. National Health Sector Strategic Plan 2017–2021. 2017. Available online: https://extranet.who.int/countryplanningcycles/sites/default/files/planning_cycle_repository/sierra_leone/sierra_leone_nhssp_2017-21_final_sept2017.pdf (accessed on 22 July 2021).
6. Donnelly, J. How did Sierra Leone provide free health care? *Lancet* **2011**, *377*, 1393–1396. [CrossRef]
7. Jalloh, M.B.; Bah, A.J.; James, P.B.; Sevalie, S.; Hann, K.; Shmueli, A. Impact of the free healthcare initiative on wealth-related inequity in the utilization of maternal & child health services in Sierra Leone. *BMC Health Serv. Res.* **2019**, *19*, 352. [CrossRef]
8. Statistics Sierra Leone. Population and Housing Census Statistics. 2015. Available online: https://www.statistics.sl/index.php/census/census-2015.html (accessed on 22 July 2021).
9. Mould-Millman, N.K.; Dixon, J.M.; Sefa, N.; Yancey, A.; Hollong, B.G.; Hagahmed, M.; Ginde, A.A.; Wallis, L.A. The State of Emergency Medical Services (EMS) Systems in Africa. *Prehosp. Disaster Med.* **2017**, *32*, 273–283. [CrossRef]
10. Maxmen, A. Sierra Leone's free health-care initiative: Work in progress. *Lancet* **2013**, *381*, 191–192. [CrossRef]
11. Calvello, E.; Reynolds, T.; Hirshon, J.M.; Buckle, C.; Moresky, R.; O'Neill, J.; Wallis, L.A. Emergency care in sub-Saharan Africa: Results of a consensus conference. *Afr. J. Emerg. Med.* **2013**, *3*, 42–48. [CrossRef]
12. Sasser, S.; Varghese, M.; Kellermann, A.; Lormand, J.D. *Prehospital Trauma Care Systems*; World Health Organization: Geneva, Switzerland, 2005.
13. World Health Organization. *Sixtieth World Health Assembly. Resolution WHA 60.22: Emergency-Care Systems*; World Health Organization: Geneva, Switzerland, 2007.
14. Ragazzoni, L.; Caviglia, M.; Rosi, P.; Buson, R.; Pini, S.; Merlo, F.; Della Corte, F.; Vandy, M.J.; Jambai, A.; Putoto, G. Designing, Implementing, and Managing a National Emergency Medical Service in Sierra Leone. *Prehosp. Disaster Med.* **2021**, *36*, 115–120. [CrossRef]
15. Medical Priority Dispatch System. Available online: https://www.emergencydispatch.org/what-we-do/emergency-priority-dispatch-system/medical-protocol (accessed on 22 July 2021).
16. Youkee, D.; Bangura, T.; O'Neill, K.; Hartshorn, L.; Samura, S. *An Observational Study of a National Referral System: An Analysis of 14,266 Referrals in Sierra Leone*; Research Square: Durham, NC, USA, 2020.
17. Bernal, J.L.; Cummins, S.; Gasparrini, A. Interrupted time series regression for the evaluation of public health interventions: A tutorial. *Int. J. Epidemiol.* **2017**, *46*, 348–355. [CrossRef]
18. Hategeka, C.; Ruton, H.; Karamouzian, M.; Lynd, L.D.; Law, M.R. Use of interrupted time series methods in the evaluation of health system quality improvement interventions: A methodological systematic review. *BMJ Glob. Health* **2020**, *5*, e003567. [CrossRef]
19. Jacobs, B.; Ir, P.; Bigdeli, M.; Annear, P.L.; Van Damme, W. Addressing access barriers to health services: An analytical framework for selecting appropriate interventions in low-income Asian countries. *Health Policy Plan.* **2012**, *27*, 288–300. [CrossRef]
20. Hjortsberg, C. Why do the sick not utilise health care? The case of Zambia. *Health Econ.* **2003**, *12*, 755–770. [CrossRef]
21. Afful-Mensah, G.; Nketiah-Amponsah, E.; Boakye-Yiadom, L. Rural-Urban Differences in the Utilization of Maternal Healthcare in Ghana: The Case of Antenatal and Delivery Services. *Afr. Soc. Sci. Rev.* **2013**, *6*, 4.
22. Yaya, S.; Uthman, O.A.; Okonofua, F.; Bishwajit, G. Decomposing the rural-urban gap in the factors of under-five mortality in sub-Saharan Africa? Evidence from 35 countries. *BMC Public Health* **2019**, *19*, 616. [CrossRef]
23. Okoli, C.; Hajizadeh, M.; Rahman, M.M.; Khanam, R. Geographical and socioeconomic inequalities in the utilization of maternal healthcare services in Nigeria: 2003–2017. *BMC Health Serv. Res.* **2020**, *20*, 849. [CrossRef] [PubMed]
24. Shanker, A. Equity Case Study: Sierra Leone—Removing Health Care User Fees to Improve Prospects for Mothers and Children. 2012. Available online: https://www.unicef.org/equity/archive/index_65330.html (accessed on 22 July 2021).
25. World Health Organization. Millennium Development Goals 4 and 5. 2020. Available online: https://www.who.int/pmnch/about/about_mdgs/en/ (accessed on 22 July 2021).
26. Treacy, L.; Sagbakken, M. Exploration of perceptions and decision-making processes related to childbirth in rural Sierra Leone. *BMC Pregnancy Childbirth* **2015**, *15*, 87. [CrossRef] [PubMed]
27. Treacy, L.; Bolkan, H.A.; Sagbakken, M. Correction: Distance, accessibility and costs. Decision-making during childbirth in rural Sierra Leone: A qualitative study. *PLoS ONE* **2018**, *13*, e0196523. [CrossRef] [PubMed]
28. Tsawe, M.; Sathiya Susuman, A. Factors associated with the upsurge in the use of delivery care services in Sierra Leone. *Public Health* **2020**, *180*, 74–81. [CrossRef]
29. Anto-Ocrah, M.; Cushman, J.; Sanders, M.; De Ver Dye, T. A woman's worth: An access framework for integrating emergency medicine with maternal health to reduce the burden of maternal mortality in sub-Saharan Africa. *BMC Emerg. Med.* **2020**, *20*, 3. [CrossRef]
30. De Ramirez, S.S.; Doll, J.; Carle, S.; Anest, T.; Arii, M.; Hsieh, Y.H.; Okongo, M.; Moresky, R.; Sachs, S.E.; Millin, M. Emergency response in resource-poor settings: A review of a newly-implemented EMS system in rural Uganda. *Prehosp. Disaster Med.* **2014**, *29*, 311–316. [CrossRef] [PubMed]
31. Tayler-Smith, K.; Zachariah, R.; Manzi, M.; Van den Boogaard, W.; Nyandwi, G.; Reid, T.; De Plecker, E.; Lambert, V.; Nicolai, M.; Goetghebuer, S.; et al. An ambulance referral network improves access to emergency obstetric and neonatal care in a district of rural Burundi with high maternal mortality. *Trop. Med. Int. Health* **2013**, *18*, 993–1001. [CrossRef] [PubMed]

32. Mahama, M.N.; Kenu, E.; Bandoh, D.A.; Zakariah, A.N. Emergency response time and pre-hospital trauma survival rate of the national ambulance service, Greater Accra (January–December 2014). *BMC Emerg. Med.* **2018**, *18*, 33. [CrossRef] [PubMed]
33. Mould-Millman, N.K.; Oteng, R.; Zakariah, A.; Osei-Ampofo, M.; Oduro, G.; Barsan, W.; Donkor, P.; Kowalenko, T. Assessment of Emergency Medical Services in the Ashanti Region of Ghana. *Ghana Med. J.* **2015**, *49*, 125–135. [CrossRef] [PubMed]
34. Venkatraman, C.; Odusola, A.O.; Malolan, C.; Kola-Korolo, O.; Olaomi, O.; Idris, J.; Nwariaku, F.E. Lagos state ambulance service: A performance evaluation. *Eur. J. Trauma Emerg. Surg.* **2020**. [CrossRef]
35. Scott, J.W.; Nyinawankusi, J.D.; Enumah, S.; Maine, R.; Uwitonze, E.; Hu, Y.; Kabagema, I.; Byiringiro, J.C.; Riviello, R.; Jayaraman, S. Improving prehospital trauma care in Rwanda through continuous quality improvement: An interrupted time series analysis. *Injury* **2017**, *48*, 1376–1381. [CrossRef]
36. Pittalis, C.; Brugha, R.; Gajewski, J. Surgical referral systems in low- and middle-income countries: A review of the evidence. *PLoS ONE* **2019**, *14*, e0223328. [CrossRef]
37. Daniels, A.A.; Abuosi, A. Improving emergency obstetric referral systems in low and middle income countries: A qualitative study in a tertiary health facility in Ghana. *BMC Health Serv. Res.* **2020**, *20*, 32. [CrossRef]
38. Somigliana, E.; Sabino, A.; Nkurunziza, R.; Okello, E.; Quaglio, G.; Lochoro, P.; Putoto, G.; Manenti, F. Ambulance service within a comprehensive intervention for reproductive health in remote settings: A cost-effective intervention. *Trop. Med. Int. Health* **2011**, *16*, 1151–1158. [CrossRef]
39. Accorsi, S.; Somigliana, E.; Solomon, H.; Ademe, T.; Woldegebriel, J.; Almaz, B.; Zemedu, M.; Manenti, F.; Tibebe, A.; Farese, P.; et al. Cost-effectiveness of an ambulance-based referral system for emergency obstetrical and neonatal care in rural Ethiopia. *BMC Pregnancy Childbirth* **2017**, *17*, 220. [CrossRef]
40. Ministry of Health and Sanitation, Republic of Sierra Leone. Human Resources for Health Country Profile. 2016. Available online: https://www.afro.who.int/sites/default/files/2017-05/hrhprofile16.pdf (accessed on 22 July 2021).
41. Wagner, A.K.; Soumerai, S.B.; Zhang, F.; Ross-Degnan, D. Segmented regression analysis of interrupted time series studies in medication use research. *J. Clin. Pharm. Ther.* **2002**, *27*, 299–309. [CrossRef] [PubMed]

Low-Wage Agricultural Migrant Workers in Apulian Ghettos, Italy: General Health Conditions Assessment and HIV Screening

PAPER

Authors
Di Gennaro F., Lattanzio R., Falanga C., Negri S., Papagni R., Novara R., Panico G. G., Totaro V., Poliseno M., Bavaro D. F., Raho L., Schiavone M., Laforgia N., Volpe A., Laforgia R., Lo Caputo S., Marotta C., Putoto G. and Saracino A.

Published in
Tropical Medicine and Infectious Disease, October 2021

Link
https://doi.org/10.3390/tropicalmed6040184

Topic
Universal coverage and equity

Focus country
Italy

Tropical Medicine and Infectious Disease

MDPI

Article

Low-Wage Agricultural Migrant Workers in Apulian Ghettos, Italy: General Health Conditions Assessment and HIV Screening

Francesco Di Gennaro [1,2,*], Rossana Lattanzio [1], Carmine Falanga [3], Silvia Negri [3], Roberta Papagni [1], Roberta Novara [1], Gianfranco Giorgio Panico [1], Valentina Totaro [1], Mariacristina Poliseno [4], Davide Fiore Bavaro [1], Lucia Raho [2], Marcella Schiavone [2], Nicole Laforgia [2], Alessandro Volpe [1], Renato Laforgia [2], Sergio Lo Caputo [4,5], Claudia Marotta [2], Giovanni Putoto [2] and Annalisa Saracino [1]

[1] Clinic of Infectious Diseases, University of Bari, University Hospital Policlinico, 70124 Bari, Italy; rossana.lattanzio@gmail.com (R.L.); robertapapagni0@gmail.com (R.P.); roberta.novara@gmail.com (R.N.); panico.gianfranco@gmail.com (G.G.P.); valenduzza@hotmail.it (V.T.); davidebavaro@gmail.com (D.F.B.); alessandro_volpe@hotmail.it (A.V.); annalisa.saracino@uniba.it (A.S.)

[2] Operational Research Unit, Doctors with Africa CUAMM, 35121 Padua, Italy; luxraho@gmail.com (L.R.); marcella.schiavone@gmail.com (M.S.); n.laforgia@gmail.com (N.L.) renatolaforgia@gmail.com (R.L.); marotta.claudia@gmail.com (C.M.); g.putoto@cuamm.org (G.P.)

[3] ANLAIDS Sezione Lombarda, 20124 Milano, Italy; falanga@anlaidslombardia.it (C.F.); psico.silvianegri@gmail.com (S.N.)

[4] Infectious Diseases Unit, Department of Clinical and Experimental Medicine, A.O.U. "Policlinico Riuniti", 710121 Foggia, Italy; polisenomc@gmail.com (M.P.); sergiolocaputo@gmail.com (S.L.C.)

[5] Italian Society for Infectious and Tropical Diseases—(SIMIT), Appulo Lucana Section, 70124 Bari, Italy

* Correspondence: Francesco.digennaro1@uniba.it or cicciodigennaro@yahoo.it

Abstract: Background: Approximately 500,000 migrants work in the agricultural sector in Italy. Many of them live in shantytowns, wrongly called "ghettos", far away from city centers, with no water, proper hygienic conditions or health services. The aim of this study is to assess general health conditions and HIV prevalence by giving hygienic and sanitary sustenance. Methods: Between June 2019 and February 2020, we performed a screening campaign for HIV–diabetes–hypertension, involving migrants living in three Apulian establishments: ghetto Pista, "Sankara House" and "Arena House". Results: Overall, 321 migrants were enrolled in the study. In the medical screening, one HIV test resulted positive. Hypertension was found in 12% of the migrants visited, diabetes in 2% and TB symptoms in 17%. Among others symptoms explored, muscle and joint pain/fatigue resulted in being the most frequent, and was reported by 34% of the migrants, followed by cough (10%). Significant predictors of muscle and joint pain/fatigue were: low BMI values (OR = 1.32; 95% CI 1.19–1.99), the absence of education (OR = 1.85; 95% CI 1.02–2.95), being employed with a regular contract (OR = 2.64; 95% CI 2.39–2.83) and living in the ghettos since >12 months (OR = 1.74; 95% CI 1.24–2.21). Conclusions: Our experience suggests that, in this population, the health condition is mainly linked to the specific working activities in the agricultural fields, as well as to the hygienic and living conditions, and that all of this is due to the lack of social protection in their life and job.

Keywords: migrant; health status; HIV; Puglia

check for updates

Citation: Di Gennaro, F.; Lattanzio, R.; Falanga, C.; Negri, S.; Papagni, R.; Novara, R.; Panico, G.G.; Totaro, V.; Poliseno, M.; Bavaro, D.F.; et al. Low-Wage Agricultural Migrant Workers in Apulian Ghettos, Italy: General Health Conditions Assessment and HIV Screening. *Trop. Med. Infect. Dis.* **2021**, *6*, 184. https://doi.org/10.3390/tropicalmed6040184

Academic Editor: John McBride

Received: 7 September 2021
Accepted: 12 October 2021
Published: 15 October 2021

Publisher's Note: MDPI stays neutral with regard to jurisdictional claims in published maps and institutional affiliations.

Copyright: © 2021 by the authors. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (https://creativecommons.org/licenses/by/4.0/).

1. Introduction

Although there is a lack of official and accurate data, it is estimated that about 500,000 migrant workers are involved in the agricultural sector in Italy; this represents half of all workers employed in agriculture in Italy [1,2].

They are a class of exploited workers and are often immigrants from the poorest countries. Most of the workers indeed come from sub-Saharan Africa, but also from Asia and Eastern Europe. Their living conditions are miserable [2,3]. Agricultural workers are

paid on a "piecework" basis, so based on the amount of harvest rather than on the time spent working, like other jobs. Thus, often they are paid more or less 12 euros for eight hours of work under the supervision of corporals [3,4].

These workers work in extremely vulnerable conditions and are further at risk when they are employed illegally by mafia-like organizations. All of this characterizes a reality made by slavery, violence, illegal recruitment, hard work and the total absence of workers' rights. This phenomenon is called "caporalato", which is a form of illegal recruitment and exploitation of labor through an intermediary, precisely called "caporale". It is widespread throughout Italy and it is particularly frequent in the agricultural and farming sectors [3,4]. There are "ringleaders", the so-called "Caporali", who are modern-day slave masters. Moreover, workers are often victims of physical assault and sexual violence and the withholding of wages and documents, and all of these are associated with threats to their families if they refuse to work under conditions imposed by the corporal. The corporal has contact with the landowner and is responsible for the transport. The workers are transported from the ghetto to the field through a minibus tested for 10 people, but they are also transported in 30. They arrive at the camp and have to recover a chest that, when empty, already weighs 70 kg. They fill it with tomatoes or oranges or other fruit depending on the season, for a total weight of 400 kg. In order to fill it up, it takes around an hour and a half. One single filled chest pays EUR 1.50 to the migrants. An average, young and healthy migrant, in one day, manages to fill eight boxes in 10 h for a total of EUR 12. Out of these EUR 12, EUR 5 must be subtracted for transport to be delivered to the corporal. A sandwich plus a small bottle of water costs EUR 3.50, and gloves cost EUR 1.50. At the end of the day, EUR 2.00 remain. Out of which, sometimes, 50 cents are subtracted in order to recharge the phone, and EUR 1.00 is substracted for a hot shower. This is money that is always requested and collected by the caporale [2–5].

Many of them live in ghettos and shanty towns, isolated from urban centers, where houses are made of tents, shacks, sheets and boards, and where windows are made of car wheel rims or seat covers. Those who are luckier live in houses that have been abandoned for a long time, with no water and no heating, which is why they often light fires, which then leads to large and sometimes destructive fires. Hygienic conditions or health services are totally absent [2].

Refs. [3–5] It is estimated that there are 50–70 ghettos in Italy that host approximately 100,000 underpaid migrant workers [4–6]. This is only an estimate; there is no official census. In spite of the universal health care system and laws protecting migrants' health, they have limited or no access to essential medical care. Regional governments, NGOs (non-governmental organization), associations and Caritas (social organizations of the Catholic Church) are trying to limit the damage of this huge and currently uncontrolled phenomenon.

Since 2015, Doctors with Africa CUAMM aims to improve the health conditions of agricultural workers living in three ghettos in Puglia by offering free-of-charge primary health care service in several settlements through a mobile clinic and a multidisciplinary team. In order to improve the sanitary assistance, this study aims to assess general health conditions and HIV prevalence.

2. Materials and Methods

2.1. Study Setting, Design and Population

Since 2015, Doctors with Africa CUAMM is committed to improving the health conditions of agricultural workers by offering free-of-charge primary health care service in several settlements through a mobile clinic and a multidisciplinary team with at least one specialized doctor, a dentist, two nurses, a cultural mediator, several volunteers and a logistician. As part of the mobile clinic services, between June 2019 and February 2020, Doctors with Africa CUAMM, in partnership with University of Bari-Infectious Diseases Clinic Bari, Anlaids and the Apulian section of the Italian Society for Infectious and Tropi-

cal diseases—(SIMIT), performed a screening campaign for HIV–diabetes–hypertension, involving migrants living in three Apulian establishments (Figure 1):

1. Ghetto Pista in Borgo Mezzanone, province of Manfredonia, an informal spontaneous settlement with 1500 estimated inhabitants;
2. "Casa Sankara" and "Arena", both based in San Severo, province of Foggia, and arranged by the Apulia region for the agricultural workers population.

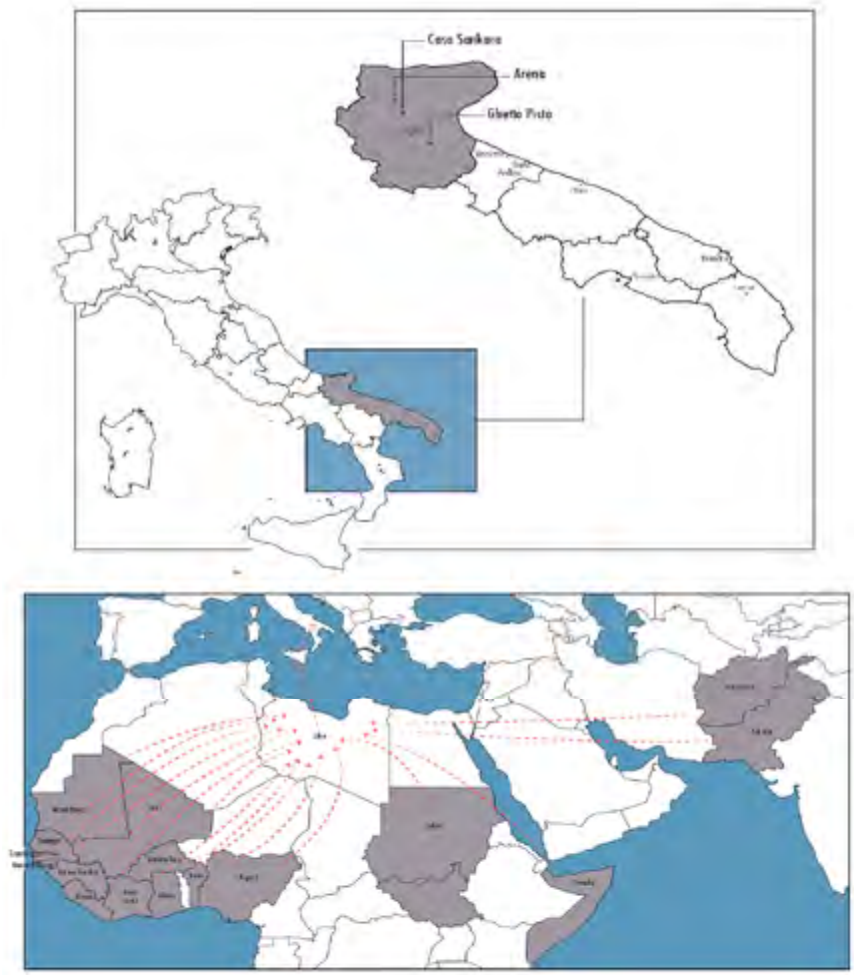


Figure 1. Localization of ghettos in Apulia region and countries of origins of migrants.

The eligible population included all of the people who were present in these establishments during the period of study. No exclusion criteria were used for this study.

2.1.1. Questionnaires

A standardized questionnaire was administered through a face-to-face interview conducted by trained nurses and doctors. It is made of questions divided into four sections: (I) socio-demographic information (age, education, occupation, marital status, typology of work contract, document to stay in Italy, information on travel from their country to

Italy), (II) sexual habits (possible pregnancy, concurrent sex partners, condom use, smoke habit and alcohol abuse, etc.), (III) medical history (including TB symptoms and other communicable—non communicable diseases) and (IV) information on HIV (previous test, HIV stigma). Before starting the interview, informed consent was obtained and the study aims were explained, as well as the methods used, to ensure the confidentiality of the data. At the end of the interview, participants received health advice if requested. The collected data were entered in a dedicated database and a quality control check of the data entry was performed before data analysis.

2.1.2. Medical Examinations

Medical examinations were carried out and medical treatment was prescribed and issued when needed, and an HIV test was also performed. A basic physical examination (vital signs, weight, height, waist circumference, blood pressure, oxygen saturation and general appearance) was performed. The body mass index (BMI) was calculated and blood pressure (BP) was measured (high pressure defined as BP > 140/90 mmHg). For the diabetes screening, two consecutive fasting blood glucose tests were performed to each participant. According to the WHO guidelines, patients were considered as non-diabetic if both measurements were $\leq$110 mg/dL and as diabetic if both measurements were above 126 mg/dL. If at least one value was between 110 and 126 mg/dL, the oral glucose tolerance test (OGTT) was performed: patients were considered diabetic when plasma glucose at 2 h was $\geq$200 mg/dL.

After informed consent, a 3rd generation capillary HIV blood rapid test was used (Alere Determine, Abbott) for HIV testing.

2.2. Statistical Analysis

Descriptive analysis was performed to define the distribution of the characteristics of the sample, and a χ^2 test (with Fisher's correction if fewer than five cases were present in a cell) was applied for categorical variables. A logistic regression model was implemented as follows. Muscle and joint pain/fatigue was considered as dependent variables and each one of the available factors at the baseline evaluation as independent variables (univariate analysis). In the multivariate analysis, factors with a p-value < 0.10, as assessed by univariate analysis, were included. Multicollinearity among covariates was assessed through the variance inflation factor, taking a value of 2 as cut-off to exclude a covariate. However, no variables were excluded according to this pre-specified criterion. Odds ratios (O.R.s) as adjusted odds ratios (adj-O.R.s) with 95% confidence intervals (CIs) were used to measure the strength of the association between factors at the baseline (exposure) and presence of muscle and joint pain/fatigue (outcome). All statistical tests were two-tailed and statistical significance was assumed for a p-value < 0.05. Statistical analyses were performed with GraphPad Prism version 8.0 (GraphPad Software, Inc., San Diego, CA, USA).

3. Results

From June 2019 and February 2020, 321 migrants (n 298, 92% male, mean age 29 years IQR 18–56) were enrolled in the study. Fifty percent (n 162) were living in the ghetto Pista, whereas the other half was based in the structures arranged by the Apulian region (n 134, 42% in "Casa Sankara" and 25, 8% in "Arena"). Forty-one per cent (n 131) of the all sample was made by migrants from Senegal, followed by 24% (n 78) from Gambia (Figure 1). Most of the migrants interviewed (n 305, 95%) reported a stopover in Libya during their trip toward Italy. Thirty-nine per cent of the sample (n 125) declared to be married, while 59% (n 191) declared to have children. When exploring their current occupation, 83% (n. 264) reported to be an agricultural worker, 3% (n. 9) to be a sex worker and 8% (n. 28) to be unemployed. Forty-three per cent (n. 139) declared to have a regular employment contract. Overall, the mean time of their stay in Italy was of 55 months. Eleven per cent of the migrants enrolled in the study declared to have a family doctor. Other socio-demographic information collected are reported in Table 1. Health perceptions and

behaviors reported during the interview are reported in Table 2. Overall, at the medical screening, one HIV test resulted positive. Hypertension was found in 12% (n. 40) of the migrants visited, tachycardia in 4% (n. 13), diabetes in 2% (n. 6), hypoxemia in 4% (n. 14), TB symptoms in 17% (n. 53) and genital secretions/ulcerations in 2% (n. 5) (Table 3). Among others symptoms explored, muscle and joint pain/fatigue resulted in being the most frequent, being reported by 34% (n. 110) of the migrants, followed by cough (n. 31, 10%) and headache (n. 26, 8%). Significant predictors of muscle and joint pain/fatigue were: low BMI values (OR = 1.32; 95% CI 1.19–1.99), absence of education (OR = 1.85; 95% CI 1.02–2.95), being employed with a regular contract (OR = 2.64; 95% CI 2.39–2.83) and living in the ghettos for >12 months (OR= 1.74; 95% CI 1.24–2.21) as showed in Table 4.

Table 1. Socio-demographic information of the 321 migrants enrolled in the study.

		N (%)
	Total Migrants	321 (100)
	Male	298 (92)
	Mean age (SD)	29 (SD)
Ghettos	Pista Sankara house Arena house	162 (50) 134 (42) 25 (8)
Nationality	Senegal Gambia Nigeria Guinea Conakry Other	131 (41) 78 (24) 32 (10) 18 (6) 62 (19)
	Stopover in Lybia	305 (95)
	Married	125 (39)
	Children	191 (59)
Occupation	Agricultural workers Sex workers Unemployed Others	264 (83) 9 (3) 28 (8) 20 (6)
	Regular employment contract	139 (43)
Education	<8 y >8 y	300 (93) 21 (6)
	Regular document to stay in Italy	184 (57)
	Hold a regular document in the past	196 (61)
	Time of stay in Italy (mean, months)	55.3 (4–140)
	Time of stay in the ghettos (mean, months)	17.9 (3–100)
	Length of the travel	12.2 (7–22)
Religion	Christian Muslim	51 (16) 270 (84)
Family doctors	Yes No	36 (11) 285 (89)

Table 2. Health perceptions and behaviors reported by the 321 migrants enrolled in the study.

		N (%)
Knowledge about sexual transmitted diseases	No Yes	85 (26) 236 (74)
Sexual orientation	Heterosexual	321 (100)
Previous HIV Test	Done Never done Unknown	80 (25) 238 (74) 3 (1)
Do you rate your health as good?	No Yes	106 (33) 215 (67)
Any known diseases	No Yes	293 (91) 28 (9)
Fair about possible stigma after a positive HIV test	No Unknown Yes	166 (52) 4 (1) 151 (47)
Condom use	No Yes	205 (64) 116 (36)
Sex for money	No Yes	173 (54) 148 (46)
At-risk sexual intercourse in the last 3 months	No Yes	191 (60) 130 (40)
Sex under drugs or alcohol	No Yes	307 (96) 14 (4)

Table 3. HIV results and medical assessment performed on 321 migrants enrolled in the study.

		N (%)
HIV test results	Positive	1 (0)
Hypertension	Yes	40 (12)
Tachycardia (FC > 100)	Yes	13 (4)
Diabetes	Yes	6 (2)
Hypoxemia (<94% xx)	Yes	14 (4)
TB symptoms	Yes	53 (17)
Genital secretions/ulcerations	Yes	5 (2)
Other symptoms	Muscle and joint pain/fatigue	110 (34)
	Cough	31 (10)
	Headache	26 (8)
	Miscellaneous (teeth, epigastric pain, etc.)	62 (19)

Table 4. Factors associated with presence of muscle and joint pain/fatigue in agricultural migrant workers.

Characteristics	Univariate Analysis	Multivariate Analysis
	O.R.	Adj-O.R.
Age (years)	1.02 (0.98–1.04)	-
Female	0.28 (0.16–0.40)	0.58 (0.47–0.78) *
Low BMI (<18)	1.80 (1.42–2.02)	1.42 (1.18–1.72) *
Contract of work	1.51 (1.43–0.70)	2.64 (2.39–2.83) *
>12 months in the ghetto	1.85 (1.35–2.45)	1.74 (1.24–2.21) *
Document to stay in Italy	0.10 (0.04–0.85)	0.39 (0.08–1.28)
Sex under influence of drugs or alcohol	0.34 (0.10–1.10)	0.95 (0.22–1.73)
HIV status	1.80 (1.50–2.00)	-
Tb symptoms	1.14 (1.08–1.78)	1.74 (1.50–2.03)
Diabetes	0.25 (0.10–0.40)	0.71 (0.28–1.23)

*: statistically significant.

4. Discussion

Our study presents the results of a health screening performed in agricultural migrant workers living in one ghetto and two establishments arranged by the region, in Apulia. In our sample, a low prevalence of HIV, diabetes and hypertension was found, whereas the signs and symptoms of their heavy working conditions and low quality of life clearly emerged. In fact, even though the majority of the migrants interviewed came to Europe from African and Asian countries with the hope of improving their economic status and quality of life, living in ghettos and working in the agricultural sector without any social protection could not live up to their expectations.

Almost all migrants enrolled were men and young (median age of 29 years), and many of them declared that they had been in the ghetto for at least one year and a half in a total period of four years in Italy. Only half of the sample claimed to have legitimate documents to reside in Italy, and less than half reported to have a regular job contract. Three to up to four migrants interviewed reported that they had never been tested for HIV and, notably, the vast majority did not use condoms during sexual intercourse, despite only one migrant testing positive. In terms of non-communicable diseases, 12.5% had hypertension, whereas just 2% had diabetes. These numbers are lower compared to data collected on population of migrants from North Africa in Italy [7]. While the most interesting finding is about sanitary situation related to work, in fact, three quarters of the sample reported signs and symptoms associated with outdoor labor (muscular pains, fatigue, headache, asthenia, etc.).

Interestingly, analyzing our data, a low BMI, no education, no regular contract and a long stay in the ghettos resulted in being risk factors for muscle and joint pain/fatigue. These underline how living in the ghettos with a poor quality of life and no job rights recognized through a regular employment contract could be strongly related to health problems and, thus, how social determinants of health are always important in a global health approach [8–10].

Few data are available on the health status of migrant workers in Europe, but previous studies in Nepal, Tanzania and Ethiopia have documented a low prevalence of HIV in migrant farm workers, low condom use, high risk of risky sex and high prevalence of malnutrition, and reinforce the need for screening for diseases related to a poor quality of work and life, which is strongly correlated with tuberculosis and non-communicable diseases, such as hypertension and diabetes, and overwork illnesses, such as rickets, asthenia, muscle/fatigue pain and mental health illnesses [11–14].

To the best of our knowledge, this is the first health assessment on migrants employed in the agricultural sector and living in ghettos in Italy. Indeed, limited and fragmented

data on their health condition, and especially on their health needs, are accessible, making national and international policy responses to their health needs more challenging.

Preliminary evidence-based recommendations that can be raised from our findings are to actively search for signs and symptoms of TB and other infectious diseases, including sexually transmitted infections or those endemic to the country of origin (such as malaria, intestinal parasitosis, etc.), but also priority to non-communicable diseases, such as diabetes and hypertension, should be given when promoting a health intervention in such a setting [15,16]. It should also be important to focus on the interaction between non-communicable and communicable diseases in worsening clinical presentations and outcomes [17–19]. From our experience, an appropriate use of point of care HIV testing in these settings could also be highlighted, since it could help to reduce stigma and increase adherence to screening [20]. The impact of the COVID-19 pandemic on migrants and refugees' health should also be assessed. In fact, as other epidemics have already shown, e.g., Ebola, during the pandemic, due to the high pressure on hospitals, many voluntary activities and health support on the migrant population were interrupted or suspended with understandable health consequences on this vulnerable population. An inclusive approach to refugee and migrant health that leaves no one behind during the COVID-19 pandemic should guide our public health efforts [21,22].

In addition, an important aspect of our study was to involve young medical residents by making them discover such a complex and marginal reality as the ghettos [23]. We hope that this will have an impact on their motivation in their professional life, keeping an inclusive view on global health issues and on the health of vulnerable populations (women, migrants, refugees, children, etc.) [24,25].

In our study, we recognize several limitations: first of all, the complexity of the setting, with the absence of census data of the population living in the settlements—there was no sample calculation to assess the prevalence of the diseases, so a convenient sample made by migrants who voluntarily agreed to join was considered. Then, it should be considered that even if all migrants with evocative signs and symptoms of TB were referred to proper health services to confirm the diagnosis, there was no feedback on the follow up, and so a real estimate of the TB prevalence was impossible to perform. In addition, a big missing area in the health assessment performed is the mental health area; in fact, due to the absence of a proper health professional, the psychological and psychiatric aspects were not evaluated. However, this study was a pilot experience to build a picture of health general conditions in this population, and, starting from all challenges raised, we will try to build further stronger research projects in order to study in depth all findings collected.

5. Conclusions

In conclusion, our experience as Doctors with Africa CUAMM and global health activists suggests that baseline health conditions of migrants' workers are quite good, since they are all young and in health to perform heavy work. The majority of health problems came as consequences of the specific working activities in the agricultural fields, or due to their hygienic conditions of life and their conditions of work. Therefore, the issue is: how can we eradicate the causes of these avoidable deaths and diseases? How can we act to fight the exploitation that these workers have to face? A response is necessary and the health sector should express its concerns and make a stand, with a coordinated and multidisciplinary action. The legal, employment and health protection of low-wage agricultural workers and their families is urgently needed. Health, migration, economy, sustainable development and justice are all interlinked facets of our world and we feel a duty for the science and health community to care and to give a voice to the voiceless. We consider a priority to place migrant and refugees' health in a central role of the national, European and global agenda as a pillar of global health. Only in this way can health, justice and development be authentically sustainable. A multidisciplinary reflection on the strategy needed to improve health conditions in such settings is urgent and is no longer able to be postponed.

Author Contributions: Conceptualization, F.D.G. and C.F.; methodology, C.M.; validation, G.G.P., A.V., V.T., R.P. and R.L. (Renato Laforgia); data curation, S.N. and M.P.; writing—original draft preparation, F.D.G., C.M., L.R., R.L. (Rossana Lattanzio) and M.S., R.N., N.L.; writing—review and editing, F.D.G., C.M., D.F.B. and G.P.; supervision, A.S. and S.L.C. All authors have read and agreed to the published version of the manuscript.

Funding: Otto per mille della Chiesa Valdese.

Institutional Review Board Statement: The study was conducted in accordance with the Declaration of Helsinki and national and institutional standards. All patients provided informed written consent for the anonymous collection and use of their data for research purposes.

Informed Consent Statement: Written informed consent has been obtained from the patient(s) to publish this paper.

Acknowledgments: We thank all of those who participated in the screening and apologize if they are still living in unacceptable conditions in 2021.

Conflicts of Interest: The authors declare no conflict of interest.

References

1. Mangano, A. *La Strage Silenziosa DEI Campi, Dove Italiani e Migranti Muoiono Insieme*; L'Espresso: Rome, Italy, 2018.
2. Sagnet, Y.; Palmisano, L. *Ghetto Italia: I Braccianti Stranieri tra Caporalato e Sfruttamento*; Fandango: Rome, Italy, 2015.
3. *Legislative Decree 29 Ottobre 2016, n. 199. Disposizioni in Materia di Contrasto ai Fenomeni del Lavoro Nero, Dello Sfruttamento del Lavoro in Agricoltura e di Riallineamento Retributivo nel Settore Agricolo*. (16G00213) 257, Italy (GU Serie Generale n. 257 del 03-11-2016). Available online: http://3.flcgil.stgy.it/files/pdf/20161104/legge-199-del-29-ottobre-2016-dispozioni-in-materia-di-contrasto-ai-fenomemi-del-lavoro-nero.pdf (accessed on 12 October 2021).
4. *Report on the Health of Refugees and Migrants in the WHO European Region: No Public Health without Refugees and Migrant Health*; WHO Regional Office for Europe: Copenhagen, Denmark, 2018. Available online: https://apps.who.int/iris/bitstream/handle/10665/311347/9789289053846-eng.pdf?sequence=1&isAllowed=y (accessed on 28 September 2021).
5. Bellizzi, T.; Di Zanni, C. Foggia, Scontro Frontale tra un Furgone e un tir: Morti Dodici Migranti. In Arrivo il Premier. La Repubblica. 2018. Available online: https://bari.repubblica.it/cronaca/2018/08/06/news/foggia_scontro_frontale_tra_furgoni_cinque_migranti_morti-203524785/ (accessed on 25 February 2021).
6. Hannigan, A.; O'Donnell, P.; O'Keeffe, M.; MacFarlane, A. *How Do Variations in Definitions of "Migrant" and Their Application Influence the Access of Migrants to Health Care Services?* Health Evidence Network (HEN) Synthesis Report 46; WHO Regional Office for Europe: Copenhagen, Denmark, 2016. Available online: http://www.euro.who.int/__data/assets/pdf_file/0013/317110/HEN-synthesis-report-46.pdf?ua=1 (accessed on 28 September 2021).
7. Ballotari, P.; Caroli, S.; Ferrari, F.; Romani, G.; Marina, G.; Chiarenza, A.; Manicardi, V.; Giorgi Rossi, P. Differences in dia-betes prevalence and inequalities in disease management and glycaemic control by immigrant status: A population-based study (Italy). *BMC Public Health* **2015**, *15*, 87. [CrossRef] [PubMed]
8. Abubakar, I.; Aldridge, R.; Devakumar, D.; Orcutt, M.; Burns, R.; Barreto, M.L.; Dhavan, P.; Fouad, F.M.; Groce, N.; Guo, Y.; et al. The UCL–Lancet Commission on Migration and Health: The Health of a World on the Move. *Lancet* **2018**, *392*, 2606–2654. [CrossRef]
9. Di Gennaro, F.; Pizzol, D.; Cebola, B.; Stubbs, B.; Monno, L.; Saracino, A.; Luchini, C.; Solmi, M.; Segafredo, G.; Putoto, G.; et al. Social determinants of therapy failure and multi drug resistance among people with tuberculosis: A review. *Tuberculosis* **2017**, *103*, 44–51. [CrossRef] [PubMed]
10. Bucciardini, R.; Ferrelli, R.M.; Giammarioli, A.M.; Bortolin, E.; Belasio, E.F.; Mattioli, B.; Donfrancesco, C.; Sabbatucci, M.; Pasetto, R.; Colucci, A.; et al. Health inequalities: A Research Positioning Exercise at the National Institute of Health, Italy. *Eur. J. Public Health* **2019**, *29*, 943–947. [CrossRef] [PubMed]
11. Bretones, F.D.; Jain, A.; Leka, S.; García-López, P.A. Psychosocial Working Conditions and Well-Being of Migrant Workers in Spain. *Int. J. Environ. Res. Public Health* **2020**, *17*, 2547. [CrossRef] [PubMed]
12. Adhikary, P.; Aryal, N.; Dhungana, R.R.; Kc, R.K.; Regmi, P.R.; Wickramage, K.P.; Duigan, P.; Inkochasan, M.; Sharma, G.N.; Devkota, B.; et al. Accessing health services in India: Experiences of seasonal migrants returning to Nepal. *BMC Health Serv. Res.* **2020**, *20*, 992. [CrossRef] [PubMed]
13. Fisher, O. The Impact of Micro and Macro Level Factors on the Working and Living Conditions of Migrant Care Workers in Italy and Israel—A Scoping Review. *Int. J. Environ. Res. Public Health* **2021**, *18*, 420. [CrossRef] [PubMed]
14. Tschirhart, N.; Nosten, F.; Foster, A.M. Migrant tuberculosis patient needs and health system response along the Thailand-Myanmar border. *Health Policy Plan* **2017**, *32*, 1212–1219. [CrossRef] [PubMed]
15. Hargreaves, S.; Rustage, K.; Nellums, L.; McAlpine, A.; Pocock, N.; Devakumar, D.; Aldridge, R.W.; Abubakar, I.; Kristensen, K.L.; Himmels, J.W.; et al. Occupational health outcomes among international migrant workers: A systematic review and meta-analysis. *Lancet Glob. Health* **2019**, *7*, e872–e882. [CrossRef]

16. Tagliacozzo, S.; Pisacane, L.; Kilkey, M. The interplay between structural and systemic vulnerability during the COVID-19 pandemic: Migrant agricultural workers in informal settlements in Southern Italy. *J. Ethn. Migr. Stud.* **2021**, *47*, 1903–1921. [CrossRef]
17. Tosti, M.E.; Marceca, M.; Eugeni, E.; D'Angelo, F.; Geraci, S.; Declich, S.; Della Seta, M.; Ferrigno, L.; Marrone, R.; Pajno, C.; et al. Health assessment for migrants and asylum seekers upon arrival and while hosted in reception centres: Italian guidelines. *Health Policy* **2021**, *125*, 393–405. [CrossRef] [PubMed]
18. Seedat, F.; Hargreaves, S.; Nellums, L.; Ouyang, J.; Brown, M.; Friedland, J.S. How effective are approaches to migrant screening for infectious diseases in Europe? A systematic review. *Lancet Infect. Dis.* **2018**, *18*, e259–e271. [CrossRef]
19. Colindres, C.; Cohen, A.; Caxaj, C. Migrant Agricultural Workers' Health, Safety and Access to Protections: A Descriptive Survey Identifying Structural Gaps and Vulnerabilities in the Interior of British Columbia, Canada. *Int. J. Environ. Res. Public Health* **2021**, *18*, 3696. [CrossRef] [PubMed]
20. Falanga, C.; Marotta, C.; Negri, S.; Di Gennaro, F.; Bavaro, D.F.; Poliseno, M.; Mazzucco, W.; Monno, L.; Saracino, A.; Caputo, S.L. HIV rapid test in a community setting as a strategy to improve access to HIV testing: Data from a multicentre experience in Italy. *Infez. Med.* **2019**, *27*, 415–421. [PubMed]
21. Kluge, H.H.P.; Jakab, Z.; Bartovic, J.; D'Anna, V.; Severoni, S. Refugee and migrant health in the COVID-19 response. *Lancet* **2020**, *395*, 1237–1239. [CrossRef]
22. Quaglio, G.; Tognon, F.; Finos, L.; Bome, D.; Sesay, S.; Kebbie, A.; Di Gennaro, F.; Camara, B.S.; Marotta, C.; Pisani, V.; et al. Impact of Ebola outbreak on reproductive health services in a rural district of Sierra Leone: A prospective observational study. *BMJ Open* **2019**, *9*, e029093. [CrossRef] [PubMed]
23. Mazzucco, W.; Marotta, C.; De Waure, C.; Marini, G.; Fasoletti, D.; Colicchio, A. Motivational aspects and level of satisfaction of italian junior doctors with regard to knowledge and skills acquired attending specific general practice training courses. a national web survey. *Euromediterr. Biomed. J.* **2017**, *12*, 77–86.
24. Di Gennaro, F.; Marotta, C.; Pisani, L.; Veronese, N.; Pisani, V.; Lippolis, V.; Pellizer, G.; Pizzol, D.; Tognon, F.; Bavaro, D.F.; et al. Maternal caesarean section infection (MACSI) in Sierra Leone: A case–control study. *Epidemiol. Infect.* **2020**, *148*, e40. [CrossRef] [PubMed]
25. Takahashi, R.; Kruja, K.; Puthoopparambil, S.J.; Severoni, S. Refugee and migrant health in the European Region. *Lancet* **2019**, *393*, 2300–2301. [CrossRef]

Inequity in uptake of hospital-based childbirth care in rural Tanzania: analysis of the 2015–16 Tanzania Demographic and Health Survey

PAPER

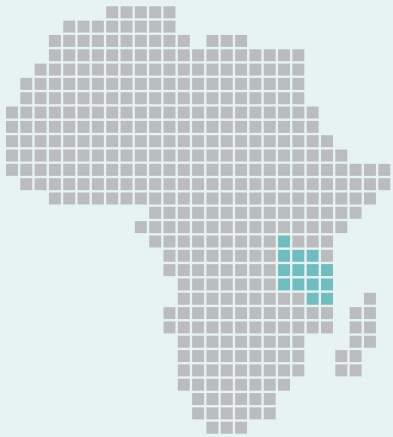
Authors
Straneo M., Benova L., Hanson C., Fogliati P., Pembe A. B., Smekens T., van den Akker T.

Published in
Health Policy and Planning, November 2021

Link
https://doi.org/10.1093/heapol/czab079

Topic
Universal coverage and equity

Focus country
Tanzania



Health Policy and Planning, **36**, 2021, 1428–1440
DOI: https://doi.org/10.1093/heapol/czab079
Advance access publication date: 19 July 2021
Original Article

Inequity in uptake of hospital-based childbirth care in rural Tanzania: analysis of the 2015–16 Tanzania Demographic and Health Survey

Manuela Straneo[1], Lenka Benova[2,3], Claudia Hanson[4,5,*], Piera Fogliati[6], Andrea B Pembe[7], Tom Smekens[8] and Thomas van den Akker[1,9]

[1]Athena Institute, VU Amsterdam, De Boelelaan 1085, 1081 HV Amsterdam, The Netherlands
[2]Sexual and Reproductive Health Group, Department of Public Health, Institute of Tropical Medicine, Nationalestraat 155, 2000 Antwerp, Belgium
[3]Faculty of Epidemiology and Population Health, LSHTM, Keppel Street, London WC1E 7HT, UK
[4]Karolinska Institutet, 171 77 Stockholm, Sweden
[5]Faculty of Infectious and Tropical Diseases, LSHTM, Keppel Street, London WC1E 7HT, UK
[6]Doctors with Africa-CUAMM, Av. Mártires da Machava n.º 859 R/C, Cidade de Maputo, Moçambique
[7]Department of Obstetrics and Gynecology, Muhimbili University of Helath and Allied Sciences, PO Box 65001, Dar es Salaam, United Republic of Tanzania
[8]Department of Public Health, Institute of Tropical Medicine, Nationalestraat 155, 2000 Antwerp, Belgium
[9]Department of obstetrics and Gynecology, Leiden University Medical Center, Rapenburg 70, 2311 EZ Leiden, The Netherlands

*Corresponding author. Health Systems and Policy, Global Public Health, Karolinska Institutet, K9 Global folkhälsa, K9 GH Stålsby Lundborg Hanson, Stockholm 171 77, Sweden. E-mail: claudia.hanson@ki.se

Accepted on 22 June 2021

Abstract

Proportions of facility births are increasing throughout sub-Saharan Africa, but obstetric services vary within the health system. In Tanzania, advanced management of childbirth complications (comprehensive emergency obstetric care) is offered in hospitals, while in frontline, primary health care (PHC) facilities (health centres and dispensaries) mostly only routine childbirth care is available. With over half (54%) of rural births in facilities, we hypothesized the presence of socio-economic inequity in hospital-based childbirth uptake in rural Tanzania and explored whether this relationship was modified by parity. This inequity may compound the burden of greater mortality among the poorest women and their babies. Records for 4456 rural women from the 2015–16 Tanzania Demographic and Health Survey with a live birth in the preceding 5 years were examined. Proportions of births at each location (home/PHC/hospital) were calculated by demographic and obstetric characteristics. Multinomial logistic regression was used to obtain crude and adjusted odds ratios of home/PHC and hospital/PHC births based on household wealth, including interaction between wealth and parity. Post-estimation margins analysis was applied to estimate childbirth location by wealth and parity. Hospital-based childbirth uptake was inequitable. The gap between poorest and richest was less pronounced at first birth. Hospital-based care utilization was lowest (around 10%) among the poorest multiparous women, with no increase at high parity (≥5) despite higher risk. PHC-based childbirth care was used by a consistent proportion of women after the first birth (range 30–51%). The poorest women utilized it at intermediate parity, but at parity ≥5 mostly gave birth at home. In an effort to provide effective childbirth care to all women, context-specific strategies are required to improve hospital-based care use, and poor, rural, high parity women are a particularly vulnerable group that requires specific attention. Improving childbirth care in PHC and strengthening referral linkages would benefit a considerable proportion of women.

Keywords: Obstetrics, maternal and child health, maternal services, equity, primary health care, health inequalities, poverty, rural, hospital, health facilities, health care utilization

Introduction

Mortality around the time of childbirth is essentially a disease of poverty. An inverse relationship between poverty and maternal health has been known for over a century. Wide inequities in maternal and perinatal mortality exist between nations, with low- and middle-income countries being the most affected (Graham *et al.*, 2016). Sub-Saharan Africa (SSA), with only 14% of global population, accounted for 66% (201 000) of maternal deaths, 40% (1 027 000) of newborn deaths and 31% (1 060 000) of stillbirths in 2015 (Alkema *et al.*, 2016; Blencowe *et al.*, 2016; World Bank, 2020; WHO, 2015a). Wide gradients also exist within countries, with the poorest disproportionately affected (Ronsmans and Graham, 2006; Houweling *et al.*, 2007; Filippi *et al.*, 2016). Such inequities are often masked by national averages (Kinney *et al.*, 2010).

Providing effective childbirth care is challenging where resources are limited, and rural SSA is a particularly arduous setting (Campbell *et al.*, 2016). In SSA countries, primary health care (PHC) has been a central strategy to ensure access

© The Author(s) 2021. Published by Oxford University Press in association with The London School of Hygiene and Tropical Medicine.
This is an Open Access article distributed under the terms of the Creative Commons Attribution License (https://creativecommons.org/licenses/by/4.0/), which permits unrestricted reuse, distribution, and reproduction in any medium, provided the original work is properly cited.

Downloaded from https://academic.oup.com/heapol/article/36/9/1428/6323932 by guest on 06 April 2022

Health Policy and Planning, 2021, Vol. 36, No. 9 1429

Key messages

- The proportion of facility births is increasing in rural Tanzania, but obstetric care at different levels of the health system varies. We hypothesized a differential use of hospitals for childbirth and assessed interaction between wealth and parity. Inequity in hospital-based childbirth care use may contribute to the burden of greater mortality among the poorest women and their babies.
- Hospital-based childbirth care use was inequitable among women in rural Tanzania. The gap between the poorest and richest use was less pronounced among women at first parity. Uptake of hospital-based care was lowest (around 10%) among poorest multiparous women, remaining low at high parity (≥5) despite higher risk of complications and death.
- Rural women's use of PHC childbirth care after the first birth was noteworthy, ranging between 30 and 51% depending on wealth and parity.
- As part of efforts to reach all women with appropriate, timely care, strategies are required to improve uptake of hospital-based care particularly among poor, rural, high parity ones. Improving quality of childbirth care in PHC and referral linkages would benefit a substantial proportion of women.

to services, including intrapartum care, for rural populations. Tanzania, with a population of 59 million (2020) (World Bank, 2020), has been at the forefront of PHC development after independence with its founding principles set out in the Arusha Declaration in 1967 (Bustreo *et al.*, 2019; Dominicus and Akamatsu, 1989). A vision of high-quality PHC for all is expressed in current policy (Vision 2025) (Tanzania URO, 2000). PHC facilities are dispensaries at village level and health centres at ward level (Tanzania MoHSW, 2015). Women can give birth at all levels of the health system, and childbirth in PHC facilities is encouraged for women with no known risk factors at onset of labour (Hanson *et al.*, 2015). In spite of a capillary PHC network, with 85% of the population living within 5 km from a facility, Tanzania's maternal mortality ratio in 2017 remained high at 524 per 100 000 live births (a reduction of 39% from 2000) (WHO, 2015b; 2019) and was among 10 countries worldwide with the highest absolute numbers of maternal, newborn deaths and stillbirths (Lawn *et al.*, 2016).

Obstetric care at different levels of the health system varies markedly in SSA (Campbell *et al.*, 2016). There is growing evidence that outcomes for mothers and their babies improve when women give birth in units offering high-quality care, not just in any facility (Gabrysch *et al.*, 2019; Hanson *et al.*, 2015; Lohela *et al.*, 2019). In Tanzania, advanced management of childbirth complications (including surgery and blood transfusions, equivalent to comprehensive emergency obstetric care [EmOC]) is available in hospitals, while lower-level, PHC facilities are generally able to provide routine childbirth care only (Campbell *et al.*, 2016; Kruk *et al.*, 2016). Although dispensaries and health centres differ in size, number of beds and staffing levels, both types of facilities have similar obstetric capacity and often do not reach a description of basic EmOC facility (Campbell *et al.*, 2016; Hanson *et al.*, 2013). Challenges to the provision of high-quality obstetric care in lower-level facilities in Tanzania have been amply described and include insufficient staffing, poor infrastructure and low birth volumes (Hanson *et al.*, 2013; Benova *et al.*, 2014; Kruk *et al.*, 2014; Hanson *et al.*, 2015; Straneo *et al.*, 2014; Baker *et al.*, 2015). Although national efforts are underway to increase obstetric care in health centres up to comprehensive EmOC, at the time of analysis very few had been upgraded. Higher mortality among poorer women and their babies may be compounded by their reduced hospital-based childbirth care uptake, where higher-quality obstetric care is more commonly found.

Over the past decade, a shift from home to facility births has been described in SSA, with increasing proportions of women giving birth in facilities in rural and urban contexts and across wealth groups, and Tanzania is no exception (Montagu *et al.*, 2017; Doctor *et al.*, 2019). However, strong socio-demographic differentials continue to be reported (Kyei-Nimakoh *et al.*, 2017; Moyer and Mustafa, 2013; Gabrysch and Campbell, 2009; Campbell *et al.*, 2016; Virgo *et al.*, 2017; Dunlop *et al.*, 2018). There is limited information on how socio-economic groups uptake obstetric care at different levels of the health system. Within the background of a renewed discussion of the most efficient configuration of childbirth care from an equity, quality and cost-efficiency perspective (Kruk *et al.*, 2016; Hanson and Schellenberg, 2019; Kruk *et al.*, 2018; Roder-DeWan, 2020), we aimed to estimate the levels of use of hospital-based childbirth care in rural Tanzania and its association with women's socio-economic status. Given the association of poverty and high parity, and the latter's implications for obstetric care, we investigated whether the association between wealth and hospital-based childbirth depended on parity.

Methods

Study setting

In Tanzania, the most recent (2015–16) Demographic and Health Survey (DHS) estimated that 63% of births in the 5-year period preceding the survey took place in health facilities (54% in rural and 86% in urban areas) (Tanzania MoHCDGEC, 2016). In the same period, there were 6790 facilities (including public, faith-based, parastatal and private), from which 257 (3.8%) were hospitals (Tanzania MoHSW, MoHMZ, National Bureau of Statistics [NBS], Office of the Chief Government Statistician [OCGS], and ICF, 2015). There were an estimated 12 million women of reproductive age and approximately 1.9 million births in 2015.

Data and population

Data from the 2015–16 Tanzania DHS were used. DHS are cross-sectional, nationally representative surveys of households, with women of reproductive age (15–49 years) self-reporting on the use of reproductive and maternal healthcare. Approximately 12 500 households were visited, and 13 000 women interviewed. Records of women living in rural areas in mainland Tanzania were used in this analysis, if they reported a live birth in the 5 years preceding the survey. Classification as 'rural' in DHS was based on census enumeration units (Tanzania NBS and Zanzibar OGCS, 2013).

Downloaded from https://academic.oup.com/heapol/article/36/9/1428/6323932 by guest on 06 April 2022

Definitions

The outcome variable was the location of the most recent live birth, in three categories: home (respondent's home, other home and en route to provider), PHC facility (dispensary, health centre, maternity home and 'other facility') and hospital (district, regional, referral or tertiary/university). All public and private (non-profit/profit) PHC facilities and hospitals were included.

Socio-economic status (SES): In DHS, SES is based on availability of durable household assets (Vyas and Kumaranayake, 2006). A wealth score is generated for each sampled household using principal component analysis and the households are then subdivided into equal-size wealth quintiles. Distribution of wealth is uneven across different contexts, with the highest (wealthiest) SES quintile households underrepresented in rural contexts. In rural Tanzania (DHS 2015–16), there were only 14.6% and 2.5% women in Quintile 4 (richer) and Quintile 5 (richest), respectively. Thus, for the purpose of this analysis, the two highest wealth quintiles were merged, resulting in the creation of four wealth groups (poorest, poorer, middle and wealthiest). The terms richest/wealthiest refer to relative wealth in a poor, rural context, thus indicate women from the least poor households. To analyse the interaction of SES and parity, a binary SES variable was created, by generating two equal groups based on wealth scores (wealth score < median recoded as poorer, wealth score ≥ median coded as richer 50%).

Parity group refers to a woman's parity at index pregnancy (0, 1–2, 3–4 and ≥5). Grand multiparity was defined as parity ≥5 (Mgaya *et al.*, 2013).

Maternal age at index birth was coded in 5-year age groups, grouping categories at the extremes of age because they had fewer than 100 observations (≤19, 20–24, 25–29, 30–34, 35–39 and ≥40 years). The 20–24 years' group was used as reference.

Maternal education was recoded into three categories: no education, completed primary and completed secondary or higher.

Marital status at survey was recoded into currently married/cohabiting and not currently married/cohabiting.

Zone of residence: Tanzania is divided into 21 administrative regions, grouped into eight zones (Tanzania MoHCDGEC, MoH [Zanzibar], and ICF, 2016). We used the eight zones to account for sub-national variation in outcomes and service availability (Armstrong *et al.*, 2016). All eight zones include rural areas; the Eastern zone includes the Dar es Salaam urban conglomerate.

Antenatal care (ANC) for the index pregnancy was categorized into no visits, 1–3 visits and ≥4 visits.

Other obstetric characteristics studied were the following: multiple index birth, a previous birth in the recall period by Caeserean section (CS), death of a previous child (born in the recall period) aged 1–12 months, death of a previous child (born in the recall period) aged <1 month, a short preceding birth interval (≤12 months).

Statistical analysis

Analysis was performed using STATA IC 15 software. Complex survey design and non-response (stratification, clustering and survey weights) were accounted for using svyset commands. Characteristics of the sample were analysed with proportions and 95% confidence intervals (CIs) of outcome and exposure variables. There were no missing data for the variables examined. Proportions of subgroups of women at each level of outcome (hospital/PHC/home birth) for each exposure variable were examined using bivariate analysis. As the interaction between SES and parity was of interest, the proportion of women giving birth at each location by combinations of parity levels and a binary SES variable (poorer/richer) were determined. Associations between the outcome variable and dependent variables (demographic, geographical characteristics, SES, ANC care received and available obstetric factors) were assessed in bivariate analysis. Variables which were significant at $P < 0.05$ level in bivariate analysis were included in the final multivariable model. Multinomial logistic regression was used as the outcome variable had three categories, thus allowing to include all births in one model. The baseline outcome was birth in PHC, thus the model produced odds ratios (ORs) of home vs PHC and hospital vs PHC birth. In the final multivariable model, we tested for an interaction between SES and parity group. We calculated the margins to obtain predicted percentages of women giving birth at each of the three locations, depending on their SES and parity group combination. Results were used to calculate the difference or gap in hospital or PHC uptake for birth between the wealthiest and poorest women.

Ethical approval

The DHS receive government permission, use informed consent and assure respondents of confidentiality. Permission to use the dataset for the purpose of this analysis was obtained from the DHS programme.

Results

Population characteristics

Observations of 4456 women living in rural mainland Tanzania and the circumstances of their most recent live birth in the 5 years preceding the survey were included in the analysis. Home birth was reported by 41% of women and a slight majority reported a facility birth (59%): 35% in PHCs and 24% in hospitals. Women from the wealthiest households were under-represented, with only 17% in the highest group compared with 28% in the lowest. Approximately one in five women was nulliparous at index birth (22%), while 25% had parity five or higher. Background characteristics are summarized in Supplementary Table S1.

Results of bivariate analysis are reported in Table 1. The percentage of rural women using hospitals for childbirth increased with higher SES, from 16% in the poorest group to 45% in the wealthiest. PHC births also rose with increasing wealth, although less steeply than hospital births. As parity increased, hospital births reduced sharply, while PHC births had a less clear trend across SES and parity and varied only marginally at around one-third of births. Hospital births increased with higher maternal age, maternal education and number of ANC visits. There was a wide variation in hospital births across the eight zones, ranging from 16% in the Lake Zone to 39% in the Southern Highlands. PHC facilities provided a substantial proportion of childbirth care in rural areas of all zones (range 23–48%, median 38%).

Examining SES and parity together, hospital births were more frequent in women from wealthier households in all parity groups, with percentages reducing as parity increased

Downloaded from https://academic.oup.com/heapol/article/36/9/1428/6323932 by guest on 06 April 2022

Health Policy and Planning, 2021, Vol. 36, No. 9

Table 1. Percentages of home, primary care facility or hospital birth by subgroups among rural women with a recent live birth (TDHS 2015–16) $n = 4456$

Variable	Women in category (%)	Home births		PHC facility births		Hospital births	
		Number	% (95% CI)	Number	% (95% CI)	Number	% (95% CI)
SES							
Poorest	1351 (29.3)	742	55.5 (50.5–60.3)	413	29.1 (25.4–33.0)	196	15.5 (12.3–19.1)
Poorer	1239 (28.4)	559	45.7 (41.5–50.0)	467	36.5 (32.7–40.5)	213	17.8 (14.9–21.1)
Medium	1104 (25.2)	383	35.5 (31.1–40.1)	448	39.7 (35.5–44.0)	273	24.9 (21.5–28.6)
Wealthiest	762 (17.1)	131	18.1 (14.1–23.0)	288	36.9 (31.9–42.2)	343	45.0 (39.4–50.7)
Parity							
0	963 (22.2)	245	25.6 (22.2–29.4)	333	32.9 (29.2–36.8)	385	41.5 (37.1–46.1)
1–2	1342 (30.6)	537	40.6 (36.4–45.1)	514	37.3 (33.5–41.3)	291	22.1 (19.0–25.5)
3–4	1057 (23.6)	475	45.4 (41.1–50.0)	410	38.9 (35.0–42.9)	172	15.7 (12.9–18.9)
≥5	1094 (23.6)	558	52.7 (48.2–57.2)	359	30.9 (27.5–34.6)	177	16.4 (13.6–19.6)
Maternal age at index birth (years)							
≤19	743 (17.6)	241	32.0 (27.7–36.6)	280	36.2 (32.0–40.7)	222	31.8 (27.2–36.8)
20–24	1124 (25.0)	459	41.6 (37.7–45.7)	412	35.7 (32.1–39.4)	253	22.7 (19.6–26.1)
25–29	946 (21.2)	400	42.9 (38.2–47.8)	343	35.7 (31.6–40.0)	203	21.4 (18.0–25.2)
30–34	744 (16.3)	321	43.9 (38.7–49.3)	255	33.4 (28.9–38.1)	168	22.7 (18.9–27.1)
35–39	594 (13.1)	249	43.7 (38.2–49.4)	228	35.7 (30.8–41.0)	117	20.6 (16.4–25.4)
40–49	305 (6.8)	145	47.9 (41.4–54.5)	98	32.3 (26.8–38.4)	62	19.7 (15.2–25.3)
Maternal education at survey							
No education	1054 (23.8)	577	54.7 (49.8–59.5)	343	32.5 (28.7–36.7)	134	12.8 (10.2–15.9)
Completed primary	3028 (67.5)	1191	40.2 (37.0–43.5)	1120	35.6 (32.9–38.5)	717	24.2 (21.6–27.0)
Secondary and above	374 (8.7)	47	13.1 (9.6–17.7)	153	38.9 (33.1–45.0)	174	48.0 (41.7–54.4)
Marital status at survey							
Currently married or cohabiting	3695 (82.9)	1548	43.6 (39.1–46.1)	1334	35.0 (32.4–37.8)	813	22.4 (20.0–25.1)
Not currently married or cohabiting	761 (17.1)	267	35.1 (30.5–40.0)	282	35.9 (31.6–40.5)	212	29.0 (24.8–33.6)
Zone of residence							
Western	515 (14.0)	255	50.1 (39.4–60.9)	170	31.8 (24.3–40.4)	90	18.1 (11.8–26.6)
Northern	420 (10.1)	164	40.7 (28.7–54.0)	95	22.6 (16.8–29.8)	161	36.6 (26.1–48.6)
Central	569 (14.0)	246	41.6 (32.6–51.2)	165	31.1 (24.4–38.8)	158	27.3 (20.9–34.8)
Southern Highlands	394 (6.0)	48	14.3 (7.2–26.6)	189	46.3 (34.9–58.0)	157	39.4 (30.1–49.5)
Southern	273 (5.5)	53	19.5 (12.5–29.0)	128	47.6 (39.5–55.8)	92	33.0 (25.3–41.7)
Southern West Highlands	588 (11.0)	256	37.5 (27.9–48.1)	255	43.5 (34.1–53.3)	77	19.1 (12.9–27.3)
Lake	1440 (32.3)	732	51.2 (46.4–55.9)	487	32.6 (28.8–36.5)	221	16.3 (13.0–20.3)
Eastern	257 (7.1)	61	24.6 (15.7–36.5)	127	47.8 (35.9–60.0)	69	27.6 (19.1–38.2)

(continued)

Downloaded from https://academic.oup.com/heapol/article/36/9/1428/6323932 by guest on 06 April 2022

Table 1. (Continued)

Variable		Women in category (%)	Home births		PHC facility births		Hospital births	
			Number	% (95% CI)	Number	% (95% CI)	Number	% (95% CI)
Antenatal visits								
None		99 (2.3)	78	77.7 (68.3–84.9)	14	13.9 (7.8–23.5)	7	8.5 (3.9–17.5)
1–3		2344 (52.4)	1088	46.9 (42.9–51.0)	783	32.4 (29.2–35.8)	473	20.7 (18.1–23.5)
≥4		2013 (45.4)	649	33.0 (29.7–36.4)	819	39.4 (36.5–42.4)	545	27.6 (24.7–30.8)
Index pregnancy was multiple								
No		4371 (98.0)	1783	41.3 (38.1–44.6)	1591	35.4 (32.8–38.0)	997	23.4 (20.9–26.0)
Yes		85 (2.0)	32	40.6 (29.4–53.0)	25	26.4 (17.6–37.5)	28	33.0 (22.8–45.1)
Previous birth was by CS								
No or no previous birth		4428 (99.1)	1811	41.5 (38.2–44.8)	1612	35.3 (32.7–37.9)	1005	23.3 (20.9–25.9)
Yes		28 (0.6)	4	13.9 (5.1–32.9)	4	17.0 (6.1–39.5)	20	69.1 (47.9–84.4)
Short previous birth interval (≤12 months)								
No or no previous birth		4410 (99.1)	1791	41.2 (38.0–44.5)	1601	35.2 (32.6–37.8)	1018	23.6 (21.2–26.2)
Yes		46 (0.9)	24	51.6 (36.0–66.9)	15	33.1 (19.5–50.3)	7	15.3 (7.2–29.7)
Death of newborn preceding index birth								
No or no previous birth		4377 (98.0)	1783	41.3 (38.1–44.6)	1586	35.1 (32.6–37.8)	1008	23.6 (21.2–26.2)
Yes		79 (2.0)	32	38.5 (27.4–51.0)	30	38.1 (26.7–51.0)	17	23.4 (14.2–36.0)
Death of child born before index birth aged >1 month and <12 months								
No		4372 (98.0)	1771	41.0 (37.8–44.4)	1589	35.3 (32.7–37.9)	1012	23.7 (21.3–26.3)
Yes		84 (2.0)	44	53.3 (41.1–65.1)	27	31.1 (21.2–43.1)	13	15.6 (8.6–26.7)
Parity by SES ($n = 4456$)								
Parity 0 ($n = 963$)	Poorer 50%	412 (43.5)	145	34.2 (28.4–40.6)	142	32.6 (27.3–38.4)	125	33.2 (26.5–40.7)
	Richer 50%	551 (56.5)	100	19.0 (15.1–23.6)	191	33.1 (28.2–38.4)	260	47.9 (42.5–53.4)
Parity 1–2 ($n = 1342$)	Poorer 50%	647 (46.5)	337	53.7 (48.4–59.0)	238	35.5 (30.8–40.6)	72	10.7 (8.1–14.1)
	Richer 50%	695 (53.5)	200	29.2 (24.3–34.7)	276	38.8 (33.7–44.2)	219	32.0 (27.5–36.8)
Parity 3–4 ($n = 1057$)	Poorer 50%	533 (49.5)	303	58.7 (53.2–64.0)	170	31.4 (27.0–36.4)	60	10.0 (7.4–13.3)
	Richer 50%	524 (50.5)	172	32.5 (27.3–38.1)	240	46.3 (40.7–52.0)	112	21.3 (17.1–26.1)
Parity ≥5 ($n = 1094$)	Poorer 50%	636 (57.8)	366	59.1 (53.6–64.4)	187	27.4 (23.1–32.0)	83	13.6 (10.5–17.4)
	Richer 50%	458 (42.2)	192	44.0 (38.4–49.9)	172	35.8 (30.9–41.0)	94	20.2 (16.3–24.8)

Downloaded from https://academic.oup.com/heapol/article/36/9/1428/6323932 by guest on 06 April 2022

Health Policy and Planning, 2021, Vol. 36, No. 9 1433

across all wealth groups. The drop of hospital use for childbirth was seen among poorer women already at Parity 1–2, while among wealthier women, this reduction was seen at Parity 3–4. Despite the decrease, the percentage of births in hospitals remained higher among wealthier than poorer women in all parity groups. The gap between the poorest and wealthiest women in hospital births was greatest at Parity 1–2 (Supplementary Graph 1).

Logistic regression

Results of bivariate and multivariate logistic regression are reported in Table 2.

In adjusted analysis, compared with women from the poorest households' group, all wealthier women were less likely to have given birth at home vs in PHC. The wealthiest were 66% less likely to do so. High-parity women (≥5) had higher odds of home birth (OR 1.54, 95% CI 1.05–2.25) compared with the reference group Parity 1–2, while odds in other parity groups were not significantly different from baseline. Higher odds of a home birth were seen in women with no ANC or 1–3 ANC visits compared with women with ≥4 visits. Compared with women with primary education, those with no education had higher odds of a home birth, while those with secondary or higher education had reduced odds. Women residing in four zones (Southern Highlands; Southern and Southern West Highlands; and Eastern) had reduced odds compared with those residing in the reference Lake Zone.

In adjusted analysis, the wealthiest rural women had higher odds (OR 1.78, 95% CI 1.26–2.50) of a hospital vs a PHC birth compared with the poorest, while other wealth groups were not significantly different from the poorest. Higher odds of hospital vs PHC birth were found in Parity 0 women compared with baseline Parity 1–2 (OR 3.22, 95%CI, 2.34–4.43), while the odds were reduced in higher-parity groups. The effect of maternal age was confounded in crude analysis; in adjusted analysis, the odds of hospital vs PHC birth increased with age. Women with a previous birth by CS had higher odds of a hospital birth compared with those with no previous CS, while women with no education, compared with those with primary education, had reduced odds of hospital vs PHC birth. Higher odds were observed in women residing in two zones (Northern and Central) compared with those residing in the reference Lake Zone.

Interaction between SES and parity

To assess the joint effects of parity and SES, the final adjusted multinomial logistic regression model was run with an interaction term between the two variables. A likelihood ratio test comparing the model with and without interaction indicated better fit of the model with interaction ($P = 0.006$). The reference group included the poorest women at parity ≥5, as this group had the lowest use of hospital-based childbirth care and was the most numerous wealth/parity subgroup ($n = 406$). Results are shown in Supplementary Tables S2a and S2b.

All combinations of SES and parity had lower odds than the baseline category of a home vs a PHC birth, although not all reached statistical significance at $P < 0.05$. The richest women at high parity (≥5) had the lowest adjusted OR (0.29, 95% CI 0.15–0.57) compared with the reference group. The poorest women at Parity 0 had an OR of 8.03 (95% CI, 4.45–14.46) compared with the baseline of a hospital vs PHC birth, while at other parity levels the ORs were not significantly different. Women at Parity 1–2 from poorer, medium and richest groups had higher odds of hospital vs PHC childbirth compared with the baseline group; the OR was non-significant in the poorest group. In other groups, ORs were not significantly different from the baseline.

We predicted the percentages of childbirth for each combination of SES and parity in each location using margins analysis; results are reported in Table 3 and displayed in Graph 1(A-C). Across all SES groups, hospital-based childbirth (Graph 1A) was highest at first birth, at >40%. Use of hospitals reduced in all SES groups with increasing parity, but the shape of this decline varied. Among the wealthiest women, hospital use decreased gradually, reaching its lowest (around 25%) at parity 3–4. Among the poorest, the decline was abrupt after parity 0, levelling out at 12% at parity 1–2. The effect of wealth on PHC births was more complex (Graph 1B). The predicted percentages at this level were lowest among nulliparous women in all wealth groups. Among the wealthiest, the percentage rose with parity, reaching its maximum (51%) at parity 3–4. Among the poorest women, the predicted utilization reached the highest level at parity 1–2 (39%) and then levelled off at around 30%. In all wealth groups, after parity 0, ≥30% of women were predicted to give birth in a PHC. Median utilization of PHC facilities in parous women was 35% (range 30–51%), while in women at first parity it was 27% (range 20–31%). The percentage of births at home (Graph 1C) increased as parity rose in all wealth groups and was lowest among the wealthiest women in all parity groups.

The profiles of birth location among the two extremes of wealth (poorest and richest women) are compared in Graph 2. Among the richest women, there was a shift in the location of births from mainly hospital (at parity 0) to mainly PHC facilities (at parity ≥5). In the poorest women's group, between parity groups 0 and ≥5, decline in hospital births was accompanied by a sharp rise in home births, with a small increase in PHC births.

Discussion

This study explored rural women's differential use of childbirth care in Tanzania. We report three key findings. First, there was a socio-economic inequity in rural women's use of hospital-based childbirth, which additionally varied with parity. Second, the poorest multiparous women had the lowest use of hospital-based care for childbirth (around 10%), with no increase in uptake at grand multiparity despite increased risk. This group also had lower uptake of PHC care. Third, PHC facilities provided care to a sizeable proportion of women after the first birth, with a median uptake of 35% (range 30–51%) by women after the first birth (compared with a median of 27% by women at first birth).

The poorest women in rural Tanzania were less likely than those from the wealthiest households to give birth in hospitals, where advanced management of childbirth complications was available. The study adds to existing evidence that wealth is not just a determinant for facility birth, but also for uptake of hospital-based childbirth care within the health system. It expands findings of a previous sub-national study (Straneo *et al.*, 2014) and earlier studies (Benova *et al.*, 2014). We found that the gap between the poorest and wealthiest women in use of hospitals was less pronounced among nulliparous

Downloaded from https://academic.oup.com/heapol/article/36/9/1428/6323932 by guest on 06 April 2022

Table 2. Crude and adjusted ORs by multinomial logistic regression of home vs PHC birth (left) and hospital vs primary care births (right) in rural women, with a live birth in the last 5 years (Tanzania, DHS 2015–16)

	Home birth vs PHC birth				Hospital birth vs PHC birth			
Variable	Crude OR	*P*-value	Adjusted OR[a]	*P*-value	Crude OR	*P*-value	Adjusted OR[a]	*P*-value
SES								
Poorest	ref		ref		ref		ref	
Poorer	0.66 (0.51–0.84)	1	0.75 (0.58–0.96)	23	0.92 (0.67–1.26)	0.6	0.90 (0.66–1.23)	501
Medium	0.47 (0.36–0.61)	<0.001	0.56 (0.43–0.74)	<0.001	1.18 (0.86–1.62)	0.3	1.05 (0.78–1.41)	731
Wealthiest	0.26 (0.18–0.37)	<0.001	0.34 (0.23–0.50)	<0.001	2.30 (1.61–3.27)	<0.001	1.78 (1.26–2.50)	0.001
Parity								
0	0.71 (0.56–0.91)	0.006	0.84 (0.63–1.12)	0.225	2.13 (1.67–2.73)	<0.001	3.22 (2.34–4.43)	<0.001
1–2	ref		ref		ref		ref	
3–4	1.07 (0.87–1.31)	0.5	1.07 (0.82–1.39)	0.642	0.68 (0.51–0.90)	0.007	0.46 (0.32–0.65)	<0.001
≥5	1.57 (1.26–1.95)	<0.001	1.54 (1.05–2.25)	0.028	0.89 (0.67–1.19)	0.4	0.59 (0.39–0.89)	0.013
Maternal age at birth								
≤19	0.76 (0.60–0.96)	0.02	0.80 (0.59–1.08)	0.151	1.38 (1.05–1.80)	0.019	0.86 (0.62–1.19)	0.366
20–24	ref		ref		ref		ref	
25–29	1.03 (0.82–1.29)	0.796	0.86 (0.66–1.13)	0.289	0.94 (0.72–1.24)	0.664	1.89 (1.37–2.60)	<0.001
30–34	1.13 (0.89–1.43)	0.322	0.80 (0.56–1.13)	0.204	1.07 (0.81–1.42)	0.636	2.69 (1.78–4.08)	<0.001
35–39	1.05 (0.81–1.35)	0.724	0.61 (0.40–0.93)	0.021	0.90 (0.64–1.27)	0.551	2.49 (1.51–4.13)	<0.001
40–49	1.27 (0.91–1.76)	0.156	0.69 (0.44–1.08)	0.104	0.96 (0.65–1.41)	0.829	2.64 (1.58–4.42)	<0.001
Maternal education at survey								
No education	1.49 (1.23–1.80)	<0.001	1.19 (0.97–1.45)	0.094	0.58 (0.44–0.75)	<0.001	0.70 (0.53–0.93)	0.013
Primary	ref		ref		ref		ref	
Secondary and above	0.30 (0.21–0.43)	<0.001	0.38 (0.25–0.59)	<0.001	1.82 (1.39–2.39)	<0.001	1.03 (0.76–1.41)	0.837
Marital status at survey								
Currently married or cohabiting	ref				ref			
Not currently married or cohabiting	0.80 (0.64–1.01)	0.059			1.26 (1.00–1.59)	0.049		

(continued)

Downloaded from https://academic.oup.com/heapol/article/36/9/1428/6323932 by guest on 06 April 2022

Table 2. (Continued)

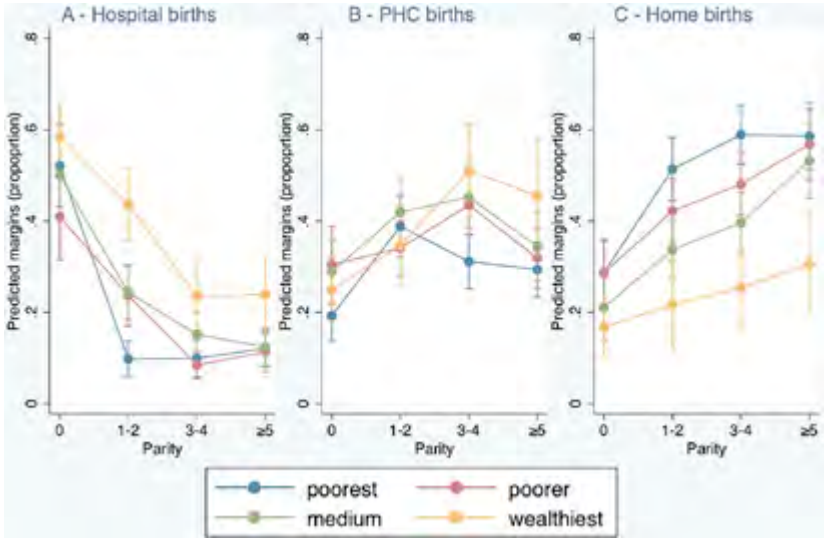
Variable	Home birth vs PHC birth				Hospital birth vs PHC birth			
	Crude OR	*P*-value	Adjusted OR[a]	*P*-value	Crude OR	*P*-value	Adjusted OR[a]	*P*-value
Zone of residence								
Western	1.00 (0.63–1.60)	0.989	0.82 (0.51–1.31)	0.401	1.13 (0.66–1.93)	0.645	1.28 (0.73–2.23)	0.394
Northern	1.15 (0.67–1.96)	0.621	1.40 (0.86–2.28)	0.181	3.23 (1.95–5.34)	<0.001	2.54 (1.56–4.13)	<0.001
Central	0.85 (0.54–1.34)	0.483	0.89 (0.57–1.39)	0.61	1.75 (1.12–2.74)	0.014	1.83 (1.16–2.88)	0.01
Southern Highlands	0.20 (0.09–0.46)	<0.001	0.24 (0.11–0.57)	0.001	1.70 (1.01–2.86)	0.045	1.52 (0.90–2.29)	0.117
Southern	0.26 (0.15–0.45)	<0.001	0.27 (0.16–0.47)	<0.001	1.39 (0.89–2.16)	0.151	1.44 (0.90–2.29)	0.124
Southern West Highlands	0.55 (0.34–0.90)	0.016	0.55 (0.34–0.91)	0.019	0.88 (0.51–1.52)	0.637	0.85 (0.49–1.49)	0.579
Lake	ref		ref		ref		ref	
Eastern	0.33 (0.18–0.61)	0.001	0.43 (0.22–0.83)	0.012	1.15 (0.65–2.06)	0.63	1.17 (0.67–2.07)	0.58
ANC (visits)								
None	6.71 (3.53–12.74)	<0.001	5.75 (3.23–10.23)	<0.001	0.87 (0.29–2.58)	0.801	0.87 (0.25–3.07)	0.828
1–3	1.73 (1.45–2.07)	<0.001	1.53 (1.28–1.83)	<0.001	0.91 (0.76–1.08)	0.276	1.10 (0.92–1.32)	0.305
≥4	ref		ref		ref		ref	
Multiple live birth at index pregnancy								
No	ref		ref		ref		ref	
Yes	1.32 (0.75–2.31)	0.332	1.17 (0.68–2.00)	0.578	1.89 (1.02–3.50)	0.042	2.24 (1.18–4.26)	0.014
Previous birth was by CS								
No	ref		ref		ref		ref	
Yes	0.69 (0.16–3.03)	0.628	0.71 (0.18–2.84)	0.626	6.15 (1.89–20.0)	0.003	6.96 (2.15–22.57)	0.001
Short preceding birth interval (≤12 months)								
No	ref				ref			
Yes	1.33 (0.63–2.79)	0.45			0.69 (0.26–1.84)	0.457		
Previous neonatal death								
No	ref				ref			
Yes	0.86 (0.49–1.51)	0.596			0.92 (0.46–1.83)	0.803		
Previous baby died								
No	ref				ref			
Yes	1.47 (0.85–2.56)	0.169			0.75 (0.35–1.58)	0.441		

[a]Adjusted for wealth, parity, maternal age at index birth, maternal education, marital status, ANC visits and multiple index pregnancy.

Downloaded from https://academic.oup.com/heapol/article/36/9/1428/6323932 by guest on 06 April 2022

Table 3. Predicted margins (%) for each outcome (home/PHC/hospital birth) in rural women, Tanzania 2015–16 DHS, by SES and parity, adjusted for wealth, parity, maternal age at index birth, maternal education, marital status, ANC visits and multiple index pregnancy

Predicted margins (%) of rural women by outcome, SES group and parity					
Outcome	**SES group**	**Parity 0**	**Parity 1–2**	**Parity 3–4**	**Parity ≥5**
Home birth	Poorest	28 (21–35)	51 (44–58)	59 (52–65)	58 (51–65)
	Poorer	28 (21–35)	42 (35–49)	47 (40–54)	56 (48–63)
	Medium	21 (14–28)	33 (27–39)	39 (33–46)	53 (45–61)
	Wealthiest	16 (10–22)	21 (11–30)	25 (17–33)	30 (19–41)
PHC birth	Poorest	20 (14–25)	39 (33–46)	31 (25–37)	30 (24–36)
	Poorer	31 (22–39)	34 (28–40)	44 (38–51)	32 (26–39)
	Medium	28 (22–35)	42 (35–49)	46 (39–52)	35 (27–42)
	Wealthiest	25 (18–32)	35 (26–43)	51 (41–61)	47 (35–59)
Hospital birth	Poorest	52 (43–61)	10 (6–14)	10 (6–14)	12 (8–16)
	Poorer	42 (32–51)	23 (17–30)	8 (6–11)	12 (8–16)
	Medium	51 (43–59)	25 (19–30)	15 (10–20)	12 (8–16)
	Wealthiest	59 (51–66)	44 (37–52)	25 (17–32)	23 (15–31)

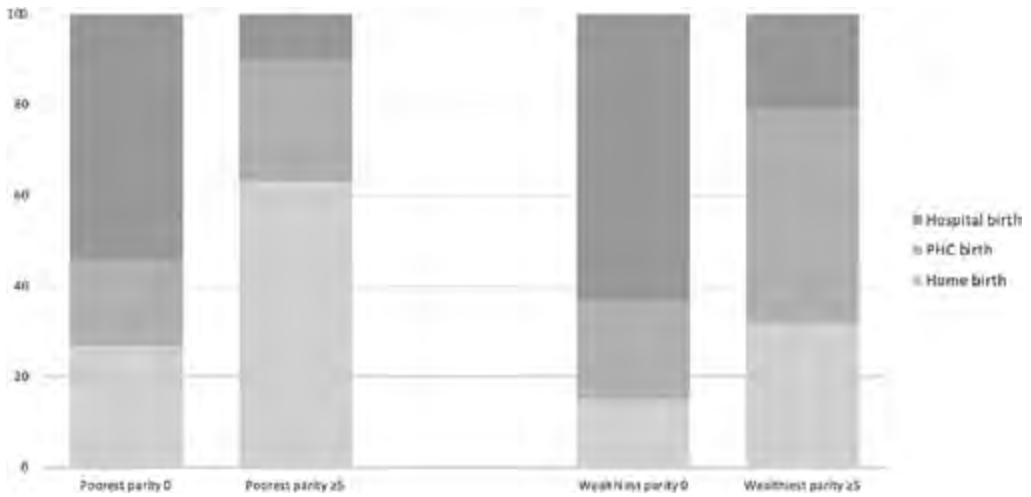


Graph 1. Predicted margins of birth at each location, rural Tanzania 2015-16, 95% CI

women. Health policy in Tanzania (Tanzania MoHSW, 2008) recommends that women's first births should take place in hospitals. In spite of the existing recommendations, uptake by rural women at first birth was not universal, as just over half used hospital-based care. We found that hospital-based care use among nulliparous women was very similar across wealth groups. Factors other than wealth are likely to limit hospital use at first birth; amongst these distance to hospital from a woman's residence, which could not be accounted for, stands out, and interaction between distance and wealth has been described (Bai *et al.*, 2002; Hanson *et al.*, 2015; Wong *et al.*, 2020). Our finding is in line with that of other researchers indicating that women and their families recognize the first birth as a higher-risk one (Jahn *et al.*, 1998; Dunlop *et al.*, 2018). Utilization of hospitals decreased at different rates in SES groups with increasing parity and the gap between the poorest and wealthiest was widest at Parity Level 1–2 but persisted across all higher-parity groups. A switch in birth location away from facilities between first- and second-order births was found to be less likely in wealthier households across low- and middle-income countries (Benova *et al.*, 2017). What this study adds is that among the poorest women between first-order and successive births (Parity 1–2), there was a switch within the health system, from hospital-based care to PHC-based care, and to home-based care.

Utilization of hospital-based childbirth is lowest among the poorest, multiparous women. Use, as estimated by margins analysis, dropped to around 10% at all levels of parity after the first-order birth. Despite greater risk in women with ≥5 previous births of adverse pregnancy outcomes, including haemorrhagic complications (Bai *et al.*, 2002; Mgaya *et al.*, 2013; Filippi *et al.*, 2016), there was no increased hospital care uptake among the poorest women. Factors contributing to this may be inadequate counselling during ANC on hospital-based childbirth resulting in low perceived risk (Pembe *et al.*, 2008), childcare duties at home, and greater economic constraints due to larger families. Reducing facility

Downloaded from https://academic.oup.com/heapol/article/36/9/1428/6323932 by guest on 06 April 2022



Graph 2. Predicted margins (percentages) of Hospital/PHC/Home births of poorest and wealthiest rural women by parity, Tanzania 2015-16

use with increasing parity is well documented (Kyei-Nimakoh *et al.*, 2017; Moyer and Mustafa, 2013; Gabrysch and Campbell, 2009; Berhan and Berhan, 2014). Results of our study add that, in rural Tanzania, multiparous women will opt for a home birth when economic means are limited but will uptake PHC-based childbirth when resources are available. Poor multiparous women constitute a disadvantaged group, least served by hospitals or indeed by any facility. Qualitative studies in southern Tanzania (Kowalewski *et al.*, 2000) indicated that in the community, these women were perceived as vulnerable due 'to fatigue and (being) overburdened with household duties', and precisely these factors prevented them from accessing health services.

Although our analysis focused on hospital births, rural women's uptake of childbirth care in lower-level facilities is noteworthy. PHC units (health centres and dispensaries) have a critical role in childbirth care in rural Tanzania, as 61% of all facility births took place here, and utilization ranged from 30 to 51% (median 35%) across all SES groups after Parity 0. The greatest use is among the wealthiest, at intermediate and high parity. This has relevance in the current debate on reorganization of maternity care in low-income countries (Campbell *et al.*, 2016; Kruk *et al.*, 2018; Hanson and Schellenberg, 2019). From these data, childbirth care in PHC facilities is used by all wealth groups: among the wealthiest, uptake increases with parity, while among the poorest, utilization is mostly at intermediate levels of parity. Comparing the shift in births between the two extremes of parity in the poorest and richest women suggests that, in this context, a reduction in the availability of facilities providing childbirth care without other measures may result in an increase in the already-high level of home births among the poorest women.

Policy recommendations arising from this study include three main points. Firstly, aiming attention on the poorest women allows identification of health system adjustments to mitigate the effects of poverty on childbirth-related deaths (WHO, 2008). A subsidized voucher scheme has been applied in Kenya (Dennis *et al.*, 2019; Wong *et al.*, 2020). Maternity waiting homes may contribute to facilitating access to hospitals (Virgo *et al.*, 2017), and there is evidence that they are utilized preferentially by poorer women (Fogliati *et al.*, 2017). Secondly, high-parity women's low use of hospital-based childbirth care, particularly among the poorest, requires urgent action. All women should receive appropriate, timely care. National policy should focus attention on grand-multiparous women as a particularly higher-risk group. Guidelines should be in place to prepare these women for hospital-based births. They may include adapted birth preparedness plans and emergency transport during labour to improve geographic accessibility. Thirdly, the current debate on centralization of childbirth care must take into account the sizeable proportions of women using PHC facilities for obstetric care. Care at childbirth is part of essential care, as defined in the Alma Ata declaration of PHC (Beard and Redmond, 1979), which also includes the 'scientifically sound' concept. Effective coverage is increasingly advocated, in place of contacts with care (Campbell *et al.*, 2016; Marsh *et al.*, 2020). In this context, to achieve effective coverage for the large proportion of women who uptake PHC-based care, quality-adjusted coverage (Marsh *et al.*, 2020) must be available at the base of the health system pyramid (Hanson and Schellenberg, 2019; Straneo *et al.*, 2014; Fogliati *et al.*, 2015). Comprehensive EmOC in strategically identified rural health centres is one possible solution (Nyamtema *et al.*, 2016); a locally adapted and community-participated reduction of birth sites may be necessary to balance quality and coverage of care (Fogliati *et al.*, 2015). From a policy perspective, the position of childbirth care in PHC should be reappraised.

Limitations

This analysis is the first, to the best of our knowledge, to examine the use of different levels of the health system for childbirth among rural women in Tanzania and analysed the interaction between wealth and parity. It is based on nationally representative data, from a country that has consistently supported the development of a PHC network (Tanzania MoHSW, 2007; Tanzania MoHSW, MoHMZ, NBS, OCGS,

Downloaded from https://academic.oup.com/heapol/article/36/9/1428/6323932 by guest on 06 April 2022

and ICF, 2015), and thus is a model for countries developing rural obstetric care. The Tanzania DHS is unique in allowing identification of facility type (hospital, health centre or dispensary) in both the public and the private sectors, thus providing a more detailed picture of where women report giving birth (Tanzania MoHCDGEC, 2016). The DHS data set was complete, with very little non-response and missing data. Multinomial logistic regression allowed us to include all three locations in one model and thus study factors significant in use of hospital vs PHC facilities, and home vs PHC. Some caution should be applied when interpreting the findings, in terms of the cross-sectional nature of the DHS data and the possible response bias. Since in Swahili all facilities may be referred to as 'hospitali', lower-level public health facilities may be misreported as district hospitals. The DHS interviewers are instructed to circle a type of facility, if known, and if not, to write down the name of the facility, which is later coded as a specific type of facility by the field supervisor. This non-differential misclassification of facilities may bias results and may have led to weaker associations. This DHS collects limited information on obstetric risk factors (Virgo *et al.*, 2017); thus, use of facilities due to risk factors identified during ANC (such as hypertension or maternal infections) cannot be fully captured. Even the risk factors for which some information is available may not fully reflect women's knowledge prior to index birth; e.g., limitations in DHS questionnaire identification of twin pregnancies have been described recently (Hanson *et al.*, 2019). This is unlikely to modify findings, as in a study on four East African countries no association between obstetric risk and birth location was found (Virgo *et al.*, 2017), while wealth and education were strong determinants. Information on referral was lacking; thus, hospital births may include women who had been referred during labour from a PHC unit. In previous studies we found that intra-partum referral rates were very low (Straneo *et al.*, 2016; Fogliati *et al.*, 2017); thus, this too is unlikely to change the findings. Distance travelled to facilities could not be taken into account. Recent studies indicate that travel time is an important factor for hospital births in Tanzania (Wong *et al.*, 2020), and current distribution leaves the rural poor underserved (Wong *et al.*, 2019). Additionally, the study broadly categorized facilities by level (PHC and hospitals) but could not account for variation of quality of care within levels, such as more limited quality at hospital level or more advanced care in health centres (Nyamtema *et al.*, 2016; Tanzania MoHSW, MoHMZ, NBS, OCGS, and ICF, 2015).

In conclusion, the study found that in rural Tanzania the use of hospital-based childbirth was not equitable. Inequity varied with parity level: at first birth, uptake varied only minimally with wealth, while in successive births it was strongly dependent on SES and parity. Uptake was the lowest amongst the poorest, multiparous women, with no increase in uptake at grand multiparity (≥ 5), in spite of increased risk. PHC-based childbirth accounted for a median of 35% of births after the first in this setting.

To leave no one behind in attaining Sustainable Development Goal 3 on maternal and preventable newborn mortality (Boerma *et al.*, 2018), it is necessary to identify who is underserved at childbirth and make adjustments to improve the use of high-quality care, bearing in mind that from a human rights' perspective health care should contribute to equity (Tudor Hart, 1971). Strategies are needed to improve uptake of hospital-based care among the poorest, rural women, particularly at high parity. A reassessment of the whole district health system, which may involve re-evaluation of childbirth care in PHC and strengthening referral linkages, would benefit a substantial proportion of women.

Supplementary data

Supplementary data are available at *Health Policy and Planning* online.

Data availability statement

The dataset is available to the public at www.measuredhs.com.

Acknowledgements

The authors wish to acknowledge ICF (Rockville, Maryland USA) for providing access to the Tanzanian DHS database.

Conflict of interest statement The authors declare that they have no conflict of interest.

References

Alkema L, Chou D, Hogan D *et al.* and UN Maternal Mortality Estimation Inter-Agency Group. 2016. Global, regional, and national levels and trends in maternal mortality between 1990 and 2015, with scenario-based projections to 2030: a systematic analysis by the UN Maternal Mortality Estimation Inter-Agency Group. *Lancet* **387**: 462–74.

Armstrong CE, Martínez-Álvarez M, Singh NS *et al.* 2016. Subnational variation for care at birth in Tanzania: is this explained by place, people, money or drugs? *BMC Public Health* **16**: 795.

Bai J, Wong FW, Bauman A, Mohsin M. 2002. Parity and pregnancy outcomes. *American Journal of Obstetrics and Gynecology* **186**: 274–8.

Baker U, Peterson S, Marchant T *et al.* 2015. Identifying implementation bottlenecks for maternal and newborn health interventions in rural districts of the United Republic of Tanzania. *Bulletin of the World Health Organization* **93**: 380–9.

Beard TC, Redmond S. 1979. Declaration of Alma-Ata. *The Lancet* **313**: 217–8.

Benova L, Cumming O, Gordon BA, Magoma M, Campbell OMR. 2014. Where there is no toilet: water and sanitation environments of domestic and facility births in Tanzania. *PLoS One* **9**: 1–10.

Benova L, Macleod D, Radovich E, Lynch CA. 2017. Should I stay or should I go?: consistency and switching of delivery locations among new mothers in 39 Sub-Saharan African and South/Southeast Asian countries. *Health Policy and Planning* **32**: 1294–308.

Berhan Y, Berhan A. 2014. A meta-analysis of socio-demographic factors predicting birth in health facility. *Ethiopian Journal of Health Sciences* **24**: 81–92.

Blencowe H, Cousens S, Jassir FB *et al.* 2016. National, regional, and worldwide estimates of stillbirth rates in 2015, with trends from 2000: a systematic analysis. *The Lancet Global Health* **4**: e98–108.

Boerma T, Requejo J, Victora CG *et al.* 2018. Countdown to 2030: tracking progress towards universal coverage for reproductive, maternal, newborn, and child health. *The Lancet* **391**: 1538–48.

Bustreo F, Mshinda H, Hinton R, Hausmann-Muela S, Tanner M. 2019. Commentary: primary health care in Tanzania - leading the way through innovation. *EClinicalMedicine* **13**: 12–3.

Downloaded from https://academic.oup.com/heapol/article/36/9/1428/6323932 by guest on 06 April 2022

Campbell OMR, Calvert C, Testa A *et al.* 2016. The scale, scope, coverage, and capability of childbirth care. *The Lancet* **388**: 2193–2208.

Dennis ML, Benova L, Abuya T *et al.* 2019. Initiation and continuity of maternal healthcare: examining the role of vouchers and user-fee removal on maternal health service use in Kenya. *Health Policy and Planning* **34**: 120–31.

Doctor HV, Radovich E, Benova L. 2019. Time trends in facility-based and private-sector childbirth care: analysis of demographic and health surveys from 25 sub-Saharan African countries from 2000 to 2016. *Journal of Global Health* **9**: 020406.

Dominicus DA, Akamatsu T. 1989. Health policy and implementations in Tanzania. *The Keio Journal of Medicine* **38**: 192–200.

Dunlop CL, Benova L, Campbell O 2018. Effect of maternal age on facility-based delivery: analysis of first-order births in 34 countries of sub-Saharan Africa using demographic and health survey data. *BMJ Open* **8**: e02023.

Filippi V, Chou D, Ronsmans C, Graham W, Say L. 2016. Levels and causes of maternal mortality and morbidity. In: Black RE, Laxminarayan R, Temmerman M, Walker N (eds). *Reproductive, Maternal, Newborn, and Child Health: Disease Control Priorities*. Vol. 2, 3rd edn. Washington, DC: The International Bank for Reconstruction and Development/The World Bank, 51–70.

Fogliati P, Straneo M, Brogi C *et al.* 2015. How can childbirth care for the rural poor be improved? A contribution from spatial modelling in rural Tanzania. *PLoS One* **10**: e0139460.

Fogliati P, Straneo M, Mangi S *et al.* 2017. A new use for an old tool: maternity waiting homes to improve equity in rural childbirth care. Results from a cross-sectional hospital and community survey in Tanzania. *Health Policy and Planning* **10**: 1354–60.

Gabrysch S, Campbell OMR. 2009. Still too far to walk: literature review of the determinants of delivery service use. *BMC Pregnancy and Childbirth* **9**: 34.

Gabrysch S, Nesbitt RC, Schoeps A *et al.* 2019. Does facility birth reduce maternal and perinatal mortality in Brong Ahafo, Ghana? A secondary analysis using data on 119 244 pregnancies from two cluster-randomised controlled trials. *Lancet Global Health* **7**: e1074–87.

Graham W, Woodd S, Byass P *et al.* 2016. Diversity and divergence: the dynamic burden of poor maternal health. *Lancet* **388**: 2164–75.

Hanson C, Cox J, Mbaruku G *et al.* 2015. Maternal mortality and distance to facility-based obstetric care in rural southern Tanzania: a secondary analysis of cross-sectional census data in 226 000 households. *The Lancet Global Health* **3**: e387–95.

Hanson C, Munjanja S, Binagwaho A *et al.* 2019. National policies and care provision in pregnancy and childbirth for twins in Eastern and Southern Africa: a mixed-methods multi-country study. *PLoS Medicine* **16**: e1002749.

Hanson C, Ronsmans C, Penfold S *et al.* 2013. Health system support for childbirth care in Southern Tanzania: results from a health facility census. *BMC Research Notes* **6**: 435.

Hanson C, Schellenberg J. 2019. Redesigning maternal health services: is centralisation the answer in low-resource settings? *BMJ Global Health* **4**: e001488.

Houweling TAJ, Ronsmans C, Campbell OMR, Kunst AE. 2007. Huge poor-rich inequalities in maternity care: an international comparative study of maternity and child care in developing countries. *Bulletin of the World Health Organization* **85**: 745–54.

Jahn A, Kowalewski M, Kimatta SS. 1998. Obstetric care in southern Tanzania: does it reach those in need? *Tropical Medicine and International Health* **3**: 926–32.

Kinney MV, Kerber KJ, Black RE *et al.* On behalf of the Science in Action: Saving the lives of Africa's mothers, newborns, and children working group. 2010. Sub-Saharan Africa's mothers, newborns, and children: where and why do they die? *PLoS Medicine* **7**: e1000294.

Kowalewski M, Jahn A, Kimatta SS. 2000. Why do at-risk mothers fail to reach referral level? Barriers beyond distance and cost. *African Journal of Reproductive Health* **4**: 100–9.

Kruk ME, Gage AD, Arsenault C *et al.* 2018. High-quality health systems in the Sustainable Development Goals era: time for a revolution. *The Lancet Global Health* **6**: e1196–252.

Kruk ME, Hermosilla S, Larson E, Mbaruku GM. 2014. Bypassing primary care clinics for childbirth: a cross-sectional study in the Pwani region, United Republic of Tanzania. *Bulletin of the World Health Organization* **92**: 246–53.

Kruk ME, Leslie HH, Verguet S *et al.* 2016. Quality of basic maternal care functions in health facilities of five African countries: an analysis of national health system surveys. *The Lancet Global Health* **4**: 1–11.

Kyei-Nimakoh M, Carolan-Olah M, McCann TV. 2017. Access barriers to obstetric care at health facilities in sub-Saharan Africa-a systematic review. *Systematic Reviews* **6**: 110.

Lawn JE, Blencowe H, Waiswa P *et al.* 2016. Stillbirths: rates, risk factors, and acceleration towards 2030. *The Lancet* **6736**: 1–17.

Lohela TJ, Nesbitt RC, Pekkanen J, Gabrysch S. 2019. Comparing socioeconomic inequalities between early neonatal mortality and facility delivery: cross-sectional data from 72 low- and middle-income countries. *Scientific Reports* **9**: 9786.

Marsh AD, Muzigaba M, Diaz T *et al.* 2020. Effective coverage measurement in maternal, newborn, child, and adolescent health and nutrition: progress, future prospects, and implications for quality health systems. *Lancet Global Health* **8**: e730–6.

Mgaya AH, Massawe SN, Kidanto HL, Mgaya HN. 2013. Grand multiparity: is it still a risk in pregnancy ? *BMC Pregnancy and Childbirth* **13**: 241.

Montagu D, Sudhinaraset M, Diamond-Smith N *et al.* 2017. Where women go to deliver: understanding the changing landscape of childbirth in Africa and Asia. *Health Policy and Planning* **122**: 1045–9.

Moyer CA, Mustafa A. 2013. Drivers and deterrents of facility delivery in sub-Saharan Africa: a systematic review. *Reproductive Health* **10**: 40.

Nyamtema AS, Mwakatundu N, Dominico S *et al.* 2016. Enhancing maternal and perinatal health in under-served remote areas in Sub-Saharan Africa: a Tanzanian model. *PLoS One* **11**: e0151419.

Pembe AB, Urassa DP, Darj E, Carlsted A, Olsson P. 2008. Qualitative study on maternal referrals in rural Tanzania: decision making and acceptance of referral advice. *African Journal of Reproductive Health* **12**: 120–31.

Roder-Dewan S, Nimako K,Twum-Danso NAY *et al.* 2020. Health system redesign for maternal and newborn survival: rethinking care models to close the global equity gap. *BMJ Global Health* **5**: e002539.

Ronsmans C, Graham WJ. 2006. Maternal mortality: who, when, where, and why. *Lancet* **368**: 1189–200.

Straneo M, Fogliati P, Azzimonti G, Mangi S, Kisika F. 2014. Where do the rural poor deliver when high coverage of health facility delivery is achieved? Findings from a community and hospital survey in Tanzania. *PLoS One* **9**: e113995.

Straneo M, Fogliati P, Pellis I *et al.* 2016. On the way to universal coverage of maternal services in Iringa rural district in Tanzania. Who is yet to be reached? *African Health Sciences* **16**: 420–8.

Tanzania MoHCDGEC, MoHMZ, National Bureau of Statistics (NBS), Office of the Chief Government Statistician (OCGS), and ICF. 2016. *Tanzania Demographic and Health Survey and Malaria Indicator Survey (TDHS-MIS) 2015–16*. Dar es Salaam, and Rockville, MD: MoHCDGEC, MoH, NBS, OCGS, and ICF.

Tanzania MoHSW. 2008. Reproductive and Child Health Section. In: *The National Road Map Strategic Plan to Accelerate Reduction of Maternal, Newborn and Child Deaths in Tanzania, 2008-15*. Dar es Salaam: MoHSW.

Tanzania MoHSW, MoHMZ, National Bureau of Statistics (NBS), Office of the Chief Government Statistician (OCGS), and ICF. 2015.

Downloaded from https://academic.oup.com/heapol/article/36/9/1428/6323932 by guest on 06 April 2022

Tanzania Service Provision Assessment Survey (TSPA) 2014-15. Dar es Salaam: NBS, MOF, OCGS, Ministry of State, President's Office.
Tanzania NBS and Zanzibar OGCS. 2013. *Census 2012: population distribution by age and sex*.
Tanzania MoHSW. 2007. *Primary Health Services Development Programme*, pp. 2007–17.
Tanzania URO. 2000. *Vision_2025_en.pdf*. Dar es Salaam Tanzania. www.tanzania.go.tz, accessed 14 January 2020.
Tudor Hart J. 1971. The inverse care law. *The Lancet* **297**: 405–12.
UNDP. 2020. https://population.un.org/wpp/DataQuery/, accessed 22 July 2020.
Virgo S, Gon G, Cavallaro FL, Graham W, Woodd S. 2017. Who delivers where? The effect of obstetric risk on facility delivery in East Africa. *Tropical Medicine & International Health* **22**: 1081–98.
Vyas S, Kumaranayake L. 2006. Constructing socio-economic status indices: how to use principal components analysis. *Health Policy and Planning* **21**: 459–68.
WHO. 2008. *Closing the Gap in a Generation. Health Equity through Action on the Social Determinants of Health. Final Report of the Commission on the Social Determinants of Health*. Geneva: World Health Organization.
WHO. 2015a. *State of Inequality. Reproductive, Maternal, Newborn and Child Health*.
WHO. 2015b. *Trends in Maternal Mortality: 1990 to 2015: Estimates by WHO, UNICEF, UNFPA, World Bank Group and the United Nations Population Division*. www.who.int, accessed 16 February 2021.
WHO. 2019. *Trends in Maternal Mortality 2000 to 2017: Estimates by WHO, UNICEF, UNFPA, World Bank Group and the United Nations Population Division*. Geneva: World Health Organization.
Wong KLM, Brady OJ, Campbell OMR, Banke-Thomas A, Benova L. 2020. Too poor or too far? Partitioning the variability of hospital-based childbirth by poverty and travel time in Kenya, Malawi, Nigeria and Tanzania. *International Journal for Equity in Health* **19**: 15.
Wong KL, Brady OJ, Campbell OMR *et al.* 2019. Current realities versus theoretical optima: quantifying efficiency and sociospatial equity of travel time to hospitals in low-income and middle-income countries. *BMJ Global Health* **4**: e001552.
World Bank. 2020. *World Bank Open Data*. https://data.worldbank.org, accessed 10 April 2020.

Downloaded from https://academic.oup.com/heapol/article/36/9/1428/6323932 by guest on 06 April 2022

Medical Electives in Sub-Saharan Africa: A 15-Year Student/NGO-Driven Initiative

PAPER

Authors
Quaglio G., Maziku D., Bortolozzo M., Parise N., Di Benedetto C., Lupato A., Cavagna C., Tsegaye A., Putoto G.

Published in
Journal of Community Health, November 2021

Link
https://doi.org/10.1007/s10900-021-01045-5

Topic
Universal coverage and equity

Focus country
Multi-countries

Journal of Community Health (2022) 47:273–283
https://doi.org/10.1007/s10900-021-01045-5

ORIGINAL PAPER

Medical Electives in Sub-Saharan Africa: A 15-Year Student/NGO-Driven Initiative

Gianluca Quaglio[1,2,3] · Donald Maziku[4] · Marta Bortolozzo[5] · Nicoletta Parise[6] · Chiara Di Benedetto[2] · Alice Lupato[5] · Chiara Cavagna[2] · Ademe Tsegaye[7] · Giovanni Putoto[2]

Accepted: 26 October 2021 / Published online: 11 November 2021
© The Author(s), under exclusive licence to Springer Science+Business Media, LLC, part of Springer Nature 2021

Abstract
Medical schools are developing global health programmes, and medical students are requesting global health training and creating opportunities when these are not provided by medical schools. This article described the Wolisso Project (WP), a medical experience on clinical electives in Sub-Saharan Africa, driven by a collaboration between a student organisation and a Nongovernmental Organization (NGO). Preclinical medical students spent 4 weeks as part of a multidisciplinary medical team in Africa. Post-elective questionnaires were administered to all subjects who participated in the project. Of all, 141 students responded to the questionnaire. The participants came from 30 Italian universities. The main difficulties reported are due to the lack of resources for the exercise of the medical activity, and difficulties related to language and communication. The African experience had a positive impact on the progress of the studies upon return, with an increase in determination and motivation. The experience had also positive influences on the future professional choices and carriers. The experience seems to contribute not only to the professional growth, but also to the personal development. A key factor in the positive outcomes of this experience is it being implemented by an NGO with long-term working relationships with the African populations. Another is that the project is carried out in health facilities where NGO staff have been working for a long time. These factors reduce the potential risks connected with this type of experience. They ensure a satisfactory level of supervision, the lack of which has been a serious problem in many similar experiences. A well-structured, mentored experience in international health can have a positive impact on preclinical students' attitudes, including their compassion, volunteerism, and interest in serving underserved populations. Only a small number of Italian universities facilitate pre-graduate medical elective experiences in LMICs. The WP seems to be attempting to compensate for the lack of international experience in LMICs offered by universities. Italian medical schools should incorporate changes in their curricula to train socially responsible physicians.

Keywords Medical elective · International health · Sub Saharan-Africa · Global health

Disclaimer The views expressed in this publication are the sole responsibility of the authors and do not necessarily reflect the views of the affiliated organisations.

✉ Gianluca Quaglio
gianluca.quaglio@europarl.europa.eu

1 European Parliamentary Research Services, (EPRS), European Parliament, Rue Wiertz, 60, B-1047 Brussels, Belgium

2 Operational Research Unit, Doctors with Africa-Cuamm, Padua, Italy

3 Department of International Health, Faculty of Health, Medicine, and Life Sciences, Care and Public Health Research Institute (CAPHRI), University of Maastricht, Maastricht, The Netherlands

4 Tosamaganga Council Designated Hospital, Iringa, United Republic of Tanzania

5 Italian Medical Students Association (SISM), Padova, Italy

6 Department of Statistical Sciences, Padua University, Padova, Italy

7 Saint Luke Hospital, Wolisso, Ethiopia

Introduction

An editorial published more than 50 years ago in JAMA stated that, "if, as a routine, young American doctors were encouraged to spend some months working in a developing country before they became tied to the responsibilities of practice, the result could only be better medicine at home and abroad" [1]. This statement is more relevant than ever in a time of globalisation, where the intensifications of movement of people, products, and services among countries affect many aspects of public health, as the COVID-19 pandemic has dramatically shown [2]. To provide global health training and facilitate international clinical experiences for medical students has now become a necessity, because mainstream medical education remains largely focused on national—as opposed to global—health issues [3]. Electives often provide students with their first exposure to international health [4], offering participants opportunities to develop clinical skills and to explore new cultures. A Lancet editorial describes how, 'no other part of the [medical] course transforms students so rapidly and profoundly' [5].

Although a significant proportion of students either remain near home or travel to developed countries, medical students are increasingly travelling further afield to low- or middle-income countries (LMICs) to undertake electives. In addition to the opportunity to discover a new country, and experience medicine in a different cultural environment, a number of benefits have been identified to explain the growth in popularity of medical electives in LMICs [6]. These include the gaining of greater experience in working in under-resourced communities, increased diagnostic skills where the use of medical technologies is extremely limited, and a greater appreciation of public health measures and primary care medicine [7–12].

Like any global health intervention, this largely unidirectional flow of students travelling from high-income countries to LMICs also requires critical evaluation of possible unintended consequences [13]. A key concern is whether students will take on excessive clinical responsibility, practising beyond their competence, which raises ethical and professional issues [14, 15]. Another concerns the health risks associated with electives [16]. Another issue is that electives can be perceived as a means to fulfil the students' own ends rather than to serve the needs of their host communities [17], raising concerns about the medical elective impact on resource-constrained host communities [18, 19].

In 2010, the Working Group on Ethics Guidelines for Global Health Training (WEIGHT) developed guidelines for best practices in IMEs to minimize possible burden on host institutions. These guidelines included recommendations for (i) structured, long-term, mutually beneficial partnerships that consider local needs and priorities; (ii) preparatory training; (iii) adequate supervision and the collection of data aimed at assessing the benefits and harms of medical electives on communities and patients [20].

In addition, it must be added that historic legacies (e.g. colonialism and the exploitation of people) permeates the design and the functioning of public health systems, resulting in ethnic, structural and racial inequities within and between communities and countries [21]. Therefore, the notion of global health, being drafted and designed mostly by western people and institutions, has been severely questioned [22]. As a result, the current experiences and practices of the international electives have come under a severe scrutiny [23, 24]. A new paradigm demands that global health practitioners meaningfully engage with the global and local structures that drive health imbalances in terms of knowledge, power, funds and leadership [25].Instead of focussing only on biomedical and clinical capacity, it should be oriented more on multidisciplinary approaches and transformative learning practices around social inequity at institution and community level [26].

Smith and Weaver have shown how a well-structured, mentored, medical elective experience in developing countries can have a positive impact on preclinical student attitudes [27]. Dowell and Merrylees observe [28], 'one way of achieving such structure is through establishing and developing institutional partnerships between the sending and receiving institutions'. They also emphasise that, 'the continuity of student presence provided by a partnership allows more comprehensive student preparation', and that the preparation of students for electives, 'is easier to organise and of more direct relevance for groups of students who are going to the same place as part of an institutional partnership. Continuity can also allow opportunities to expand the student contribution through, for example, student fundraising and support for specific projects'.

This present paper sets out the experience of Italian medical students on clinical electives in Sub-Saharan Africa, in an initiative called the Wolisso Project (WP) [29], driven by a collaboration between the Italian Medical Students Association (SISM) [30] and the Non-governmental Organization (NGO), Doctors with Africa—CUAMM (DwA) [31]. DwA works to improve the health of African populations, providing healthcare services open to all. The organisation has been working in Africa since 1950 and as its main strategy has adopted the strengthening of health systems to build resilient communities in Africa [32]. It also works by promoting learning environments and knowledge about global health issues.

The WP is governed by a memorandum of understanding, signed by DwA and SISM. It takes its name from the

city of Wolisso in Ethiopia, which was the location for the first medical elective site that hosted students. Later, the project expanded to include the Tosamaganga hospital in Tanzania, but the name of the project remains unchanged. The project offers undergraduates the chance to undertake a medical elective in one of the two African sites. It also aims at kindling a desire to work in the international medical field. We report here the15years' experience of the WP, through the results of a survey distributed to all subjects who participated in the project.

Methods

DwAis present in eight Sub-Saharan African countries: Angola, Central African Republic, Ethiopia, Mozambique, South Sudan, Uganda, Sierra Leone, and Tanzania. It operates through expatriated and local health professionals, technicians and administrative staff, providing support to hospitals, health districts (for public health activities, mother–child care, infectious diseases), rehabilitation centres, nursing schools, and medical universities (in Uganda, Mozambique and Ethiopia) [31]. DwA has a long-term working relationship with African populations and is well integrated into a number of communities. The WP is being carried out in health facilities where DwA staff have been working for many years: this allows for understanding the conditions of the local health system in relation to social determinants and local healthcare seeking behaviours. Knowledge of health seeking behaviours brings an understanding of how people use the health care systems in their specific socio-cultural, economic, and demographic context. The knowledge of social determinants while delivering services helps in developing health promotion interventions and in suggesting appropriate health policies to decision-makers.

The SISM, a member of the International Federation of Medical Students Associations (IFMSA) [33], provides training to medical students through national and international initiatives. The objective is to improve the clinical skills of future physicians and raise awareness of ethical and social aspects of the medical profession from a global health perspective [30]. The members of the association are committed to operating in an independent, intercultural and collaborative way of working, based on equality, transparency, and legality, with the aim of improving the knowledge levels and skills of medical students. The association is organized into 39 local committees. Each of them is related to one or more Faculties of Medicine and Surgery, often having physical offices in the academic locations. The association organises at least two national meetings per year. The main governing bodies are the National Council and the Executive Council.

Participants' Selection

The selection concerns medical students attending the year 5 and year 6 as well as newly graduated doctors. The selection is and managed by the SISM project staff (on average 10/12 people), which provides information, opens calls, collects applications, and selects students. The evaluation of applications is based on guidelines established by the SISM, with a final verification in agreement with DwA and the African local health authorities. In the selection process, scores are ascribed on (i) expectations—10 point; (ii) motivation—10 points; (iii) previous international medicine experiences (also as active engagement as volunteers in national and local projects supporting health service for migrants and marginalised people)—3 point; (iv) collaboration within the SISM association (coverage of assignments, project organization, involvement in working groups)—maximum 3 point; (v) attendance of the online global health activities provided by DwA—1 point; (vi) collaboration with DwA—1 point. The duration of the elective is 4 weeks and in each hospital students can choose in what specialty/department they want to do their elective.

Pre-departure and Post Departure

The pre-departure training is also organised by SISM. It mainly concerns information on ethical, practical, and attitudinal aspects, which need to be considered in this type of experience. The pre-departure phase provides a description of the socio-political, economic, and cultural context in Ethiopia and Tanzania [29]. Students are put in contact with the DwA staff in order to get pre-departure information. Any costs incurred, such as for travel and accommodation, are covered by the students. Occasionally, DwA provides funding support for the initiative. DwA offers training courses on global health and health cooperation in many Italian universities, in collaboration with SISM. For example, in 2019, 27 courses in 23 Italian universities were organised [34].Students participating in medical electives have the opportunity to attend these training courses on a voluntary basis. However, the participation in these courses is considered an added value during the selection phase for the project [35]. At the end of the WP experience, students complete an evaluation form and attend debriefing sessions with DwA staff. Students are also encouraged to elaborate on their experience through reflective writing, published on the DwA website [36] and are invited to share their experiences at the WP annual meeting.

Setting and On-site Activities

Initially, since its inception in 2005, the experience was involved only with the Wolisso hospital in Ethiopia; later

in 2010 it was extended to the Tosamaganga hospital in Tanzania. For different reasons, the site in Tanzania was closed—partially or totally—in 2011 and 2017. The Wolisso hospital is a referral, non-profit facility located in Wolisso town, 115 km from Addis Ababa. Wolisso is the capital of the Southwest Shoa Zone (SWSZ) in the Oromiya region. The SWSZ has a population of about 1.1 million (Table 1). The Tosamaganga hospital is located in the district of Iringa DC, Tanzania. This is a rural area 500 km from Dar Es Salaam, the county's largest city. DwA has supported the hospital in terms of governance and human resources for more than 30 years. The Tosamaganga hospital serves an estimated population of 265,000 (Table 1).

In these two African hospitals students do not have a single tutor but are supervised by all the staff, including expatriated and local health personnel. Under supervision, the students are encouraged to develop clinical learning through observation, participation in the clinical decision making process, participation in bedside visits, collegial discussion of clinical cases, and meetings with nurses and relatives. All these activities are carried out without a direct involvement in diagnosis and therapy. Students do not intervene on patients except for simple nursing activities, and this is on a voluntary basis, and again always under supervision.

In the strategic plan of DwA [32], the continuity of care between hospitals, peripheral health centres, and communities is key to the organization's activities. Accordingly, in addition to hospital activities, students carry out visits to peripheral health centres and communities. These visits are mediated by government health staff (District Health Management Teams and Community Health Workers). The meetings with communities, especially with women, are aimed at learning about health care seeking behaviours and the cultural, geographical, and financial barriers that prevent populations from accessing services. The goal is to foster among students the ability to listen to local populations and the ability to raise the right questions in situations with limited resources, analysing reality from a public health and global health perspective. Further group discussions focus on social determinants and communities as a subject of health. Engagement with these issues is further deepened by involving the students with the operational research on clinical and public health issues carried out in the field.

Data Collection

The study used a mix of quantitative and qualitative methods to collect and analyse data. The survey was electronically distributed to all individuals who participated in the project. After an initial invitation to take part, two follow-up reminders were sent out. Participants were informed that the survey would be used for research purposes. The Ethics Committee of DwA-CUAMM approved the study and the data collection was performed in accordance with relevant guidelines and regulations. Participants were assured of their anonymity. The questionnaire comprised four domains: (i) general information: age, gender, university of provenance and prior experience in LMICs; (ii) obstacles encountered by students during the experience; (iii) impact that the experience had on medical studies and future clinical approaches; (iv) reflections, wherein the survey asked how the experience contributed to personal and professional growth, and about students' availability for future experiences in LMICs (Annex I).

Data Analysis

Each item of the questionnaire has been described using the univariate analysis. Categorical variables are summarised using frequency tables, and ordinal variables are summarised using quartiles. In the second stage, bivariate analysis was conducted with the aim of identifying any associations between variables or differences between groups of respondents. Cross tables and Pearson's chi-square test were used to evaluate the associations between categorical variables. Paired t-tests were used to see if the means of two paired measurements (pre-departure score and post-departure score, used by respondents to describe their opinions and attitudes) were different. A value of $p < 0.05$ was considered significant. Statistical analyses were performed using SPSS (SPSS Inc., United States). We extracted de-identified free-text data from the online repository and completed a qualitative thematic analysis, using the frameworks of conventional qualitative content analysis and inductive category development. A trained researcher (N.P.) independently coded responses and recorded emergent themes. A second experienced qualitative researcher (G.Q.) used the established themes to independently code the same written transcripts.

Table 1 Sites of electives undertaken by participants and some hospitals indicators (year 2019)

Hospital	Population served	Beds	Out patients	Admissions	Antenatal visits	Births	Vaccination	Total staff	Qualified staff
Tosamaganga	687 460	165	25 850	6931	1661	2708	8298	165	109
Wolisso	1 198 149	200	78716	14742	8244	3687	5552	353	228

Results

General Information

Figure 1 shows the number of applications and departures during the 2005–2019 study period. The WP received an average of 92 requests per year, with a substantial increase over the years, but with a reduction in 2019 (probably because the Tosamaganga site was temporarily closed and the students were less attracted to having only one site available). In the same period, there were on average 22 departures per year. Of the 333 students who took a medical elective during the study period, 257 were contacted for the survey. (For the others the email address was invalid). Of those, 141 responded (a 55% response rate). The majority of the questionnaires (76 subjects, 54%) were completed by those who had had the elective experience in the last 4 years (2016–2019). The majority of students were female and carried out the electives at Wolisso hospital. At the time of departure, most of the participants were Year 5 or Year 6 medical students. The participants came from 30 Italian universities. The majority had previously carried out voluntary activities: however, the majority had never been to Africa before (Table 2).

Table 2 General information of participants

General information	N. (%)
Sex	
Female	117 (83)
Male	24 (17)
Location	
Wolisso	95 (67)
Tosamaganga	46 (33)
Position at the time of departure	
5-year medical students	62 (44)
6-year medical students	25 (18)
Already graduates but not yet residents	54 (38)
Medical practice before departure	
Yes	77 (55)
No	64 (45)
Previous voluntary activities	
Yes	108 (77)
No	33 (33)
In Africa before	
Never	95 (67)
As a volunteer	24 (17)
As a tourist	22 (16)

Obstacles During the Experience

Although the students were not directly involved in diagnostic and therapeutic activities, the biggest difficulties reported are mainly the lack of resources for the medical practice (55% of subjects), problems related to language and communication (35% of respondents) and different systems of values (30%). A minority also reported as difficulties the lack of hygiene (12%) and the distance from relatives (10%) (Fig. 2). In the open question that asked to report other relevant obstacles, few respondents added difficulties in relations with local staff, the lack of a person to coordinate activities and difficulties due to the political situation of the country.

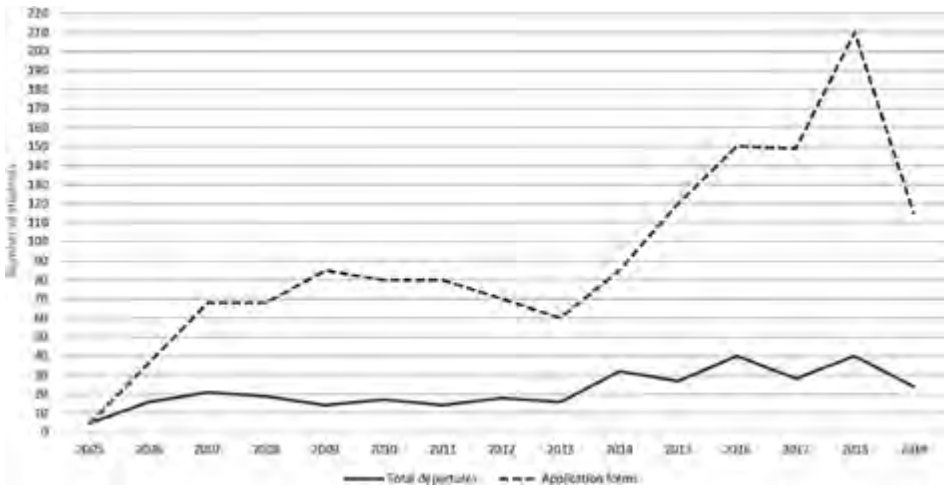


Fig. 1 Number of total applications and departures, period 2005–2019

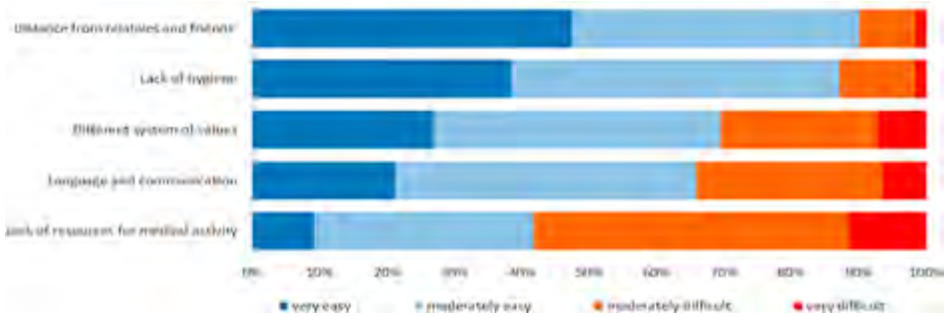


Fig. 2 Obstacles reported during the medical elective

The analysis of these obstacles in relation to the period of departure (2005–2015 versus 2016–2019) showed that the distance from family and friends was significant for the subjects who did the experience in the period 2005–2015 ($p < 0.05$); language and communication ($p < 0.05$) and lack of hygiene ($p < 0.05$) were statistically significant for people in Tosamaganga than in Wolisso.

Impact on Medical Studies, Clinical Approach and Future Professional Choices

The African experience had a positive impact on the progress of the studies upon return, with an increase in determination and motivation in 65% and 70% of cases respectively. The majority report also an increase in creativity (55%), whereas only 25% report an increase in the organisation of work.

The experience had positive influences on the future clinical approach of the students. Respondents say they have gained in terms of humanity (84% of subjects)and in resilience (83%).The percentage of those who declare that they feel more courageous (73%) and empathetic (72%) is also significant. High percentages of subjects also declared a greater ability to collaborate (68%) and an increase of patience (62%), self-confidence (61%), and respect for others (59%). The analysis of these responses in relation to the period of departure, country of destination and clinical experience revealed no statistically significant differences. Seventy-one participants (50%) reported that the experience had had an impact on their future career choices.

In the open question related to the impact of the experience on future professional choices, most of comments were related to the international cooperation as a whole:

> I decided to undertake a post-graduate in international health cooperation.
>
> I started to think of international health cooperation as a concrete possibility for the future.
>
> I have decided to pursue a career as a cooperating doctor and that is what I am currently doing.
>
> This experience has been useful for me to understand that working permanently in a developing country is not for me: however, this experience gave me a desire to return to Africa with more skills to share.

A substantial number of comments relate to the fact that experience influenced the choice of the specialisation:

> I changed my mind … and I decided to do anesthesia.
>
> I chose to become a pediatrician.
>
> I opted for a surgical specialty.
>
> After this experience, I decided to take care of the health of migrants in Italy.
>
> I have definitely chosen a career in pediatrics.
>
> I became passionate about neonatology, which I had not considered before.
>
> I saw how public health and hygiene are crucial topics in the management of health systems.
>
> I want to work in the field of migration medicine.

Many also expressed the desire to repeat the experience.

> I would like to spend part of my residency in Africa.
>
> I would like to return with greater professionalism to be able to give a more concrete help
>
> I would like to relive a similar experience.
>
> Now I know I want to go back to Africa.
>
> I have a desire to return to Africa for longer periods.
>
> I am sure I will return to Africa for another international collaboration experience.

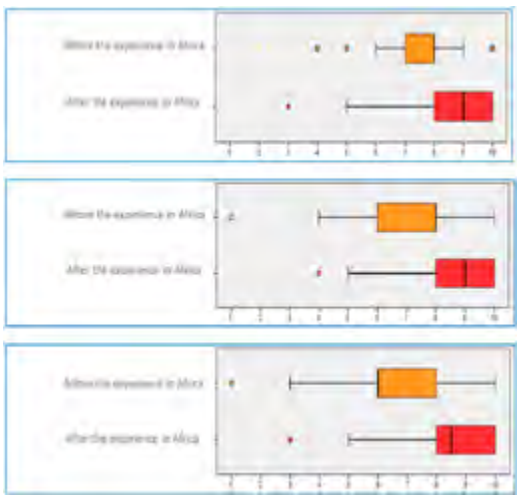


Fig. 3 Health inequalities (upper box), commitment to reduce the environment damage (intermediate box), and awareness of the wasting health resources (lower box) before and after the experience in Africa (1 = low; 10 = high)

Reflections

This section explored how the experience had had an effect on students' interest in health inequalities, their commitment to reduce the environment damage, and their awareness of the wasting health resources, comparing pre and post-experience data (Fig. 3). All these pre-post differences result statistically significant ($p < 0.01$). These changes were not affected by the destination or by the period of departure.

A further question explored how the clinical elective experience contributes to both personal and professional growth. On a scale of 1 to 10 (where 1 = low and 10 = high), 75% of respondents chose a score equal to or greater than 7 to describe their professional growth. The same percentage of respondents chose a score equal to or greater than 8 to describe their personal growth (Fig. 4).

The final questions revealed that the majority were willing to repeat the experience, with 51% saying definitely and 46% probably. Only 3% excluded this possibility. Of all respondents, 20% have already spent additional time in a medical setting in Africa. After the African experience, 66% of respondents say they have maintained some form of contact with DwA, participating in training, awareness and support activities of cooperation projects.

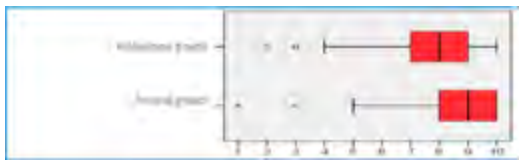


Fig. 4 Personal and professional growth before and after the experience in Africa (1 = low; 10 = high)

Discussion

In this study nearly all students gave positive feedback about the overall experience. Most students were positively influenced personally and professionally, and said they were willing to repeat the experience. The two biggest difficulties reported are a lack of resources for the practice of the medical activities (although the students were not directly involved in diagnostic and therapeutic activities) and problems with communication. These obstacles are recognised elsewhere [37, 38]. Apparently, as observed by Mutchnick et al.[3], 'living in alternative social environments creates an educational experience unmatched in any textbook or classroom exercise'. Professionally, students declare that they have returned home with a greater sense of empathy towards patients, an augmented confidence in their clinical skills, and abetter appreciation of the importance of issues such as health inequalities. The experience also seems to influence the orientation of the students' careers, increasing the interest in public service. The students also report an increased awareness of problems concerning the use of resources. Similar results have been found in other studies [39–44].

Jeffrey et al. [45] carried out a literature review examining the potential role of international health electives in improving students' professional growth and career choices. Key findings from the review suggest that a medical elective experience gives opportunities for medical students to strengthen self-confidence in medical practices, increase knowledge of tropical diseases, gain a better awareness of environmental health and public health actions. In addition, medical electives seem to influence the career choices of medical students. The results of Jeffrey et al. are in line with the results of the present study, where the vast majority of students declare that the experience has had a positive impact on a personal level, and that the experience led them to reflect more deeply on future choices at post-graduated level.

The number of students doing a medical elective in a LMICs has progressively increased over the years [11]. It is also confirmed by the present study. In the first 5 years of the project (2005–2009) there was each year an average of 52 applications. This increased to 148 in the last 5 years of the

project (2015–2019). During the course of the project there was a corresponding increase in the number of departures, from an average of 15 over the first five years to 32 over the final five years. It should be noted that increase occurred despite the fact that travel and accommodation costs are incurred directly by students and that the recognition of experience with credits does not seem to be widespread in many universities.

Although educational and other potential benefits offered by elective periods in LMICs are recognised, the experience presents a number of challenges, with a danger 'of doing more harm than good' [38]. For instance, electives may falsely raise student expectations, and put strain on local human resources. As observed by Ackerman [46], 'on-site supervisors, the back-bone of most electives, are only possible with a reciprocal, long-term relationship either through a local university and medical school, a Nongovernmental Organization (NGO), or an International Nongovernmental Organization (INGO) working in the area. The educators must ensure that the host organization is appropriately integrated into the community and that community goals are at the forefront'. Willott*et al*. [47] highlights that, 'even if sending institutions oblige that students pre-prepare objectives and receive guidance about what is expected of them during elective, effective monitoring of students' activities on the ground is nearly impossible'. In addition, he observed that, 'students frequently want to be able to decide for themselves where they go and how they spend their electives, but this may not be what is best for hosting institutions, nor for global health more generally'. As pointed out by Edwards and colleagues [14], a major concern regarding medical electives is that students may practice, 'beyond their competence, to their own and their patients' detriment. This may be more common in developing countries where supervision is scant and students may assume that limited health care resources justify their adopting roles or performing procedures which would be restricted to fully trained staff at home'.

These reflections highlight the benefits of an experience like the WP, which is organised and implemented by an NGO with long-term working relationships with the African populations and is well integrated into the community. The project is carried out in health facilities where DwA staff have been working for many years. Having well-known locations for electives reduces the potential risks connected with this type of experience, and better ensures a satisfactory level of supervision, the lack of which being a serious problem in many similar experiences [38, 48].

The project described herein was possible thanks to the initiative and collaboration of an NGO and a medical students' organisation, without any direct support form a university. To the best of our knowledge, only a small number of Italian universities facilitate pre-graduate medical elective experiences in LMICs. The WP has enabled pre-graduate medical elective experiences to students from 30 different Italian universities (there are 43 faculties of medicine in Italy). The WP therefore, seems to be making up for the lack of international experience in LMICs offered by universities.

Pre-graduate medical electives are often organised by individual universities. It is therefore not straightforward to make comparisons between countries. However, it seems possible to make some observations. In comparison with many European Union Member States (and associated countries), it might be said that the Anglo-Saxon countries have a more robust and structured tradition of medical elective, with the development of specific guidelines and the promotion more global health opportunities for medical students[11, 49–52]. For example, in Australia electives are a compulsory component of all medical curricula. They usually last2 to 8 weeks, and take place either in Australia or overseas, including LMICs [11]. In the UK approximately 90% of medical students undertake medical electives, with 44% of them doing so in LMICs [53]. However, positive experiences have also been enabled in Europe. A study from Switzerland (related to the year 2009–2010) showed that from 106 medical students who underwent a medical elective, 50% went to a LMIC [54]. In Switzerland, undergraduate medical education is provided at all five medical universities, each of which recognizes time spent away by awarding academic credit [54]. In Ireland there is a certain level of recognition of international medical electives by all medical schools [38]. A study from Germany (Munchen University) found that 17% of pre-graduate medical students undertake medical electives in LMICs [55].

However, at post-graduate level, the situation in Italy seems to be in better shape. A number of initiatives appear to be going in the right direction, including agreements between DwA and some Italian universities, concerning collaboration on global health and medical experience and operational research in Africa [56].

We should note that before medical schools allocate substantial resources for international medical education, more rigorous evaluation of the effectiveness of medical elective experience is needed to demonstrate whether they add value to medical training [49], and what impact they may have on the communities and institutions involved [57]. Long-term follow-ups of elective participants after medical school in relation to their career choices (e.g., type of medical practice, career developed in public or private sectors) can provide more convincing arguments to medical schools that investing in medical electives will pay dividends in the long run [45].

Conclusion

Although common to other experiences of this type, it cannot be overlooked that the project has several shortcomings. The experience does not last long, contacts with local communities are limited, and it is difficult to estimate their real impact. The supervision of students in the field can and needs to be strengthened. Although in ways, it is encouraging, feedback from local supervisors and local communities it is not systematically evaluated. The students interviewed did electives on sites only within one region: sub-Saharan Africa. Therefore, the findings presented here cannot automatically be applied to electives in other LMICs. The study utilised a self-administered questionnaire, without any corroborating measures available to address potential self-reporting bias (e.g., clinical skills performance testing, feedback from hosting institutions, etc.). The study did not have a control group. Finally, although the majority of questionnaires were completed by those who had the experience in the last 3 years (2016–2019), there was significant variation in the time elapsed between the experience in Africa and the administration of the questionnaire. Future objectives of the WP is to improve the pre-departure training (e.g. offering guidelines for pre-departure), to be developed more in partnership with receiving institutions [58]. Another future objective is to improve the selection procedure (e.g. through mini interviews as a pre-departure tool) [59]. Additional aims are to have structured feedback from local supervisors and local communities, to better quantify the impact of the elective experience through questionnaires administered before and after departure, and to develop additional outcome measures (other than self-reports) focusing on provider behaviour, clinical knowledge, and quality of patient care [15].

The mission of the medical school should be not only to train good clinicians, but also to be more community oriented, reconciling individual and community health needs [53, 60].Cross-cultural exchanges like medical electives have the potential to help medical students become culturally-aware and globally-competent physicians [3, 61, 62]. Despite its limitations, the present study provides evidence that international electives in LMICs develop students' idealism about their role as future physicians. As noted by Godkin and Savageau, 'even if international electives do nothing more than preserve idealistic values, they have served a useful purpose' [41].

Supplementary Information The online version contains supplementary material available at https://doi.org/10.1007/s10900-021-01045-5.

Acknowledgements Not applicable.

Author Contributions GP, CDB and CC, contributed to the conception and design of the study. CC, CDB, MB, and AL contributed to data acquisition. GQ provided the literature review.NP provided the statistical analysis. All authors contributed to the data analysis and interpretation, and the drafting and revision of the article. All authors approved the final manuscript for publication.

Funding No funding was obtained for this study.

Data Availability The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request. The questionnaire used in the study was developed specifically for this study (in Italian). An English version is available as a supplementary file.

Code Availability Not applicable.

Declarations

Conflict of interest The authors declare that they have no competing interests.

Ethical Approval This study was approved by the Ethics Committee of DwA-CUAMM (reference number: 2521). All potential participants were sent brief details of the study and offered a more detailed standard information sheet. The data collection was carried out in accordance with relevant guidelines and regulations.

Consent to Participate The informed consent obtained from study participants was in a written format.

Consent for Publication Not applicable.

References

1. Editorial. (1969). Overseas medical aid. *Journal of the America Medical Association, 209*(10), 1521–1522.
2. James, H. (2020). Could coronavirus bring about the 'waning of globalization'? *World Economic Forum.* Retrieved November 9, 2021, from https://www.weforum.org/agenda/2020/03/globalization-coronavirus-covid19-epidemic-change-economic-political
3. Mutchnick, I. S., Moyer, C. A., & Stern, D. T. (2003). Expanding the boundaries of medical education: Evidence for cross-cultural exchanges. *Academic Medicine, 78*(10 Suppl), S1–S5.
4. Banerjee, A., Banatvala, N., & Handa, A. (2011). Medical student electives: Potential for global health? *The Lancet, 377*(9765), 555.
5. Editorial. (1993). The overseas elective: Purpose or picnic? *The Lancet, 342*(8874), 753–754.
6. Kumwenda, B., Royan, D., Ringsell, P., & Dowell, J. (2014). Western medical students' experiences on clinical electives in sub-Saharan Africa. *Medical Education, 48*(6), 593–603.
7. Thompson, M. J., Huntington, M. K., Hunt, D. D., Pinsky, L. E., & Brodie, J. J. (2003). Educational effects of international health electives on U.S. and Canadian medical students and residents: A literature review. *Academic Medicine, 78*(3), 342–347.
8. Ramsey, A. H., Haq, C., Gjerde, C. L., & Rothenberg, D. (2004). Career influence of an international health experience during medical school. *Family Medicine, 36*(6), 412–416.
9. Drain, P. K., Primack, A., Hunt, D. D., Fawzi, W. W., Holmes, K. K., & Gardner, P. (2007). Global health in medical education: A call for more training and opportunities. *Academic Medicine, 82*(3), 226–230.
10. Drain, P. K., Holmes, K. K., Skeff, K. M., Hall, T. L., & Gardner, P. (2009). Global health training and international clinical

rotations during residency: Current status, needs, and opportunities. *Academic Medicine, 84*(3), 320–325.
11. Law, I. R., Worley, P. S., & Langham, F. J. (2013). International medical electives undertaken by Australian medical students: Current trends and future directions. *Medical Journal of Australia, 198*(6), 324–326.
12. Umoren, R. A., Gardner, A., Stone, G. S., Helphinstine, J., Machogu, E. P., Huskins, J. C., et al. (2015). Career choices and global health engagement: 24-year follow-up of U.S. participants in the Indiana University-Moi University elective. *Healthcare, 3*(4), 185–189.
13. Kleinman, A. (2010). Four social theories for global health. *The Lancet, 375*, 1518–1519.
14. Edwards, R., Piachaud, J., Rowson, M., & Miranda, J. (2004). Understanding global health issues: Are international medical electives the answer? *Medical Education, 38*(7), 688–690.
15. Murdoch-Eaton, D., & Green, A. (2011). The contribution and challenges of electives in the development of social accountability in medical students. *Medical Teacher, 33*(8), 643–648.
16. Johnston, N., Sandys, N., Geoghegan, R., O'Donovan, D., & Flaherty, G. (2018). Protecting the health of medical students on international electives in low-resource settings. *Journalof Travel Medicine*. https://doi.org/10.1093/jtm/tax092
17. Dharamsi, S., Osei-Twum, J. A., & Whiteman, M. (2011). Socially responsible approaches to international electives and global health outreach. *Medical Education, 45*(5), 530–531.
18. Crump, J. A., & Sugarman, J. (2008). Ethical considerations for short-term experiences by trainees in global health. *Journal of the America Medical Association, 300*(12), 1456–1458.
19. Roebbelen, E., Dorman, K., Hunter, A., Kraeker, C., O'Shea, T., & Bozinoff, N. (2018). "They will come to understand": Supervisor reflections on international medical electives. *Teaching and Learning in Medicine, 30*(4), 377–385.
20. Crump, J. A., & Sugarman, J. (2010). Ethics and best practice guidelines for training experiences in global health. *American Journal of Tropical Medicine and Hygiene, 83*(6), 1178–1182.
21. Keller, R. C. (2006). Geographies of power, legacies of mistrust: Colonial medicine in the global present. *Historical Geography, 34*, 26–48.
22. Horton, R. (2013). Offline: Is global health neo-colonialist? *Lancet, 382*, 1690.
23. Eichbaum, Q. G., Adams, L. V., Evert, J., Ho, M. J., Semali, I. A., & van Schalkwyk, S. C. (2021). Decolonizing global health education: Rethinking institutional partnerships and approaches. *Academic Medicine, 96*(3), 329–335.
24. Herzig van Wees, S., & Holmer, H. (2020). Global health beyond geographical boundaries: Reflections from global health education. *BMJ Global Health, 5*(5), e002583.
25. Harvard Chan student committee for the decolonization of public health. (2019). Decolonizing global health conference 2019. Retrieved November 9, 2021, from https://www.hsph.harvard.edu/decolonizingglobal-health-so/
26. Ventres, W. B., & Wilson, B. K. (2020). Rethinking goals: Transforming short-term global health experiences into engagements. *Academic Medicine, 95*(1), 32–36.
27. Smith, J. K., & Weaver, D. B. (2006). Capturing medical students' idealism. *Annalsof Family Medicine, 4*(Suppl 1), S32–S60.
28. Dowell, J., & Merrylees, N. (2009). Electives: Isn't it time for a change? *Medical Education, 43*(2), 121–126.
29. Italian Medical Students Association (SISM). (2021). Wolisso Project website. Retrieved November 9, 2021, from http://wolisso.sism.org/
30. Italian Medical Students Association (SISM). (2021). SISM website. Retrieved November 9, 2021, from https://nazionale.sism.org/
31. Doctors with Africa-CUAMM (DwA-CUAMM). (2021). DwA website. Retrieved November 9, 2021, from https://doctorswithafrica.org/
32. Doctors with Africa-CUAMM. (2015). Strategic Plan 2016–2030. Retrieved November 9, 2021, from https://www.mediciconlafrica.org/en/who-we-are/mission/strategic-plan-2016-2030/
33. International Federation of Medical Students Associations (IFMSA). (2021). IFMSA website. Retrieved November 9, 2021, from https://ifmsa.org/
34. Doctors with Africa-CUAMM (DwA-CUAMM). Annual report 2019. (2020). CUAMM website. Retrieved November 9, 2021, from https://www.mediciconlafrica.org/wp-content/uploads/2020/07/CUAMM_annual_report_2019_eng_web-1.pdf
35. Doctors with Africa-CUAMM (DwA-CUAMM). (2021). Global health: Ideas on education and public awareness website. Retrieved November 9, 2021 from http://www.educationglobalhealth.eu/en/
36. Doctors with Africa-CUAMM (DwA-CUAMM). (2021). Italian medical students association (SISM). Guest book website. Retrieved November 9, 2021 from http://www.educationglobalhealth.eu/it/blog
37. Elit, L., Hunt, M., Redwood-Campbell, L., Ranford, J., Adelson, N., & Schwartz, L. (2011). Ethical issues encountered by medical students during international health electives. *Medical Education, 45*(7), 704–711.
38. O'Donnell, P., McAuliffe, E., & O'Donovan, D. (2014). Unchallenged good intentions: A qualitative study of the experiences of medical students on international health electives to developing countries. *Human Resources for Health, 12*, 49.
39. Haloburdo, E. P., & Thompson, M. A. (1998). A comparison of international learning experiences for baccalaureate nursing students: Developed and developing countries. *Journal of Nursing Education, 37*(1), 13–21.
40. Haq, C., Rothenberg, D., Gjerde, C., Bobula, J., Wilson, C., Bickley, L., et al. (2000). New world views: Preparing physicians in training for global health work. *Family Medicine, 32*(8), 566–572.
41. Godkin, M. A., & Savageau, J. A. (2001). The effect of a global multiculturalism track on cultural competence of preclinical medical students. *Family Medicine, 33*(3), 178–186.
42. Esfandiari, A., Drew, C. R., Wilkerson, L., Gill, G., & Drew, C. R. (2001). An international health/tropical medicine elective. *Academic Medicine, 76*(5), 516.
43. Kollar, S. J., & Ailinger, R. L. (2002). International clinical experiences: Long-term impact on students. *Nurse Educator, 27*(1), 28–31.
44. Stys, D., Hopman, W., & Carpenter, J. (2013). What is the value of global health electives during medical school? *Medical Teacher, 35*(3), 209–218.
45. Jeffrey, J., Dumont, R. A., Kim, G. Y., & Kuo, T. (2011). Effects of international health electives on medical student learning and career choice: Results of a systematic literature review. *Family Medicine, 43*(1), 21–28.
46. Ackerman, L. K. (2010). The ethics of short-term international health electives in developing countries. *Annals of Behavioral Science and Medical Education, 16*, 40–43.
47. Willott, C., Khair, E., Worthington, R., Daniels, K., & Clarfield, A. M. (2019). Structured medical electives: A concept whose time has come? *Global Health, 15*(1), 84.
48. Watson, D. A., Cooling, N., & Woolley, I. J. (2019). Healthy, safe and effective international medical student electives: A systematic review and recommendations for program coordinators. *Tropical Diseases, Travel Medicine and Vaccines, 5*, 4.
49. Wiskin, C., Barrett, M., Fruhstorfer, B., & Schmid, M. L. (2018). Recommendations for undergraduate medical electives: A UK consensus statement. *Medical Education, 52*(1), 14–23.

50. Lumb, A., & Murdoch-Eaton, D. (2014). Electives in undergraduate medical education: AMEE guide no. 88. *Medical Teacher, 36*(7), 557–572.
51. Watterson, R., Matthews, D., Bach, P., Kherani, I., Halpine, M., & Meili, R. (2015). Building a framework for global health learning: An analysis of global health concentrations in Canadian medical schools. *Academic Medicine, 90*(4), 500–504.
52. McCool, J., Curtis, E., MacCormick, A. D., Cavadino, A., Smith, M., & Bagg, W. (2019). Medical electives: Exploring the determinants of placement and access variables between 2010 and 2016 at the University of Auckland. *BMC Medical Education, 19*(1), 398.
53. Miranda, J. J., Yudkin, J. S., & Willott, C. (2005). International health electives: Four years of experience. *Travel Medicineand Infectious Disease, 3*(3), 133–141.
54. Dupuis, M., & Schirlo, C. (2012). The clinical electives year in undergraduate medical training in Switzerland: An overview. *Journal of Evidence and Quality in Health Care, 106*(2), 85–91.
55. Störmann, S., & Angstwurm, M. W. (2018). What do international health electives and state examination scores have in common?—A cohort study to compare the results of written medical licensing examinations with the participation in international health electives during the final year of undergraduate medical education in Germany. *GMS Journal for Medical Education, 35*(5), 54.
56. Da Dalt, L., Putoto, G., Carraro, D., Gatta, A., Baraldi, E., & Perilongo, G. (2014). International child health elective for pediatric residents. *Italian Journalof Pediatrics, 40*, 13.
57. Renaud-Roy, E., Bernier, N., & Fournier, P. (2020). Host perspective on academic supervision, health care provision and institutional partnership during short-term electives in global health. *Medical Education, 54*(4), 303–311.
58. Kalbarczyk, A., Nagourney, E., Martin, N. A., Chen, V., & Hansoti, B. (2019). Are you ready? A systematic review of pre-departure resources for global health electives. *BMC Medical Education, 19*(1), 166.
59. Satterfield, C. A., Dacso, M. M., & Patel, P. (2018). Using multiple mini interviews as a pre-screening tool for medical student candidates completing international health electives. *Medical Education Online, 23*(1), 1483694.
60. Boelen, C. (1995). Prospects for change in medical education in the twenty-first century. *Academic Medicine, 70*(7), S21–S31.
61. Shaywitz, D. A., & Ausiello, D. A. (2002). Global health: A chance for Western physicians to give-and receive. *American Journal of Medicine, 113*(4), 354–357.
62. Quaglio, G. L., Bortolozzo, M., Di Benedetto, C., Lupato, A., Cavagna, C., & Putoto, G. (2021). Medical electives in Sub-saharan Africa: A 14-years student/NGO-driven Initiative. Research Square. Retrieved November 9, 2021 from https://assets.researchsquare.com/files/rs-96220/v1/6dc9ebf2-6b7a-4547-b21d-4c31b1d68d6e.pdf?c=1631858813

Publisher's Note Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

Association between ambulance prehospital time and maternal and perinatal outcomes in Sierra Leone: a countrywide study

PAPER

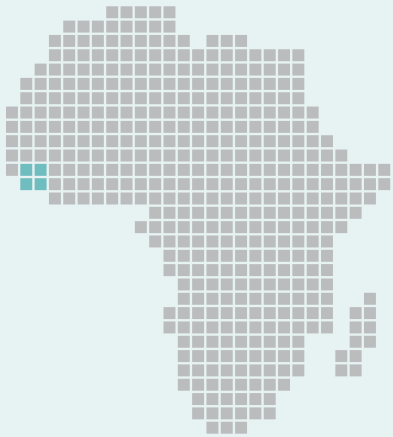
Authors
Caviglia M., Putoto G., Conti A., Tognon F., Jambai A., Jusu Vandy M., Youkee D., Buson R., Pini S., Rosi P., Hubloue Y., Della Corte F., Ragazzoni L., Barone-Adesi F.

Published in
BMJ Global Health,
November 2021

Link
http://dx.doi.org/10.1136/bmjgh-2021-007315

Topic
Universal coverage and equity

Focus country
Sierra Leone



Original research

BMJ Global Health

Association between ambulance prehospital time and maternal and perinatal outcomes in Sierra Leone: a countrywide study

Marta Caviglia ,[1] Giovanni Putoto,[2] Andrea Conti ,[1] Francesca Tognon ,[2] Amara Jambai,[3] Matthew Jusu Vandy,[3] Daniel Youkee,[4] Riccardo Buson,[2,5] Sara Pini,[2,5] Paolo Rosi,[6] Ives Hubloue,[7] Francesco Della Corte,[1] Luca Ragazzoni,[1] Francesco Barone-Adesi[1]

To cite: Caviglia M, Putoto G, Conti A, *et al*. Association between ambulance prehospital time and maternal and perinatal outcomes in Sierra Leone: a countrywide study. *BMJ Global Health* 2021;**6**:e007315. doi:10.1136/bmjgh-2021-007315

Handling editor Seema Biswas

LR and FB-A contributed equally.

Received 28 August 2021
Accepted 9 November 2021

Check for updates

© Author(s) (or their employer(s)) 2021. Re-use permitted under CC BY-NC. No commercial re-use. See rights and permissions. Published by BMJ.

For numbered affiliations see end of article.

Correspondence to
Dr Marta Caviglia;
marta.caviglia@med.uniupo.it

ABSTRACT

Introduction Sierra Leone, one of the countries with the highest maternal and perinatal mortality in the world, launched its first National Emergency Medical Service (NEMS) in 2018. We carried out a countrywide assessment to analyse NEMS operational times for obstetric emergencies in respect the access to timely essential surgery within 2 hours. Moreover, we evaluated the relationship between operational times and maternal and perinatal mortality.

Methods We collected prehospital data of 6387 obstetric emergencies referrals from primary health units to hospital facilities between June 2019 and May 2020 and we estimated the proportion of referrals with a prehospital time (PT) within 2 hours. The association between PT and mortality was investigated using Poisson regression models for binary data.

Results At the national level, the proportion of emergency obstetric referrals with a PT within 2 hours was 58.5% (95% CI 56.9% to 60.1%) during the rainy season and 61.4% (95% CI 59.5% to 63.2%) during the dry season. Results were substantially different between districts, with the capital city of Freetown reporting more than 90% of referrals within the benchmark and some rural districts less than 40%. Risk of maternal death at 60, 120 and 180 min of PT was 1.8%, 3.8% and 4.3%, respectively. Corresponding figures for perinatal mortality were 16%, 18% and 25%.

Conclusion NEMS operational times for obstetric emergencies in Sierra Leone vary greatly and referral transports in rural areas struggle to reach essential surgery within 2 hours. Maternal and perinatal risk of death increased concurrently with operational times, even beyond the 2-hour target, therefore, any reduction of the time to reach the hospital, may translate into improved patient outcomes.

Key questions

What is already known?

- Maternal and perinatal mortality disproportionately affects low-income countries (LICs), where timely access to emergency and surgical care is often compromised by lack of transportation infrastructure and geographical distance, as described by the 'Three Delays' framework recommended by the Lancet Commission on Global Surgery.
- A 2-hour threshold is internationally recognised for obstetric emergencies to access healthcare. A recent review identified only three studies in low-income and low-middle-income countries describing successful interventions implemented to increase the availability to timely surgical access.
- The development of emergency medical services (EMS) in the African context represents a targeted intervention that has the potential to address the geographical and transportation barriers that contribute to the delay in reaching care, thus reducing the avoidable burden of disease associated to obstetric emergencies. However, available literature reports that only 16 African countries have a functioning EMS, to which is added the development of the first National Emergency Medical Service (NEMS) in Sierra Leone in 2018.

What are the new findings?

- To our knowledge, this is the first nationwide study directly documenting prehospital operational times in relation to obstetric emergencies in an LIC.
- Our results, based on more than 6000 obstetric emergency referrals, highlight a great heterogeneity countrywide regarding NEMS operational times.
- There is a clear association between increasing prehospital time and maternal and perinatal mortality.

INTRODUCTION

Maternal and perinatal mortality constitutes a substantial proportion of burden of disease in low-income countries (LICs) and its reduction worldwide is included among the sustainable development goals to be reached by 2030.[1 2] Timely access to prompt and safe

BMJ Glob Health: first published as 10.1136/bmjgh-2021-007315 on 29 November 2021. Downloaded from http://gh.bmj.com/ on April 6, 2022 by guest. Protected by copyright.

Key questions

What do the new findings imply?

- Geographical distance to reach hospitals still poses a major barrier for timely access to care.
- Different interventions, such as the strengthening of the existing primary health system and appropriate decentralisation of maternal care to peripheral facilities able to provide quality care, could reduce maternal and perinatal mortality.
- Any reduction of prehospital times, even exceeding the 2-hour threshold, could translate into improved maternal and neonatal outcomes, a wake-up call for other LICs to invest in prehospital transportation infrastructure.

surgical care constitutes one of the most important determinants for maternal and perinatal mortality.[3] An indicative threshold of 2 hours is generally accepted for emergency obstetric surgical care, based on the estimated average interval between the onset of major obstetric complications and death, in the absence of interventions.[4] In its 2015 report, the Lancet Commission on Global Surgery proposed to measure access to timely and essential surgery using the proportion of population that can access essential surgical resources, defined as the Bellwether procedures, within a 2-hour travel time (TT), an indicator that was also included in the WHO 100 Core Global Health Indicators.[3 5] At present, however, little is known regarding the compliance to this target in LICs, and the few studies available show that serious gaps exist in accessing emergency obstetric surgical care within the above-mentioned time frame.[6–10] To this regard, it is broadly acknowledged that poorly developed transportation infrastructure, lack of ambulance systems and geographical barriers play a major role in the so-called 'second delay'—the delay in reaching care—described in the Three Delays framework,[3] thus limiting access to timely emergency care in these countries.[11]

In the past 10 years, many sub-Saharan African countries have tried to develop emergency medical services (EMS) with the aim of providing prehospital care alongside prompt and safe transport to hospitals, in particular for obstetric emergencies.[12] Despite the efforts, prehospital EMS currently exist in only one-third of African countries, and, when present, are generally limited in terms of population coverage, referral and communication network.[13]

Sierra Leone, one of the world's poorest LIC that has long strived to tackle its high maternal and perinatal mortality, launched the first National Emergency Medical Service (NEMS) in 2018.[14] The NEMS was designed to function as a tiered system of care initiated by peripheral health units (PHUs), responsible both for the primary assessment and care of patients and for the activation of the emergency medical dispatch of ambulances through a centralised operation centre (OC). NEMS is a free-of-charge service, and its fleet includes 81 ambulances, all of which are operative at the same time, and a total number of 450 paramedics and 450 prehospital care

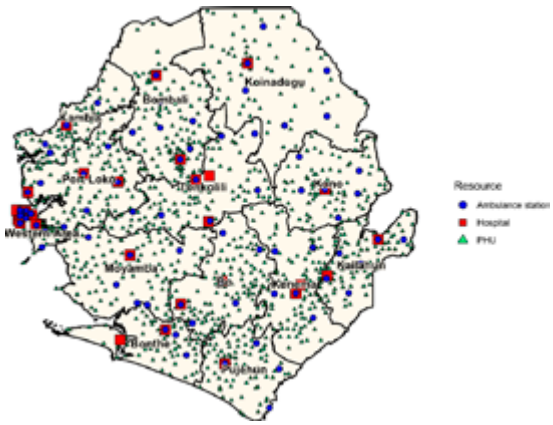


Figure 1 Distribution of district hospitals, peripheral health units (PHUs) and National Emergency Medical Service ambulances in Sierra Leone.

drivers, working to ensure timely and medically appropriate responses to each request for prehospital care and transportation to the nearest district hospital.[14]

The implementation of NEMS contributed to enhance access to healthcare especially for obstetrics and gynaecology cases and for people residing in the rural areas of the country.[15] To understand countrywide variability in access to timely essential obstetric surgery following the implementation of NEMS, we aimed to perform an assessment of prehospital operational times for obstetric emergencies in Sierra Leone, and to evaluate the association between operational times and maternal and perinatal mortality.

METHODS

Study design

This was a retrospective study analysing NEMS operational times in response to obstetric emergencies recorded countrywide between 1 June 2019 and 31 May 2020, thus including both the rainy (June to November) and the dry (December to May) season.

Study setting

The study facilities consisted of 1368 PHUs and 33 referral hospitals, including government district hospitals, faith-based clinics, and health centres managed by non-governmental organisations (figure 1). PHUs provide different levels of care, which can be described as 'level one PHUs' providing basic ante-natal and post-natal care and assistance to uncomplicated deliveries, and 'level two PHUs' offering basic emergency obstetric and neonatal care (BEmONC) services, which included the administration of antibiotics, oxytocics and anticonvulsants, manual removal of placenta and retained products of delivery, assisted vaginal delivery and basic neonatal resuscitation.[16] Comprehensive emergency obstetric care (CEmOC) services, including all the BEmOC functions

BMJ Glob Health: first published as 10.1136/bmjgh-2021-007315 on 29 November 2021. Downloaded from http://gh.bmj.com/ on April 6, 2022 by guest. Protected by copyright.

plus caesarean section and blood transfusion, were provided only at the district hospital level. Healthcare professionals in the PHUs were responsible for activating NEMS after providing primary assessment and care to pregnant women. The emergency requests received via phone from the PHUs were evaluated and managed by trained nurses at the NEMS OC. Subsequent phases entailed the dispatch of ambulance teams, composed of trained paramedic and an ambulance driver, and contact with the proposed referral facility.[14] At the district level, ambulance to population ratio ranged from 0.8 to 1.8 ambulances per 100 000 inhabitants and ambulance distribution in the different districts was based on population density and the dimension of the geographical area covered.[14] Treatment provided in the ambulances entailed oxygen delivery, administration of rectal misoprostol for prevention of postpartum haemorrhage, fluid resuscitation, assistance to labour and delivery, and basic life support manoeuvres. Ambulance personnel underwent a series of ad hoc basic training courses that included the management of medical, trauma, obstetrics, gynaecology and paediatric emergencies and basic life support and resuscitation manoeuvres without the support of automated external defibrillator.[14]

While currently managed by the Ministry of Health and Sanitation and financed though governmental budget, during the study period the NEMS has been managed and coordinated by a government-backed joint venture comprising Doctors with Africa (CUAMM, Padua, Italy), the Regional Government of Veneto (Italy) and the Research Center in Emergency and Disaster Medicine (Università del Piemonte Orientale, Italy) and financed by the World Bank.[14]

Although in July 2017 the new administrative division of Sierra Leone increased the number of districts from 14 to 16, the NEMS design and implementation was based on the initial district subdivision. Moreover, in this study the two districts of Western Area Urban and Western Area Rural, which included the densely inhabited capital city of Freetown and its surroundings, were analysed together as 'Western Area'.

Data collection

Assessment of prehospital operational times

We retrieved prehospital data from the OC software, an in-house developed software for call-taking, triage, aided dispatching, mission monitoring and data collection. The OC software also recorded data on operational times received from the 81 ambulance units dispatched on the ground, as paramedics were required to contact the OC by cell phone at the following time points: (1) when leaving ambulance station, (2) when arriving at the PHU, (3) when departing from the PHU, (4) when arriving at hospital, (5) when departing from hospital and (6) when arriving at ambulance station. We used this information to calculate the prehospital time (PT), defined as the time elapsed between the receipt of the emergency call from the PHU and the arrival at the hospital facility.

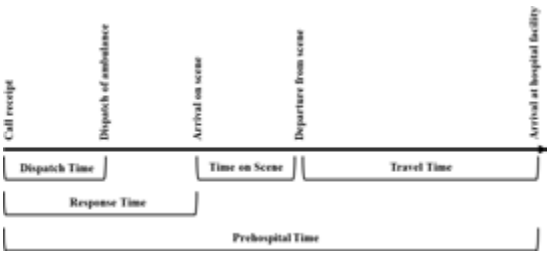


Figure 2 Prehospital operational times of the National Emergency Medical Service (NEMS) in Sierra Leone dispatch time: time between the receipt of the emergency call and the dispatch of NEMS ambulance. Response time: time between the receipt of the emergency call and the arrival at the peripheral health unit (PHU).Time on scene: time between the arrival at the PHU and departure from the PHU. Travel time: time between departure from the PHU and the arrival at the hospital facility. Prehospital time: total time elapsed between the receipt of the emergency call and the arrival at the hospital facility.

In addition, we defined other time variables of interest, which included dispatch time (DT), response time (RT), time on scene (ToS) and TT, described in figure 2. Additional data extracted by OC software included age of the patient, mission priority, mission complaint. We included in the analysis 6387 obstetric emergencies classified as 'Red' triage codes, clinically defined as 'immediately life threatening', while we excluded 'Yellow' triage codes, clinically defined as 'not life-threatening but still serious'. Evaluation and triage of obstetric cases was performed by the OC operators through codes and scripted questions adapted from the Medical Priority Dispatch system,[17] available on request from the authors. Data on the population of Sierra Leone and its districts were extracted from the 2015 Sierra Leone Census, as reported on the Sierra Leone Statistics website.[18]

Evaluation of maternal and perinatal outcomes

We adopted the 10th Revision of the International Classification of Diseases (ICD-10) to define maternal mortality as 'deaths from any cause related to or aggravated by pregnancy or its management (excluding accidental or incidental causes) during pregnancy and childbirth or within 42 days of termination of pregnancy, irrespective of the duration and site of the pregnancy'. According to ICD-10, the perinatal period included the 'time frame that begins before birth and ends 28 days following the delivery.' To evaluate the association between PT and maternal and perinatal mortality, we retrieved data from the national referral coordinators' database, storing details on all incoming referrals collected at each hospital facility including in-hospital patient outcomes, a piece of information that was only available from January 2020 onwards. For this reason, we used a unique mission code to merge the above-mentioned database with a subset of data from the OC software, corresponding to 1717 referrals of obstetric emergencies recorded from 1 January

BMJ Glob Health: first published as 10.1136/bmjgh-2021-007315 on 29 November 2021. Downloaded from http://gh.bmj.com/ on April 6, 2022 by guest. Protected by copyright.

2020to 31 of May 2020. Among these 1717 obstetric emergencies, 1606 missions included maternal conditions also affecting the neonate, while the remaining 111 missions referred to conditions limited to the mother (eg, postpartum haemorrhage). All emergency obstetric referrals were classified according to the type of emergency recorded by the OC and based on patient assessment at the PHUs level.

Statistical analysis

For each district, we used median and IQRs to display the operational times and we estimated the proportion of missions that had a PT within 2 hours. The association between PT and mortality was investigated using modified Poisson regression models for binary data with robust estimate of the variance.[19] Natural cubic splines were incorporated into the models to assess the shape of the association and allow for possible non-linear effects. The optimal degree of smoothing was chosen using a model selection procedure proposed by Royston and Sauerbrei.[20 21] All the analyses were performed using Stata V.15 (StataCorp. 2017. Stata Statistical Software: Release 15. StataCorp).

Patient and public involvement

Patients and the public were not involved in the design of this study and in the dissemination plans of our research.

RESULTS

Among the 6387 emergency obstetric referrals included in the analysis of the operational times, the majority of pregnancy-related complaints were antepartum haemorrhages (18.7%) and hypertensive disorders (16.7%), while delivery-related emergencies were mostly represented by obstructed labours (25.2%) and postpartum haemorrhages (15.8%) (table 1).

Prehospital operational times

Except for the Western Area, which reported a median PT of 65 min, in all the other districts median PT ranged between 92 and 204 min (table 2). An analysis of the different operational times showed that DT and ToS contributed very little to the PT (overall median DT and ToS were 14 and 11 min, respectively), and were quite similar among districts. In contrast, median RT and TT differed greatly among districts (from 23 to 69 min and from 28 to 87 min, respectively) proving to be the determining factor for longer PT. At the national level, the proportion of emergency obstetric referral with a PT within 2 hours was 58.5% (95% CI 56.9% to 60.1%) during the rainy season and 61.4% (95% CI 59.5% to 63.2%) during the dry season (table 3). Results were substantially different among districts, with the Western Area reporting more than 90% of missions with a PT within the target and some rural districts reporting less than 40% (table 3).

Table 1 National Emergency Medical Services obstetric emergencies presented by type

Type of emergency	N, (%)
Pregnancy related	
Antepartum haemorrhage	1193 (18.7)
Hypertensive disorders	1066 (16.7)
Anaemia	452 (7.1)
Abortion	213 (3.3)
PROM	24 (0.4)
Ectopic pregnancy	18 (0.3)
Delivery related	
Obstructed labour	1611 (25.2)
Postpartum haemorrhage	1012 (15.8)
Foetal distress	175 (2.7)
Other*	338 (5.3)
Missing	285 (4.5)
Total	6387

*The 'Other' category includes severe malaria, respiratory distress, trauma, severe diarrhoea and dehydration, sepsis.
N, number; PROM, premature rupture of membranes.

Maternal and perinatal outcomes

Between 1 January 2020 and 31 May 2020, out of the 1717 referrals of obstetric emergencies retrieved from the referral coordinators' database, 41 and 211 missions resulted in the subsequent death either of the mother or the child, respectively. Specifically, we report two maternal deaths during transport and three on arrival to the hospital facility. With respect to perinatal death, we report 55 (26%) neonatal deaths and 156 (73%) stillbirths. Figures 3 and 4 show the association between PT and maternal and perinatal mortality. A continuous, monotonic increase in the risk of death for both mother and child was evident with increased duration of PT. Risk of maternal death at 60, 120 and 180 min of PT was 1.8%, 3.8% and 4.3%, respectively. Corresponding figures for perinatal death were 16%, 18% and 25%. On the relative scale, the association with PT was stronger for mothers, whose risk of death increases 2.4 times (from 1.8% to 4.3%) when passing from a PT of 60 min to a PT of 180 min. However, on the absolute scale the increase in risk was much larger for perinatal mortality, which increased from 16% to 25% in the same range of PT (figures 3 and 4).

DISCUSSION

In this study, we report the first countrywide evaluation of prehospital operational times for obstetric emergencies in Sierra Leone and its association with maternal and perinatal mortality.

Overall, the proportion of obstetric emergencies able to access hospital care within 2 hours using NEMS ambulances varied greatly among the districts, highlighting a significant difference between urban and rural areas. In the capital city of Freetown and its surroundings,

BMJ Glob Health: first published as 10.1136/bmjgh-2021-007315 on 29 November 2021. Downloaded from http://gh.bmj.com/ on April 6, 2022 by guest. Protected by copyright.

Table 2 Median (IQR) National Emergency Medical Services operational times for obstetric emergencies presented by district

District	Dispatch time	Response time	Time on scene	Travel time	Prehospital time
Bo	13 (9–20)	47 (31–71)	12 (5–24)	34 (17–56)	109 (75–155)
Bombali	11 (9–15)	38 (27–59)	8 (3–15)	33 (18–68)	92 (63–146)
Bonthe	17 (12–40)	50 (30–97)	12 (1–21)	41 (13–63)	113 (88–162)
Kailahun	14 (11–17)	42 (29–63)	18 (8–29)	52 (24–80)	116 (84–157)
Kambia	15 (10–20)	42 (31–62)	13 (4–26)	37 (17–75)	108 (72–160)
Kenema	14 (10–19)	43 (24–73)	13 (5–23)	42 (16–78)	118 (66–177)
Koinadugu	17 (12–24)	70 (36–117)	12 (2–26)	87 (34–172)	205 (131–297)
Kono	14 (9–20)	42 (24–94)	9 (1–18)	38 (17–75)	111 (65–168)
Moyamba	14 (11–19)	64 (28–103)	17 (7–33)	77 (45–111)	159 (115–230)
Port Loko	14 (11–19)	42 (28–62)	9 (3–19)	33 (18–54)	94 (68–137)
Pujehun	17 (12–32)	68 (43–105)	11 (1–25)	61 (36–94)	160 (116–221)
Tonkolili	14 (10–21)	51 (31–83)	11 (3–23)	65 (31–117)	146 (98–210)
Western Area*	13 (10–17)	23 (17–31)	11 (5–18)	28 (15–39)	65 (50–84)
Total	14 (10–20)	38 (23–67)	11 (4–22)	37 (18–70)	101 (67–160)

Time variables are expressed in minutes.
*Western Area includes the capital city of Freetown and its surroundings.

characterised by the highest concentration of healthcare facilities and paved roads, emergency obstetric referrals were within 2 hours in more than 90% of cases. Conversely, the remaining districts, where districts hospitals are considerably fewer and road conditions are generally poor, reported different degrees of delay, contributing to the substantial burden of maternal and perinatal deaths in the country.

Not surprisingly, the underlying reason for longer PTs in rural areas was longer RT and TT intervals, thus reflecting the geographical distance between the PHUs and the district hospitals rather than possible system shortcomings. These findings are corroborated by other studies performed in African LICs where attempts to reduce PT are often hindered by long-distance travels,[22 23] and confirm that distance is one of the most influential contributing factors to the second delay.[24] Therefore, the addition of more ambulances distributed in strategic locations could represent a potential solution to cover the emergency demand and reduce RT, TT and therefore PT. Nonetheless, a cost-effectiveness analysis should be performed prior considering this option, as estimated NEMS current recurrent costs per ambulance ride and yearly cost per inhabitants

Table 3 Proportion of National Emergency Medical Services obstetric emergencies within the 2-hour target in the districts of Sierra Leone during the rainy and the dry season

	Rainy season		Dry season	
District	N/tot	Proportion (95% CI)	N/tot	Proportion (95% CI)
Bo	172/335	51.3 (45.9 to 56.6)	174/268	64.9 (58.9 to 70.4)
Bombali	171/264	64.8 (58.8 to 70.3)	95/146	65.1 (56.9 to 72.4)
Bonthe	89/182	48.9 (41.6 to 56.2)	107/178	60.1 (52.7 to 67.1)
Kailahun	77/144	53.4 (45.2 to 61.5)	57/115	49.6 (40.4 to 58.7)
Kambia	119/190	62.6 (55.5 to 69.3)	86/171	50.3 (42.7 to 57.8)
Kenema	136/278	48.9 (43 to 54.8)	125/234	53.4 (46.9 to 59.8)
Koinadugu	29/117	24.8 (17.7 to 33.5)	16/92	17.4 (10.8 to 26.7)
Kono	88/165	53.3 (45.6 to 60.9)	63/111	56.7 (47.2 to 65.7)
Moyamba	35/138	25.4 (18.7 to 33.4)	43/120	35.8 (27.6 to 44.9)
Port Loko	164/273	60.1 (54.1 to 65.7)	133/177	75.1 (68.2 to 81)
Pujehun	72/296	24.3 (19.7 to 29.6)	76/220	34.5 (28.5 to 41.1)
Tonkolili	115/328	35.1 (30.1 to 40.4)	103/263	39.1 (33.4 to 45.2)
Western Area*	851/907	93.8 (92.1 to 95.2)	622/675	92.1 (89.8 to 94)
Total	2,188/3,617	58.5 (56.9 to 60.1)	1,700/2,770	61.4 (59.5 to 63.2)

*Western Area includes the capital city of Freetown and its surroundings.
N, number.

BMJ Glob Health: first published as 10.1136/bmjgh-2021-007315 on 29 November 2021. Downloaded from http://gh.bmj.com/ on April 6, 2022 by guest. Protected by copyright.

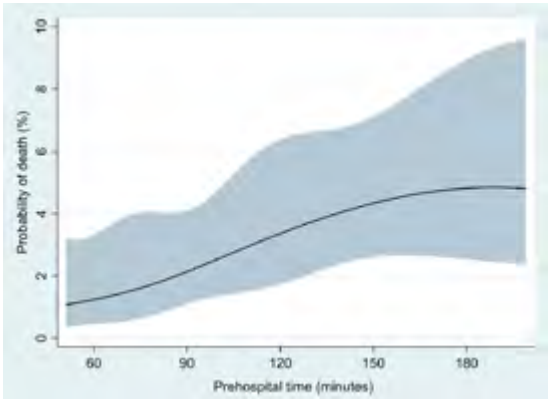


Figure 3 Association between prehospital time and maternal risk of death.

are moderately higher compared with other African countries.[15]

Together with geographical distance, road conditions represent an important factor influencing NEMS ambulances' speed and therefore time variables. As only 20% of the roads in Sierra Leone are paved,[25] mostly concentrated in the area of Freetown, efforts to improve the public road network would lead to reduced ambulance TT.

Alternative solutions to obtain a reduction in time needed to reach proper obstetric care demand the strengthening of the existing health system. Specifically, in those areas reporting longer PTs and when the starting point is represented by a level one PHU, an intermediate stop to a level 2 PHU able to offer BEmONC services could be advised either to obtain patient stabilisation before further referral to district hospitals or to achieve definitive care, according to the type of obstetric emergency.

A second approach entails appropriate decentralisation of maternal care in selected PHUs, after being upgraded

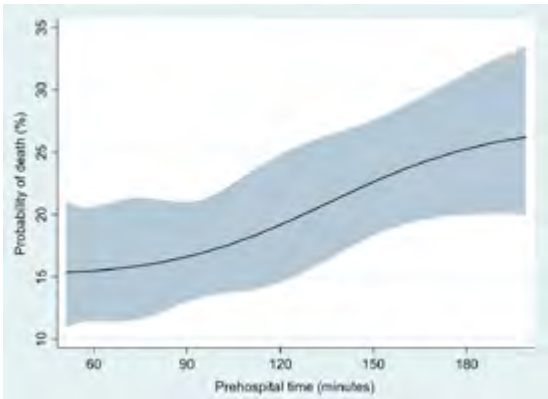


Figure 4 Association between prehospital time and perinatal risk of death.

to provide CEmOC services, similarly to what has been developed in Tanzania.[26] Although the long-standing debate between centralisation and decentralisation of maternal care is still ongoing and different strategies have been proposed to improve health systems in LICs,[27 28] our findings suggest that Sierra Leone could benefit from a partial redesign of its health system, enabling some PHUs to support the existing hospital network in providing comprehensive obstetric care. While in the past years the country has witnessed an impressive growth in the number of PHUs nationwide,[16] where however the quality of care provided is generally low, future strategies could envisage a quality-over-quantity approach, with the aim of better supporting pregnant women facing geographical barriers to reach district hospitals, and in line with WHO recommendation of having at least one CEmOC facility for every 500 000 population.[4] As one of the major challenges in Sierra Leone is the chronic shortage health qualified workforce,[29] the effort to scale up the current BEmONC PHUs should entail strategic measures such as the education and training of non-physician clinicians in providing CEmOC services, to obtain an adequate staffing level. This has been already achieved in Tanzania,[30] where hands-on training, coaching, mentoring and supervision activities improved the safety and quality of care provided by non-physician clinicians.[26]

Beside the specific strategies adopted, it is noteworthy that any reduction of operational times is expected to substantially improve patient outcomes. Our study shows a clear association between PT and risk of maternal and perinatal death during obstetric emergencies. While the association between PT and perinatal mortality is well studied in high-income countries,[31–33] only few studies evaluated the relationship between longer TT and adverse perinatal outcomes in low-income and low-middle-income countries,[34–36] and quantitative data on maternal risk of death are even less investigated. The high rates of perinatal deaths reported in our study concur with the results of van Duinen *et al*,[34] who reported a 19% perinatal mortality following emergency caesarian sections in Sierra Leone. Similar to what observed by van Duinen *et al*,[34] our findings show that the 2-hour target did not represent an exact cut-off point, as both maternal and perinatal risk of death increased continuously and especially in the PT interval between 120 and 180 min, where the majority of PT values in rural districts are. These results further emphasise that every minute is crucial and even small reductions in operational times can translate into substantial improvements of maternal and perinatal survival, which should act as a wake-up call to action for investment on transportation infrastructure in LICs.

Nonetheless, it should be reminded that the 2-hour target mainly refers to the critical time from postpartum haemorrhages and death if no intervention is provided.[4] There are other obstetric emergencies that might actually benefit from more advanced hospital care even when TT extend beyond 2 hours. In the current Sierra Leonean context, in case of prolonged and obstructed labour, when operative delivery

BMJ Glob Health: first published as 10.1136/bmjgh-2021-007315 on 29 November 2021. Downloaded from http://gh.bmj.com/ on April 6, 2022 by guest. Protected by copyright.

is needed and not provided at the PHU level, centralisation may in fact be the only appropriate intervention to provide quality care especially as risk for complications dramatically increases with advanced stages of labour.[37] In spite of international recommendation suggesting a 30 min decision-to-delivery interval in case of emergency caesarean sections,[38 39] the achievability of this goal in low-income settings is still largely aspirational, while a more realistic target emerging from the literature is a time frame ranging from 2 to 5 hours.[40 41] Therefore, improvements at the NEMS OC level to perform a more thorough triage of obstetric emergencies in order to establish different strategies within the 'red' codes category could support more targeted referral pathways especially in those districts experiencing longer TT. To this regard, future studies are needed to better investigate the relation between time and maternal and perinatal risk of death in the different categories of obstetric emergencies.

Some limitations of the study need to be considered. First, data on operational times were collected via mobile phone, a procedure that is not exempt from errors and inaccuracy, also considering the poor mobile phone reception in remote areas of the country. However, a quality check of the data of each mission showed consistency in the values of the reported operational times, suggesting that, overall, this approach was reliable. Second as we did not have any information regarding the TT from patients' home to the PHUs, our study underestimates the total time elapsed between the occurrence of an emergency and the arrival at the hospital, which might represent a considerable part of patients' journey time-wise. The degree of such underestimation is expected to be larger in the rural compared with urban areas, as the average distance between homes and PHUs is usually longer. Therefore, our estimate of the proportion of missions within the 2-hour target should be considered conservative and not completely comparable with those from studies using other methods, including total time from home.[33] On the other hand, according to the 2016 annual report or Maternal Death, Surveillance and Response,[42] before NEMS inception, when patients could reach hospital facilities either through private vehicles or paying public transport, the high number of maternal deaths reported at the hospitals' level were associated with late referral from the PHUs. Therefore, while not providing a comprehensive evaluation of the 'second delay', we believe that in this context the estimate of the time elapsed from the first clinical assessment at the PHU to the arrival at the hospital constitutes an objective, reliable and useful indicator of the performance of the newly developed prehospital health system, highlighting existing gaps and area fur further improvements.

CONCLUSIONS

This was the first nationwide evaluation of prehospital operational times of Sierra Leone.

Apart from the capital city of Freetown and its surroundings, obstetric emergencies referred by NEMS still struggle to access hospital care and therefore essential surgery within a 2-hour time frame. The main reason for the delay in access to obstetric emergency care was related to the geographical distance from PHUs to district hospitals. Maternal and perinatal risk of death increased concurrently with operational times and any reduction of time to reach the hospital, even if still exceeding the 2-hour target, might translate into improved patient outcomes.

Author affiliations
[1]CRIMEDIM - Center for Research and Training in Disaster Medicine, Humanitarian Aid, and Global Health, Università degli Studi del Piemonte Orientale Amedeo Avogadro Scuola di Medicina, Novara, Italy
[2]Research Section, Doctors with Africa CUAMM, Padova, Veneto, Italy
[3]Ministry of Health and Sanitation, Government of Sierra Leone, Freetown, Western Area, Sierra Leone
[4]School of population health and environmental sciences, King's College London, London, UK
[5]Cuamm Medical Doctors for Africa, Padova, Veneto, Italy
[6]SUEM 118 - Servizio Urgenza Emergenza Medica, Azienda ULSS 3 Serenissima, Venezia, Veneto, Italy
[7]Research Group on Emergency and Disaster Medicine, VUB, Brussel, Belgium

Twitter Daniel Youkee @mirrorsandmaps

Acknowledgements The study was conducted in the framework of the International PhD in Global Health, Humanitarian Aid and Disaster Medicine jointly organised by Università del Piemonte Orientale (UPO) and Vrije Universiteit Brussel (VUB).

Contributors MC guarantor, conceived the presented idea, participated in project administration, data curation, formal analysis and investigation, drafted the article, designed figures and tables, and provided final approval of the version to be submitted; GP participated project administration, investigation and interpretation of results, critical revision of the article and provided final approval of the version to be submitted; AC designed figures and tables, critically revised the article and provided final approval of the version to be submitted; FT provided study resources, participated in critical revision of the article, interpretation of results, and provided final approval of the version to be submitted; AJ, MJV, DY, RB, SP and PR provided study resources, participated in critical revision of the article and provided final approval of the version to be submitted. IH and FDC supervised the present research, participated in critical revision of the article and provided final approval of the version to be submitted. LR participated in the study design, project administration and supervision, participated in critical revision of the article, interpretation of results and provided final approval of the version to be submitted. FB-A participated in the study design, project administration and supervision, performed formal analysis, provided study validation and designed figures, participated in critical revision of the article, interpretation of results and provided final approval of the version to be submitted.

Funding The authors have not declared a specific grant for this research from any funding agency in the public, commercial or not-for-profit sectors.

Map disclaimer The inclusion of any map (including the depiction of any boundaries therein), or of any geographic or locational reference, does not imply the expression of any opinion whatsoever on the part of BMJ concerning the legal status of any country, territory, jurisdiction or area or of its authorities. Any such expression remains solely that of the relevant source and is not endorsed by BMJ. Maps are provided without any warranty of any kind, either express or implied.

Competing interests None declared.

Patient and public involvement Patients and/or the public were not involved in the design, or conduct, or reporting, or dissemination plans of this research.

Patient consent for publication Not applicable.

Ethics approval Comitato Etico Interaziendale AOU 'Maggiore della Carità' di Novara, ASL BI, ASL NO, ASL VCO, Protocollo 895/CE, ID CE 203/20; Office of the Sierra Leone Ethics and Scientific Review Committee.

Provenance and peer review Not commissioned; externally peer reviewed.

Data availability statement Data may be obtained from a third party and are not publicly available. Restrictions apply to the availability of these data. Data were obtained from the National Emergency Medical Service Operation Center and from the Referral Coordinators Database and are available from the authors with the permission of the Ministry of Health and Sanitation of Sierra Leone.

BMJ Glob Health: first published as 10.1136/bmjgh-2021-007315 on 29 November 2021. Downloaded from http://gh.bmj.com/ on April 6, 2022 by guest. Protected by copyright.

Open access This is an open access article distributed in accordance with the Creative Commons Attribution Non Commercial (CC BY-NC 4.0) license, which permits others to distribute, remix, adapt, build upon this work non-commercially, and license their derivative works on different terms, provided the original work is properly cited, appropriate credit is given, any changes made indicated, and the use is non-commercial. See: http://creativecommons.org/licenses/by-nc/4.0/.

ORCID iDs
Marta Caviglia http://orcid.org/0000-0002-4164-4756
Andrea Conti http://orcid.org/0000-0002-0021-117X
Francesca Tognon http://orcid.org/0000-0001-6649-1525

REFERENCES

1 WHO, UNFPA, UNICEF, World Bank Group and United Nations Population Divisions. Trends in maternal mortality from 2000 to 2017. Geneva, Switzerland:, 2019. Available: https://www.unfpa.org/resources/trends-maternal-mortality-2000-2017-executive-summary [Accessed 26 Jul 2021].
2 United Nations. Transforming our world: the 2030 agenda for sustainable development. Available: https://sdgs.un.org/2030agenda [Accessed 26 Jul 2021].
3 Meara JG, Leather AJM, Hagander L, *et al*. Global surgery 2030: evidence and solutions for achieving health, welfare, and economic development. *Lancet* 2015;386:569–624.
4 WHO. *Monitoring emergency obstetric care: a Handbook, WHO, UNICEF, UNFPA and AMDD*. World Health Organization, 2009.
5 World Health Organization. *Global reference list of 100 core health indicators*. Geneva, Switzerland: World Health Organization, 2018. https://score.tools.who.int/fileadmin/uploads/score/Documents/Enable_data_use_for_policy_and_action/100_Core_Health_Indicators_2018.pdf
6 Holmer H, Bekele A, Hagander L, *et al*. Evaluating the collection, comparability and findings of six global surgery indicators. *Br J Surg* 2019;106:e138–50.
7 Binda C, Zivkovic I, Duffy D, *et al*. Evaluation of interventions addressing timely access to surgical care in low-income and Low-Middle-Income countries as outlined by the Lancet Commission 2030 global surgery goals: a systematic review. *World J Surg* 2021;45:2386–97.
8 Banke-Thomas A, Wright K, Collins L. Assessing geographical distribution and accessibility of emergency obstetric care in sub-Saharan Africa: a systematic review. *J Glob Health* 2019;9:010414.
9 Dahir S, Cotache-Condor CF, Concepcion T, *et al*. Interpreting the Lancet surgical indicators in Somaliland: a cross-sectional study. *BMJ Open* 2020;10:e042968.
10 Albutt K, Punchak M, Kayima P, *et al*. Access to safe, timely, and affordable surgical care in Uganda: a stratified randomized evaluation of nationwide public sector surgical capacity and core surgical indicators. *World J Surg* 2018;42:2303–13.
11 Kironji AG, Hodkinson P, de Ramirez SS, *et al*. Identifying barriers for out of hospital emergency care in low and low-middle income countries: a systematic review. *BMC Health Serv Res* 2018;18:291.
12 Calvello E, Reynolds T, Hirshon JM, *et al*. Emergency care in sub-Saharan Africa: results of a consensus conference. *African Journal of Emergency Medicine* 2013;3:42–8.
13 Mould-Millman N-K, Dixon JM, Sefa N, *et al*. The state of emergency medical services (EMS) systems in Africa. *Prehosp Disaster Med* 2017;32:273–83.
14 Ragazzoni L, Caviglia M, Rosi P, *et al*. Designing, implementing, and managing a national emergency medical service in Sierra Leone. *Prehosp Disaster Med* 2021;36:115–20.
15 Caviglia M, Dell'Aringa M, Putoto G, *et al*. Improving access to healthcare in Sierra Leone: the role of the newly developed national emergency medical service. *Int J Environ Res Public Health* 2021;18:9546.
16 Ministry of Health and Sanitation, Republic of Sierra Leone. Sierra Leone basic package of essential health services 2015-2020. Available: https://mohs2017.files.wordpress.com/2017/06/gosl_2015_basic-package-of-essential-health-services-2015-2020.pdf [Accessed 26 Jul 2021].
17 Medical priority dispatch system. Available: https://www.emergencydispatch.org/what-we-do/emergency-priority-dispatchsystem/medical-protocol [Accessed 26 Jul 2021].
18 Statistics Sierra Leone. Population and housing census statistics, 2015. Available: https://www.statistics.sl/index.php/census/census-2015.html [Accessed 26 Jul 2021].
19 Zou G. A modified poisson regression approach to prospective studies with binary data. *Am J Epidemiol* 2004;159:702–6.
20 Royston P, Sauerbrei W. Multivariable modeling with cubic regression splines: a principled approach. *Stata J* 2007;7:45–70.
21 Bassig BA, Zhang L, Cawthon RM, *et al*. Alterations in leukocyte telomere length in workers occupationally exposed to benzene. *Environ Mol Mutagen* 2014;55:673–8.
22 Masters SH, Burstein R, Amofah G, *et al*. Travel time to maternity care and its effect on utilization in rural Ghana: a multilevel analysis. *Soc Sci Med* 2013;93:147–54.
23 Paranjothy S, Watkins WJ, Rolfe K, *et al*. Perinatal outcomes and travel time from home to hospital: Welsh data from 1995 to 2009. *Acta Paediatr* 2014;103:e522–7.
24 Geleto A, Chojenta C, Musa A, *et al*. Barriers to access and utilization of emergency obstetric care at health facilities in sub-Saharan Africa: a systematic review of literature. *Syst Rev* 2018;7:183.
25 HOTOSM Sierra Leone roads, 2020. Available: https://data.humdata.org/dataset/hotosm_sierra_leone_roads [Accessed 13 Oct 2021].
26 Nyamtema A, Mwakatundu N, Dominico S, *et al*. Increasing the availability and quality of caesarean section in Tanzania. *BJOG* 2016;123:1676–82.
27 Roder-DeWan S, Nimako K, Twum-Danso NAY, *et al*. Health system redesign for maternal and newborn survival: rethinking care models to close the global equity gap. *BMJ Glob Health* 2020;5:e002539.
28 Iverson KR, Svensson E, Sonderman K, *et al*. Decentralization and regionalization of surgical care: a review of evidence for the optimal distribution of surgical services in low- and middle-income countries. *Int J Health Policy Manag* 2019;8:521–37.
29 Bolkan HA, Hagander L, von Schreeb J, *et al*. The surgical workforce and surgical provider productivity in Sierra Leone: a countrywide inventory. *World J Surg* 2016;40:1344–51.
30 Nyamtema AS, Pemba SK, Mbaruku G, *et al*. Tanzanian lessons in using non-physician clinicians to scale up comprehensive emergency obstetric care in remote and rural areas. *Hum Resour Health* 2011;9:28.
31 Paranjothy S, Watkins WJ, Rolfe K, *et al*. Perinatal outcomes and travel time from home to hospital: Welsh data from 1995 to 2009. *Acta Paediatr* 2014;103:e522–7.
32 Ravelli ACJ, Jager KJ, de Groot MH, *et al*. Travel time from home to hospital and adverse perinatal outcomes in women at term in the Netherlands. *BJOG* 2011;118:457–65.
33 Malouf RS, Tomlinson C, Henderson J, *et al*. Impact of obstetric unit closures, travel time and distance to obstetric services on maternal and neonatal outcomes in high-income countries: a systematic review. *BMJ Open* 2020;10:e036852.
34 van Duinen AJ, Adde HA, Fredin O, *et al*. Travel time and perinatal mortality after emergency caesarean sections: an evaluation of the 2-hour proximity indicator in Sierra Leone. *BMJ Glob Health* 2020;5:e003943.
35 Wariri O, Onuwabuchi E, Alhassan JAK, *et al*. The influence of travel time to health facilities on stillbirths: a geospatial case-control analysis of facility-based data in Gombe, Nigeria. *PLoS One* 2021;16:e0245297.
36 Niyitegeka J, Nshimirimana G, Silverstein A, *et al*. Longer travel time to district hospital worsens neonatal outcomes: a retrospective cross-sectional study of the effect of delays in receiving emergency cesarean section in Rwanda. *BMC Pregnancy Childbirth* 2017;17:242.
37 Sobhy S, Arroyo-Manzano D, Murugesu N, *et al*. Maternal and perinatal mortality and complications associated with caesarean section in low-income and middle-income countries: a systematic review and meta-analysis. *Lancet* 2019;393:1973–82.
38 Royal College of Obstetricians and Gynaecologists Report of Joint Working Group. *Organization of standards for maternity services*. London: RCOG Press, 2005.
39 American College of Obstetricians and Gynecologists Committee on Professional Standards. *Standards for obstetrics and gynecology services*. 7th edn. Washington DC, 1989.
40 Oppong SA, Tuuli MG, Seffah JD, *et al*. Is there a safe limit of delay for emergency caesarean section in Ghana? results of analysis of early perinatal outcome. *Ghana Med J* 2014;48:24–30.
41 Onuoha O, Ramaswamy R, Srofenyoh EK, *et al*. The effects of resource improvement on decision-to-delivery times for cesarean deliveries in a Ghanaian regional hospital. *Int J Gynecol Obstet* 2015;130:274–8.
42 Ministry of Health and Sanitation, Republic of Sierra Leone. Maternal death surveillance and response annual report, 2016. Available: https://sierraleone.unfpa.org/en/publications/maternal-death-surveillance-and-response-annual-report [Accessed 16 Oct 2021].

BMJ Glob Health: first published as 10.1136/bmjgh-2021-007315 on 29 November 2021. Downloaded from http://gh.bmj.com/ on April 6, 2022 by guest. Protected by copyright.

Measuring Physical access to primary health care facilities in Gambella Region (Western Ethiopia)

PAPER

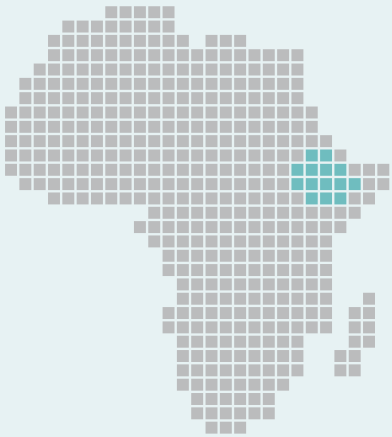
Authors
Fantozzi P., Baracca G., Manenti F., Putoto G.

Published in
International Cartographic Association, December 2021

Link
10.5194/ica-proc-4-30-2021

Topic
Universal coverage and equity

Focus country
Ethiopia



International Cartographic Association
Association Cartographique Internationale

Measuring Physical access to primary health care facilities in Gambella Region (Western Ethiopia)

Pier Lorenzo Fantozzi[a*], Giuseppe Baracca [b], Fabio Manenti [b], Giovanni Putoto [b]

[a] *University of Siena Department of Physics, Earth and Environmental Sciences, Via laterina 8, 53100, Siena Italy- fantozzip@unisi.it*
[b] *Doctors with Africa Cuamm, Via San Francesco 126, Padova Italy - international@cuamm.org*

* Corresponding author

Abstract: As part of the project "More equity and quality of health services in Gambella, Gambella Region", financed by the Italian Agency for Development Cooperation (AICS) and implemented by the Italian NGO Doctors with Africa CUAMM (Padua, Italy) a geographic database of the distribution of health facilities of Gambella Region (western Ethiopia) was created. This data collection was carried out in two missions carried out in February 2018 and November-December 2019. It allowed a mapping of the access roads and the location of health facilities using Geomatic Approaches and related technologies (Remote Survey, Field Survey, GPS, GIS). The field work has allowed the investigation in 11 Waredas (i.e. districts) with the census of 3 primary hospitals, 26 health centres and 121 HPs and related road access by car or, in case of inaccessibility of vehicles, by foot or boat.The final result of this work is the availability of a detailed cartographic picture of the geographical distribution of Health Facilities (HFs) in order to support the modern decision-making tools to be adopted for the distribution of human and instrumental resources. As an example we describe a network analysis performed by ESRI ™ Netwok Analyst which showed the importance of this approach to remodel a more efficient referral system.

Keywords: GIS, Network Analysis, Health Facility

1. Introduction

This study was implemented into the framework of the project, “MORE QUALITY AND EQUITY OF HEALTH SERVICES IN GAMBELLA, GAMBELLA REGION, ETHIOPIA”, financed by the Italian Agency for Development Cooperation (IADC) and executed by the Italian NGO Doctors with Africa CUAMM.

The general goal of the program is to improve medical of the mother and baby in order obtain a lasting and concrete result in reducing maternal and infant mortality. For the case study the project was focused on the challenging access to the obstetric emergency referral system in the project area as a proxy for all kinds of emergencies, either surgical or medical. The field work was carried out in two stages: in February 2018 and November - December 2019 with the target of mapping health facilities and relative access roads using the Geographical Information System technology (GIS). Data elaboration was realized in preliminary stage in 2018 and the completed analysis with Map Atlas compilation and diffusion to the ethiopian partners was realized in September 2020. The study area, surrounding the Gambella town, is typical rural area of African countries with scattered villages, low density of population, very few asphalted roads and general lacking of public transport.

In the Gambella Region, as in many African countries, detailed updated cartography at an operational scale (i.e. 1: 10.000 - 1: 25.000) is present only in urban areas, while in rural areas there is only a 1:50000 scale cartography (dating back to the several decades ago) that does not report the updates of the communication routes built recently. Even the Health Facilities map and the relative catchment area was not available for the Gambella Region, so that frequently the Local Officiers of the Health Centre trace manually a sketch map for their competence area in order to support their work for vaccination or other needs (Figura 1).

Figura 1. Manual sketch map drown by the Local Officers for the Health Centre catchment area.

Proceedings of the International Cartographic Association, 4, 2021.
30th International Cartographic Conference (ICC 2021), 14–18 December 2021, Florence, Italy. This contribution underwent single-blind peer review based on submitted abstracts. https://doi.org/10.5194/ica-proc-4-30-2021 | © Author(s) 2021. CC BY 4.0 License.

It follows that for the purposes of programming medical services and decision support there **is not rational and geographic reference framework that allows adequate and efficient programming of services**. To overpass this limitation in order to fulfil the project targets a team from the Department of Physics, Earth and Environmental Sciences from the University of Siena (Italy) assured the specialized technical support both for field survey and in data elaboration for GIS analysis and map production (for references about the use of GIS in health system see Mc Lafferty SL (2003) and Fogliati P. et al., 2015) . In this way the use of GIS analysis was intended to create a database referring to the type, location and spatial distribution of health facilities in the study area and to measure distance and travel time from the peripheral health facilities to the higher referral level. This data set can now be utilized to identify areas that are under-served and to propose valuable alternatives that could be implemented within this resource limited setting, in order to maximize effectiveness of the ambulance referral system.

2. Contribution of the study: aim and objectives

2.1 Aim

Scope of this project "More equity and quality of health services in Gambella, Gambella Region" was to appraise the diverse sustainable existing choices that could be implemented, in order to improve the obstetric emergency referral system performance for reducing the coverage gaps, in a context with scarce resources.

2.2 Objectives

The specific objective were: 1- to create a geographical database of the type, location and spatial distribution of health facilities for the whole region of Gambella; 2- emphasize the use of the spatial analysis (using ESRI™ Network Analyst™) within a subset of the collected data, the Woreda of Gambella, Abobo and Gambella Town, in order to shows how is possible identify under-served areas, because of their excessive distance and/or access time from the reference centre, and consequently propose advantageous alternative options that could be implemented within this resource limited setting. This case study, related to a subset of the collected data (see in the follow the section 6.2), examines only the spatial components of the health care system accessibility related to the obstetric emergency referral system.

3. Background

3.1 Government and administration in Ethiopia

Ethiopia is a federal parliamentary republic with a Prime Minister serving as head of government. The 1995 Ethiopian Constitution created nine Regional States and two City Administrations which are divided into Woredas (Districts) and Kebeles (Sub-districts). A Woreda is the basic decentralized administrative unit presided by an elected administrative council.

3.2 The National Health System in Ethiopia

The National Health System (NHS) in Ethiopia has a pyramidal shape made of three-tiers health care delivery system (Federal Democratic Republic of Ethiopia, 2010): **level one** is a Woreda/District health system comprised of a primary hospital (to cover 60,000-100,000 people), Health Centres, HCs, (1/15,000-25,000 population) and their satellite Health Posts, HPs, (1/3,000-5,000 population) connected to each other by a referral system. The primary hospital, HCs and HPs form a Primary Health Care Unit (PHCU). **Level two** is a General Hospital covering a population of 1-1.5 million people; and **level three** is a Specialized Hospital covering a population of 3.5-5 million people (HSDP-IV 2010/2015, MoH). HPs should mainly provide preventive services and promoting clients' positive attitude toward health besides of basic curative services (malaria treatment, cure of common infections and ORS treatment for diarrheal, etc.). More complex curative and rehabilitative care is provided at Health Centre and Hospital levels according to their specific capability, as per national minimum standards, to manage patients according to diagnosis and therapy complexity.

4. Study area

The survey area cover the main part of Gambella Region, in the westernmost part of the Ethiopia, along the boundary of Sudan and South Sudan (Figura 2).

Figura 2. In yellow the Gambella Region

The study area extend from 33°,00' to 35°,39' East longitude and from 6°,32' to 8°,71' North Latitude. According to "Gambella, 2019 Pledge Progress Report (UNHCR Ethiopia, 2019), the region has a population of about 409,000 inhabitants (2015 population projection, https://www.citypopulation.de/Ethiopia.html).

The altitude in the study area range from 300 up to 2300 meters above the sea level. The natural morphology of the region is characterized in the eastern part by of the Ethiopian plateau that to the west gradually slopes towards a region of undulating plains where the vegetation of the savannah prevails, with large humid area flooded during rainy season.

The climate is tropical with two seasons, rainy from February-March up to September-October and dry season for the remaining months of the year. Annual rainfall

Proceedings of the International Cartographic Association, 4, 2021.
30th International Cartographic Conference (ICC 2021), 14–18 December 2021, Florence, Italy. This contribution underwent single-blind peer review based on submitted abstracts. https://doi.org/10.5194/ica-proc-4-30-2021 | © Author(s) 2021. CC BY 4.0 License.

averages about 600 mm while the minimum/ maximum temperatures are approximately 21° C and 35° C respectively. In the lowland during the raining season the flooding are very frequent causing interruption of the connections between the villages and severe limitation of the sanitary assistance. In the northern area flows the Baro river that cross Gambella Town, the regional capital. The Baro rivers and main tributaries are navigable and marks the border with South Sudan. These river network connecting Gambella Region to South Sudan is one of the main communication way for refugees transit. Gambella region hosts the largest refugee population in Ethiopia, over 300000 settled in 7 refugee camps. This region is divided into 13 Wareda, having a total land area ca 26,000 km2. The Region is one of the poorest in the country, with 35.3 % of the population positioned in the lowest wealth quintile. The 32.2 % of females and 22.3 % of males are illiterates; only 3 % of females and 7 % of males respectively have an education above the secondary school, as reported in the Ethiopia Mini Demographic and Health Survey (EMDHS 2014).

5. Methods and tools

5.1 Preliminary work

The preliminary works was carried out in the Geographic Information System Laboratory of the Department of Physics, Earth and Environmental Sciences of the University of Siena (Italy) analyzing the satellite images of the Gambella Region. The target of this stage was prepare a preliminary maps that could assist the field work and for planning and realization of field activities; in this way we compared the name of cities, villages and sites of location of the HF's supplied by the Gambella Town operative staff of CUAMM, with the available sources of data and particularly satellite images and the available maps in web GIS (i.e. Google Earths™, Google Maps™, Bing™, Open Street Map™). Unfortunately we found a very scarce correspondence between the list of the available place names included in the source of data and the name of the HF's. Given this scarcity of available data the large part of the work was based to the fieldwork relating to the direct survey of the geographic position of the HFs and relative access roads. The final result of the preliminary work was a sketch map of the available place names of the region and relative possible access roads; this map was used for planning the field work described in following chapter.

5.2 Field works

In order to operate in safety conditions and avoid any possible access problems, the survey agenda was discussed and approved by, the Country Manager of CUAMM. The technical equipment, supplied by the University of Siena, included a Dell Latitude rugged tablet (with two lithium batteries and included GPS), and 5 Garmin Etrex10 portable GPS to be assigned to the Extension Worker duties. Further equipment (laptops, cameras, hard disks, GIS platform (ArcGIS™ etc), was used as normal procedure for managing the collected spatial data. The Field work has been organized using the four-wheel drive, with the support of the local staff composed by a CUAMM and local assistants. The use of boat was necessary for survey facilities placed along the rivers. The GPS equipment managed ArcGIS™ platform allowed us a real-time capturing of data: during the motion (car, boat or walking) the parameter was set in order to acquire a detailed position, and this position was recorded in a feature attribute table that can be elaborated to define the travelled roads (Figura 3).

Figura 3. ArcMap™ interface with GPS tracks and satellite images.

Particularly during the field work carried out in November – December 2019 the study area was interested by large flooded areas so in several case we used boat to reach the remote HF's not accesible by other way (car or walking) (Figura 4, Figura 5).

Figura 4. Use of boat for reaching facilties not accessible during rainy season

Proceedings of the International Cartographic Association, 4, 2021.
30th International Cartographic Conference (ICC 2021), 14–18 December 2021, Florence, Italy. This contribution underwent single-blind peer review based on submitted abstracts. https://doi.org/10.5194/ica-proc-4-30-2021 | © Author(s) 2021. CC BY 4.0 License.

Once arrived at the HFs site, we recorded data relatively to the geographic coordinates and other ancillary data related to the availability of electrical power, water, name of responsible person and phone number. Pictures with relative coordinates were collected in any HF, more than 1500 geotagged pictures were collected during the fieldworks.

Figura 5. Example of surveyed Health Post in located in village along the Jilo river.

During the fieldwork, in selected HFs, we assigned a portable GPS device to the Extension Worker, asking him/her to walk along the path from the community/village to the referral HFs (Figura 6).

Figura 6. A brief training for the Extension Worker on the use of the device was supplied by the CUAMM Staff

The field work results was an essential part for the preparation of the subsequent processing of data and the final report.

5.3 Compilation of Map Atlas

The field work allowed the investigation in 11 Waredas with the census of 3 primary hospitals, 26 health centres and 121 HPs and related road access by car or in case of inaccessibility of vehicles by foot or boat. All the data was collected in a A4 size atlas map with including more the 250 original maps. The maps are relative to each wareda and its HF's with the access road (Figura 7). For the surveyed Wareda, the atlas map include other detailed map for each health centres and relative HPs and detailed report for each HFs (Figura 8 and Figura 9).

Figura 7. Example of the wareda Health Facilities map.

Figura 8. Example of the Health centre and relative Health Post map.

Figura 9. Example of resuming report realized for each facilities and included in a 250 pages Atlas Map.

In order to facilitate the diffusion of the results, all the data were collected and represented in a synoptic and map (Figura 10).

5.4 Elaboration of different scenarios

On the basis of the collected data we elaborated a different scenarios for support to maternal and newborn

Proceedings of the International Cartographic Association, 4, 2021.
30th International Cartographic Conference (ICC 2021), 14–18 December 2021, Florence, Italy. This contribution underwent single-blind peer review based on submitted abstracts. https://doi.org/10.5194/ica-proc-4-30-2021 | © Author(s) 2021. CC BY 4.0 License.

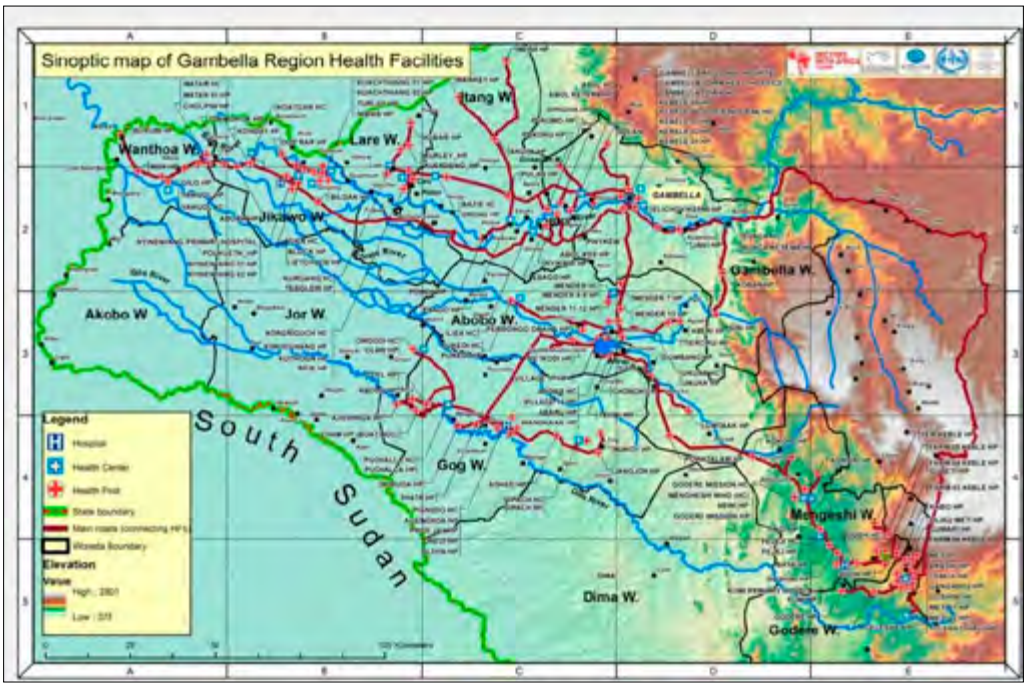


Figura 10

community health services provided by the first level HCs in Gambella, Gambella town and Abobo Districts. The result of these elaboration are descrive in the follows as use of data set for planning a rational ambulance referral system

5.4.1 *Short description of obstetric and neonatal packages offered by the health system*

Obstetric emergencies happen at any time during pregnancy. In accordance with the kind of occurring problem the emergency in developing countries is taken in charge by the system at two levels. At HC, with the package called Basic Emergency Obstetric Neonatal Care (BEmONC), which provides parenteral antibiotics, utero-tonic drugs, anti-convulsion drugs, manual removal of placenta, removal of retained products, assisted vaginal delivery and neonatal resuscitation; whereas at hospital level the package is fulfilled with Cesarean Section and blood transfusion and is called Comprehensive Emergency Obstetric Neonatal Care (CEmONC) (WHO, UNFPA, UNICEF, AMOD 2009).

5.4.2 *Transportation time as limiting factor*

When quality health services provided by the system at facility level are available the limiting factors to reduce mortality and morbidity are distance and time needed to transport the patients (McKinnon B. et al. 2014). The cut off point, that makes the difference for the needed transportation time is estimated at two hours (UNFPA 2004; Maine D. et al. 1997) especially for taking care of hemorrhage, one of the most important and frequent complications of the pregnancies. The idle time due to difficulty in communication for the net black out and/or other delays have to be included within the two hours.

5.4.3 *The referral system how it is presently organized in the study area*

Both the Woreda of Gambella and the Woreda of Abobo has an ambulance provided by the Federal Ministry of Health (FMoH) and are parked at the Woreda Health Office (WoHO) in Abobo and in Abol HC in Gambella, at disposition when called. The system is organized to transport the emergencies from the HPs to the HC of reference and from here to the Gambella Regional Hospital if the case requires. Using the Network analysis the travel time between the facilities and hospital (Figura 11), has been calculated and discussed as follows.

The Woreda of Gambella Town encompasses five urban Kebeles, which are not affected from the problem of delayed reference to emergency care as all Kebeles have easy access to Gambella HC and Gambella Hospital. The ambulance parked in Gambella Town HC provides the referral service. The Woreda of Gambella is provided with two ambulances parked in Abol and Bonga HCs.

Proceedings of the International Cartographic Association, 4, 2021.
30th International Cartographic Conference (ICC 2021), 14–18 December 2021, Florence, Italy. This contribution underwent single-blind peer review based on submitted abstracts. https://doi.org/10.5194/ica-proc-4-30-2021 | © Author(s) 2021. CC BY 4.0 License.

Figura 11. Example of a Health Facilities and space-time tabular data elaborated by the use on Network Analyst™ application.

Abol is situated at the northwest of the Woreda, while Bonga is located at the opposite southeast, see the Figura 11. The health facilities which refer BEmONC cases to Abol HC are far from it less than two hours, are six over seven (86%). One HP of the Abol catchment area is beyond two hours: (Niykwo), while another is at threshold (Solan), as shown in Table 1. In case the emergency is CEmONC the patient cannot be managed at HC level and the case has to be referred to the Hospital in Gambella. The travel time increases and the coverage of health facilities, including Abol HC, becomes six over eight (75%), as the HPs of Solan and Niykwo are afar more than two hours for the referral system, see table 2.

N°	Health Facility Name of Abol catchment area	Time in minutes from Abol to HF	Time in minutes to return from HF to Abol	Total time to Gambella Regional Hospital
1	Abol - Abol Ketema	1	2	24
2	Abol - Pinykew	12	23	45
3	Abol - Opagna	14	28	50
4	Abol - Abol Ker	15	30	52
5	Abol - Pukong	23	45	67
6	Abol - Solan	57	115	137
7	Abol - Nyikwo	89	178	200
8	Abol - Gambella Hospital			22

Table 1. List of health facilities referring to Abol HC in the Woreda of Gambella, their time in minutes to travel to the HC of reference and additional time to reach Gambella Regional Hospital

The health facilities referring BEmONC cases to Bonga HC, which are far from it less than two hours are four over five (80%). One HP, Siri, is far beyond two hours for the referral system, seeTable 3.The coverage of CEmONC referral cases, including Bonga HC, is five over six (83%). The HP of Siri is still out of reach for an effective referral (Table 2).

N°	Health Facility Name of Bonga catchment area	Time in minutes from Bonga to HF	Time in minutes to return from HF to Bonga	Total time travel Bonga - HF - Bonga - Gambella Hospital
1	Bonga - Bonga Ketema	1	2	46
2	Bonga - Jawi	21	41	85
3	Bonga - Koban	36	72	116
4	Bonga - Elichoy/Kermi	31	62	106
5	Bonga - Siri	65	131	175
6	Bonga - Gambella Hospital			44

Table 2. List of health facilities referring to Bonga HC, their time in minutes to travel to the HC and additional time to reach Gambella Regional Hospital.

Data collected during the field activities in the Woreda of Abobo are shown in Table 3

N°	Health Facility Name of Abobo catchment area	Time in minutes from Abobo to HF	Time in minutes to return from HF to Abobo	Total time to Gambella Regional Hospital
1	Abobo - Wangkaak	1	2	140
2	Abobo - Abaru	3	5	143
3	Abobo - Village 14	8	16	154
4	Abobo - Tegni	27	53	191
5	Abobo - Lumtaak	93	187	325
6	Abobo - Powatalam	97	193	331
7	Abobo - Gambella Hospital	0	0	138
8	Abobo - Tietkodi	27	55	193
9	Abobo - Village 17	9	18	156
10	Abobo - Dumbang	59	24	137
11	Abobo - Chobokier	11	21	159
N°	Health Facility Name of Pukedi catchment area	Time in minutes from Abobo to HF	Time in minutes to return from HF to Pukedi	Total time to Gambella Regional Hospital
12	Abobo - Perbongo Omaha	26	44	208
13	Abobo - Pukedi HP	70	-	208
14	Abobo - Pukedi Health Center	70	-	208
N°	Health Facility Name of Ukuna catchment area	Time in minutes from Abobo to HF	Time in minutes to return from HF to Ukuna	Total time to Gambella Regional Hospital
15	Abobo - Ukuna HP	31	3	129
16	Abobo - Ukuna Health Center	32	-	127
17	Abobo - Aberi	47	15	157
18	Abobo - Tierciru	39	7	141
N°	Health Facility Name of Mender catchment area	Time in minutes from Abobo to HF	Time in minutes to return from HF to Mender	Total time to Gambella Regional Hospital
19	Abobo - Mender 8-9	35	-	89
20	Abobo - Mender Health Center	35	-	89
21	Abobo - Mender 7	38	3	95
22	Abobo - Mender 11-12	43	8	105
23	Abobo - Mender 13	23	12	89

Table 3. List of health facilities in the Woreda of Abobo, their time in minutes to travel to the Health Center of reference and additional time to reach Gambella Regional Hospital.

The BEmONC referral system coverage in Abobo HC catchment area is eight over ten (80%), in Pukedi is two over two (100%), in Ukuna is three over three (100%) and for Mender is four over four (100%).

For the CEmONC cases the picture change dramatically due to the limiting factor of delay caused for transporting patients from the Health Centers, where the patients have been clinically stabilized, to the Hospital in Gambella. Only Mender health center is located to a distance shorter than two hours travel time to Gambella. In this scenario the referral system coverage for the whole Woreda of Abobo decreases to only five facilities over twenty-three (22%).

5.5 Strategies to improve the referral system performance

1) Adapting the official norms defined at central level to the local context

In accordance with the norms defined at central level, the referral system loop starts at the ambulance parking place, from here it goes to the facility where the patient is admitted and after the ambulance travels directly to the Health Center of reference where the BEmONC cases are taken in charge in loco. If the clinical case is a CEmONC the patient is stabilized in loco with an appropriated treatment and than transported to the Hospital.

Introducing new norms: a) presence on board of kit to stabilize the patient and b) midwife or MNCH (Maternal, Newborn and Child Health) staff able to diagnostic cases of CEmONC to allow transportation directly to Gambella

Proceedings of the International Cartographic Association, 4, 2021.
30th International Cartographic Conference (ICC 2021), 14–18 December 2021, Florence, Italy. This contribution underwent single-blind peer review based on submitted abstracts. https://doi.org/10.5194/ica-proc-4-30-2021 | © Author(s) 2021. CC BY 4.0 License.

Hospital from the peripheral health facility in order to avoid the delay caused by travelling to Health center, we can achieve a little increase of coverage and some important spare of time as shown in Table 4 and Table 5 versus Table 1 and Table 2. For Abol Health Center catchment area the facilities covered increase of one unit i.e. Solan, but the travel time decreases consistently for Nyikwo (Table 4).

N°	Health Facility Name of Abol catchment area	Time in minutes from Abol to HF	Time in minutes to return from HF to Abol	Total time travel Abol - HF - Abol - Gambella Hospital	Time from HF to Gambella Hospital avoiding Abol
1	Abol - Abol Ketema	1	2	24	24
2	Abol - Pinykew	12	23	45	36
3	Abol - Opagna	14	28	50	50
4	Abol - Abol Ker	15	30	52	52
5	Abol - Pukong	23	45	67	67
6	Abol - Solan	57	115	137	102
7	Abol - Nyikwo	89	178	200	156
8	Abol - Gambella Hospital			22	22

Table 4. List of health facilities and time needed to transport the CEmONC cases directly from the facility to the Hospital in Gambella, avoiding Abol Health Center.

For the catchment area of Bonga the coverage does not change but also here there is a consistent reduction of travel time for Elichoy/Kermi and Jawi, which is an evident benefit for cases in need of urgent care in specialized setting (Table 5).

N°	Health Facility Name of Bonga catchment area	Time in minutes from Bonga to HF	Time in minutes to return from HF to Bonga	Total time travel Bonga - HF - Bonga - Gambella Hospital	Time from HF to Gambella Hospital avoiding Bonga
1	Bonga - Bonga Ketema	1	2	46	45
2	Bonga - Jawi	21	41	85	64
3	Bonga - Koban	36	72	116	116
4	Bonga - Elichoy/Kermi	31	62	106	75
5	Bonga - Siri	65	131	175	175
6	Bonga - Gambella Hospital			44	44

Table 5. List of health facilities and time needed to transport the CEmONC cases directly from the facility to the Hospital in Gambella, avoiding Bonga Health Center.

N°	Health Facility Name of Abobo catchment area	Time in minutes from Abobo to HF	Time in minutes to return from HF to Abobo	Total time to Gambella Regional Hospital	Time from HF to Gambella Hospital avoiding Abobo
1	Abobo - Wangkaak	1	2	140	138
2	Abobo - Abaru	3	5	143	138
3	Abobo - Village 14	8	16	154	138
4	Abobo - Tegni	27	53	191	191
5	Abobo - Lumtaak	93	187	325	325
6	Abobo - Powatalam	97	193	331	331
7	Abobo - Gambella Hospital	0	0	138	138
8	Abobo - Tietkodi	27	55	193	193
9	Abobo - Village 17	9	18	156	156
10	Abobo - Dumbang	59	24	137	137
11	Abobo - Chobokier	11	21	159	159
N°	Health Facility Name of Pukedi catchment area	Time in minutes from Abobo to HF	Time in minutes to return from HF to Pukedi	Total time to Gambella Regional Hospital	Time from HF to Gambella Hospital avoiding Pukedi
12	Abobo - Perbongo Omaha	26	44	208	164
13	Abobo - Pukedi HP	70	-	208	208
14	Abobo - Pukedi Health Center	70	-	208	208
N°	Health Facility Name of Ukuna catchment area	Time in minutes from Abobo to HF	Time in minutes to return from HF to Ukuna	Total time to Gambella Regional Hospital	Time from HF to Gambella Hospital avoiding Ukuna
15	Abobo - Ukuna HP	31	3	129	126
16	Abobo - Ukuna Health Center	32	-	127	127
17	Abobo - Aberi	47	15	157	142
18	Abobo - Tierciru	39	7	141	134
N°	Health Facility Name of Mender catchment area	Time in minutes from Abobo to HF	Time in minutes to return from HF to Mender	Total time to Gambella Regional Hospital	Time from HF to Gambella Hospital avoiding Mender
19	Abobo - Mender 8-9	35	-	89	89
20	Abobo - Mender Health Center	35	-	89	89
21	Abobo - Mender 7	38	3	95	92
22	Abobo - Mender 11-12	43	8	105	105
23	Abobo - Mender 13	23	12	89	77

Table 6. List of health facilities and time needed to transport the CEmONC cases directly from the Health Posts to the Hospital in Gambella, avoiding Pukedi, Ukuna, Mender and Abobo Health Centers Bonga.

The previuous Table 6 shows the theoretical reduction in travel times when applying the alternative strategy of adapting the official norms for the referral system to the facilities in the Woreda of Abobo. For the Health Posts in the catchment area of Abobo and Ukuna Health Centers the time reduction is very much insignificant due to the geographical bottleneck of the access roads. For the Health Posts depending on Pukedi Health Center there is only Perbongo Omaha, which benefits the reduction of forty-four minutes travel time, the remaining facilities are in the same situation of those depending from Abobo and Ukuna due to the access roads bottleneck.

2) Integrating the referral system by ambulance with maternity waiting homes situated in crucial health centers.

The second scenario forecasts a mix of interventions i.e. integration of obstetric referrals by ambulance with the offer of lodging pregnant women at MWHs (Maternity Waiting Homes) in proximity of Health Centers, destined to host selected pregnant women at risk for complications, well in advance before the foresees date of delivery. Ideally, the best sites to organize MWHs are the Health Centers of Abobo, Bonga and the Gambella Hospital. By doing so, it is possible to overcome the excess of travel time to and from the farthest health facilities: Powtalam, Dumbang and Lumtaak for Abobo; Siri and Koban for Bonga; Solan and Nyikwo for Abol. The following tables Table 7, Table 8 and Table 9 show the effects of implementing such a scenario. The mix - ambulance referral system plus MWH- in Gambella Hospital can assure full coverage for all health facilities under competence of Abol Health Center (Table 7).

N°	Health Facility Name of Abol catchment area	Time in munutes to travel one way from Abol to HF	Time in munutes to return travel from HF to Abol	Time to Gambella Regional Hospital
1	Abol - Abol Ketema	1	2	24
2	Abol - Pinykew	12	23	45
3	Abol - Opagna	14	28	50
4	Abol - Abol Ker	15	30	52
5	Abol - Pukong	23	45	67
Pregnant women in need for BEmONC or CEmONC are already admitted at the Mother Wayting Home				
6	Gambella Hospital (Solan)	-	-	0
7	Gambella Hospital (Nyikwo)	-	-	0

Table 7. The table shows travel times to Gambella Hospital when pregnant women at risk for BEmONC or CEmONC from Solan and Nyikwo Health Posts are admitted well in advance at the Gambella Hospital Mother Waiting Home.

The mix -ambulance referral system plus MWH- in Bonga Health Center can assure too a complete coverage for all health facilities under competence of the Health Center (Table 8).

N°	Health Facility Name of Bonga catchment area	Time in minutes from Bongal to HF	Time in minutes to return from HF to Bonga	Total time travel Bong - HF - Bonga Gambella Hospital
1	Bonga - Bonga Ketema	1	2	46
2	Bonga - Jawi	21	41	85
3	Bonga - Elichoy/Kermi	31	62	106
Pregnant women in need for BEmONC or CEmONC are already admitted at the Mother Wayting Home				
4	Bonga - (Siri) - Gambella Hospital	-	-	44
5	Bonga - (Koban) - Gambella Hospital	-	-	44

Table 8. The table shows travel times to Gambella Hospital when pregnant women at risk for BEmONC or CEmONC from Solan and Nyikwo Health Posts are admitted well in advance at the Gambella Hospital Mother Waiting Home.

Proceedings of the International Cartographic Association, 4, 2021.
30th International Cartographic Conference (ICC 2021), 14–18 December 2021, Florence, Italy. This contribution underwent single-blind peer review based on submitted abstracts. https://doi.org/10.5194/ica-proc-4-30-2021 | © Author(s) 2021. CC BY 4.0 License.

The mix ambulance referral system plus MWH in Abobo Health Center does not assure the full coverage of the Woreda, neither for the BEmONC nor for the CEmONC cases. See Table 9. However, for some health facilities i.e. Tegni, Lumtaak, Powtalam, Tietkodi, Dumbang and Chobokier, the decrease of travel time from Abobo to Gambella Hospital is on average one hundred minutes. The same occurs for the facilities referring to Pukedi Health Center: i.e. Pukedi Health Post and Perbongo Omaha, the decrease in travel time is on average seventy minutes. For the facilities referring to Ukuna Health Center there is only one Health Post with a reduced travel time (nineteen minutes) to Gambella Hospital i.e. Aberi. The case of Mender Health Center is even counterproductive with increased travel times of forty-five minutes on average.

N°	Health Facility Name of Abobo catchment area	Time in munutes to travel from Abobo to HF	Time in munutes to return from HF to Abobo	Total time to Gambella Hospital	Time from MWH in Abobo to Gambella Hospital
1	Abobo - Wangkaak	1	2	140	138
2	Abobo - Abaru	3	5	143	138
3	Abobo - Village 14	8	16	154	138
4	Abobo - Tegni	27	53	191	138
5	Abobo - Lumtaak	93	187	325	138
6	Abobo - Powatalam	97	193	331	138
7	Abobo - Gambella Hospital	0	0	138	138
8	Abobo - Tietkodi	27	55	193	138
9	Abobo - Village 17	9	18	156	138
10	Abobo - Dumbang	59	117	230	138
11	Abobo - Chobokier	11	21	159	138
N°	Health Facility Name of Pukedi catchment area	Time in munutes to travel from Abobo to HF	Time in munutes to travel from HF to Pukedi HC	Time to Gambella Regional Hospital	Time from MWH in Abobo to Gambella Hospital
12	Abobo - Perbongo Omaha	26	44	208	138
13	Abobo - Pukedi HP	70	-	208	138
14	Abobo - Pukedi Health Center	70	-	208	138
N°	Health Facility Name of Ukuna catchment area	Time in munutes to travel from Abobo to HF	Time in munutes to travel from HF to Ukuna HC	Time to Gambella Regional Hospital	Time from MWH in Abobo to Gambella Hospital
15	Abobo - Ukuna HP	31	3	129	138
16	Abobo - Ukuna Health Center	32	-	127	138
17	Abobo - Aberi	47	15	157	138
18	Abobo - Tierciru	39	7	141	138
N°	Health Facility Name of Mender catchment area	Time in munutes to travel from Abobo to HF	Time in munutes to travel from HF to Mender HC	Time to Gambella Regional Hospital	Time from MWH in Abobo to Gambella Hospital
19	Abobo - Mender 8-9	35	-	89	138
20	Abobo - Mender Health Center	35	-	89	138
21	Abobo - Mender 7	38	3	95	138
22	Abobo - Mender 11-12	43	8	105	138
23	Abobo - Mender 13	23	12	89	138

Table 9. The table shows travel times to Gambella Hospital when pregnant women at risk for BEmONC or CEmONC are admitted well in advance at Abobo Health Center Mother Waiting Home.

6. Discussion and conclusion

There are no blue prints or magic bullets, which may solve the problem of delayed emergency referrals. Anyway, we might expand the coverage and reduce the gaps assuring a more equitable and performing service by adopting the mix of interventions proposed, by coupling the traditional referral with ambulance and lodging pregnant women in dedicated structures, situated in crucial settings, well in advance before the foreseen date of delivery. Of course this may have additonal costs to bear by mothers and by the referral system, but this have to be compared with the advantage in term of possible morbidity and mortality saved. Considering the resident population in the study, according to the WHO (WHO 1985), the expected pregnancies and the estimate of emergencies which may occur during pregnancies, are in the range between 5% and 15% i.e. in our case of the order of 300. Th benefit for the Health System performance become even more evident if we consider all the other medical and surgical additional referrals that a better-organized scheme can make. Finally we stress that the main contribution of this paper is not a mere pioneering utilization of GPS or GIS and satellite images utilization in public health, as the scientific literature on the issue is very much established. The importance of this study is more linked to the fact that in Gambella Region such a kind of planning in public services, based on scientific evidence, has never been carried out. In other words this study is a preliminary work whose results could be useful for re-shaping a more efficient ambulance referral system.

Acknowledgement

We thanks for the collaboration in field works and about data elaboration: M.Amaddii (satellite image processing), C. Biffi (CUAMM Country Manager), A. Tsegaye (CUAMM Head of Program), M. Perrella (CUAMM, Administrator), A. W. Yohanis (CUAMM, Project Assistant), Ajulo Ogula (CUAMM, Midwife), Mr. Bureau Omod and Mr. Addisu Alemu (CUAMM, Public Health Nurses), Wondemagegn F. and Alemayehu A. (CUAMM, Drivers) and for the Support provided in the field by the Zonal Health Departments, Woreda Health office representatives and Head of Primary Hospitals, Health centres and the Health extension workers in each of the Health Posts. Moreover, we would like to extend our gratitude to Gambella Region Catholic Church as they have been supporting the mission in difficult areas through the provision of accommodation and transport by car and boat.

7. References

ArcGIS Network Analyst™, (https://desktop.arcgis.com/en/arcmap/latest/extensions/main/about-arcgis-for-desktop-extensions.htm)

CUAMM, MAP ATLAS, Support To Maternal and Newborn Community Health Services, Provided by First Level Health Cenres, in Gambella Region, Padua (Italy), 240 pages, 2020.

Federal Democratic Republic of Ethiopia Ministry of Health Health Sector Development Program IV2010/11 – 2014/15, FINAL DRAFT, 2010

Fogliati P, Straneo M, Brogi C, Fantozzi PL, Salim RM, Msengi HM, et al. (2015) How CanChildbirth Care for the Rural Poor Be Improved? AContribution from Spatial Modelling in Rural Tanzania. PLoS ONE 10(9): e0139460. doi:10.1371/journal.pone.0139460

Mc Lafferty SL (2003). GIS and health care: Annual review Public Health, 2003

Mc Kinnon B., Harper S., Kaufman JS, Abddullah M. (2004). Distance to emergency obstretic services and eary neonatal mortality in Ethiopia: Trop Med Int. Health, 2014

More equity and quality of health services in Gambella region, Ethiopia (http://openaid.aics.gov.it/en/iati-activity/XM-DAC-6-4-010923-01-0)

Summary Pledge Progress Report Ethiopia, Version UNHCR, 2019/02.

World Health Oganization, UNFPA, UNICEF, AMDD. Monitoring emergency obstetric careç a handbook, Geneve, WHO, 2009

Proceedings of the International Cartographic Association, 4, 2021.
30th International Cartographic Conference (ICC 2021), 14–18 December 2021, Florence, Italy. This contribution underwent single-blind peer review based on submitted abstracts. https://doi.org/10.5194/ica-proc-4-30-2021 | © Author(s) 2021. CC BY 4.0 License.

Critically ill COVID-19 patients in Africa: it is time for quality registry data

PAPER

Authors
Pisani L., Waweru-Siika W., Sendagire C., Beane B., Haniffa R.

Published in
Lancet,
August 2021

Link
https://doi.org/10.1016/S0140-6736(21)01549-X

Topic
Universal coverage and equity

Focus country
Multi-countries

Correspondence

The fragility of abortion access in Europe: a public health crisis in the making

Poland is rightly being criticised for suppressing abortion services.[1] Since January, 2021, abortion is only legal if the pregnancy is directly life-threatening or the result of rape or incest. However, countries with allegedly more progressive policies have reasons to be self-critical as well.

An example is Germany, considered a liberal country in terms of abortion law from an international perspective, since women can be granted an abortion on request for any reason, including socioeconomic reasons. Yet, abortion in Germany is technically a crime (albeit not punished up to 12 weeks from conception), and gynaecologists are losing court cases for stating on their websites that they provide abortion care in a supportive environment.[2] Attacks on abortion rights and services are nourished by vocal conservative and religious forces whose agendas find support in a non-negligible share of the population.

The number of doctors providing abortion services is declining,[3] teaching of abortion techniques in medical schools is marginal,[4] and a mandatory consultation before an abortion (in some regions done by religious organisations) and a so-called cooling-off period add barriers to access.[5] As a result, some women from Germany (and other European countries) are seeking care in the Netherlands, as highlighted by the Europe Abortion Access Project.

Women on Web, a non-governmental organisation, has recently recorded an increased demand for abortion pills in Germany.[6] The COVID-19 pandemic has created further access challenges, in the form of reduced opening hours of clinics, fewer social infrastructures, and rise in domestic violence. Contrary to some other countries (eg, the UK and France),[7] demands from reproductive health activists to modify medical abortion delivery (eg, through telecare or drug mailing) have remained unheard in Germany.

Yet Germany is still seen as a safe haven for Polish women who are living in fear under one of the strictest abortion laws in Europe. Poland and Germany are only two examples of how fragile abortion access remains in Europe (in both constrained and more liberal societies) paving the way for a public health crisis. Denied or reduced access to abortion services has short-term and long-term health consequences, and disproportionately affects the most vulnerable groups in societies. Initiatives led by civil society (eg, Doctors for Choice, Women on Web) and crossborder care alone cannot compensate for the scarcity of governmental impetus, and cannot mitigate the threats to abortion rights coming from growing right-wing and anti-feminist movements in Europe. As a matter of health equity, abortion access needs to be sustainably guaranteed in practice, including beyond the allegedly permissive legislations.

CM reports funding from Bielefeld University, Germany, for a postdoctoral researcher position. OR declares no competing interests. The funders had no role in the writing of or decision to submit this Correspondence.

*Céline Miani, Oliver Razum
celine.miani@uni-bielefeld.de

School of Public Health, Department of Epidemiology and International Public Health, Bielefeld University, Bielefeld 33615, Germany

1 The Lancet Regional Health – Europe. Anti-abortion laws—the antithesis of the fundamental rights of women. *Lancet Regional Health Europe* 2021; **3:** 100111.
2 Deutsches Ärzteblatt. OLG Frankfurt bestätigt §219a-Urteil gegen Hänel, Verfassungsbeschwerde angekündigt. Jan 19, 2021. https://www.aerzteblatt.de/nachrichten/120309/OLG-Frankfurt-bestaetigt-219a-Urteil-gegen-Haenel-Verfassungsbeschwerde-angekuendigt (accessed July 28, 2021).
3 Zeit Online. Weniger Ärzte nehmen Schwangerschaftsabbrüche vor. Aug 28, 2018. https://www.zeit.de/gesellschaft/zeitgeschehen/2018-08/schwangerschaftsabbrueche-statistisches-bundesamt-arztpraxen-kliniken (accessed July 28, 2021).
4 Gamillscheg M. Moderne Medizin. Dec 13, 2018. https://www.zeit.de/campus/2019/01/medizinstudium-schwangerschaftsabbruch-papaya-werbeverbot-universitaet-bildung (accessed July 28, 2021).
5 Bundeszentrale für gesundheitliche Aufklärung. Der Beratungsschein. March 20, 2020. https://www.familienplanung.de/schwangerschaftskonflikt/schwangerschaftsabbruch/der-beratungsschein/ (accessed July 28, 2021).
6 Killinger K, Günther S, Gomperts R, Atay H, Endler M. Why women choose abortion through telemedicine outside the formal health sector in Germany: a mixed-methods study. *BMJ Sex Reprod Health* 2020; published online Nov 23. https://doi.org/10.1136/bmjsrh-2020-200789.
7 Moreau C, Shankar M, Glasier A, Cameron S, Gemzell-Danielsson K. Abortion regulation in Europe in the era of COVID-19: a spectrum of policy responses. *BMJ Sex Reprod Health* 2020; published online Oct 22. https://doi.org/10.1136/bmjsrh-2020-200724.

For more on the **World's Abortion Laws** see https://maps.reproductiverights.org/worldabortionlaws

Critically ill COVID-19 patients in Africa: it is time for quality registry data

Amanuel Sileshi/Getty Images

The African COVID-19 Critical Care Outcomes Study (ACCCOS) Investigators are to be commended for providing the first multinational study reporting epidemiological, management, and outcome data of critically ill COVID-19 patients in Africa.[1] However, this important effort lags behind other international cohorts in timing and included less than half of the countries expected by the study investigators.[1,2]

During this period of accelerated COVID-19 research in low-income and middle-income countries (LMICs),[3] it is important to understand barriers to data acquisition, often attributed to research infrastructure limitations.

Critical care registries provide real-time, low-cost epidemiological, management, and outcome data. Although registry output has historically been low in the hierarchy of evidence,[4] methodological improvements, international harmonisation efforts, and widespread implementation in LMICs are underway, providing

For more on the **Europe Abortion Access Project** see https://europeabortionaccessproject.org/

Submissions should be made via our electronic submission system at http://ees.elsevier.com/thelancet/

Correspondence

robust data for pandemic preparedness, reporting, and response.

Crit Care Africa, funded by UK Research and Innovation, and a sibling of the ten-country Wellcome-funded Asia network,[5] is one such initiative that has built a federated network of high-quality registries of intensive care units across the continent. The network uses a setting-adapted data platform and a Common Data Model, enabling local research priorities and seamless data sharing with the WHO–International Severe Acute Respiratory and Emerging Infection Consortium pandemic protocol (appendix). Informed by this model, a similar network has been implemented across nine African countries: Kenya, Uganda, South Africa, Namibia, Mozambique, Ethiopia, Ghana, Sierra Leone, and Cameroon.

See Online for appendix

Functionality, rather than limitation of resources, was raised by the ACCCOS findings. Critical care registries in LMICs have the potential to provide quality data in resource-limited environments, overcoming some of the limitations faced by the ACCCOS.

AB and RH received research support from the Wellcome Trust and UK Research and Innovation. RH is first trustee for the UK charity Network for Improving Critical Care Systems and Training and received travel support from the American Thoracic Society as congress faculty. LP, CS, and WW-S received a part time salary from UK Research and Innovation Medical Research Council grant, which funded the African Critical Care registry. The African Critical Care registry network is funded by a UK Research and Innovation Medical Research Council grant (MR/V030884/1).

*Luigi Pisani, Wangari Waweru-Siika, Cornelius Sendagire, Abi Beane, Rashan Haniffa
luigipisani@gmail.com

Critical Care Asia Africa Network, Mahidol Oxford Tropical Research Unit, Bangkok 10400, Thailand (LP, AB, RH); Doctors with Africa CUAMM, Padova, Italy (LP); Department of Anaesthesia, Aga Khan University, Nairobi, Kenya (WWS); Department of Anaesthesia and Critical Care, Makerere University College of Health Sciences, Kampala, Uganda (CS)

For more on the **ACCCOS risk stratification calculator** see https://www.asos.org.za/index.php

1 The African COVID-19 Critical Care Outcomes Study (ACCCOS) Investigators. Patient care and clinical outcomes for patients with COVID-19 infection admitted to African high-care or intensive care units (ACCCOS): a multicentre, prospective, observational cohort study. *Lancet* 2021; **397:** 1885–94.

2 Armstrong RA, Kane AD, Cook TM. Outcomes from intensive care in patients with COVID-19: a systematic review and meta-analysis of observational studies. *Anaesthesia* 2020; **75:** 1340–49.

3 GloPID-R, UKCDR, COVID-19 Clinical Research Coalition Cross-Working Group on COVID-19 Research in LMICs. Priorities for COVID-19 research response and preparedness in low-resource settings. *Lancet* 2021; **397:** 1866–68.

4 Frieden TR. Evidence for health decision making—beyond randomized, controlled trials. *N Engl J Med* 2017; **377:** 465–75.

5 CRIT CARE ASIA. Establishing a critical care network in Asia to improve care for critically ill patients in low- and middle-income countries. *Crit Care* 2020; **24:** 608.

Authors' reply

Luigi Pisani and colleagues highlight the potential and needed role of critical care registries in the COVID-19 pandemic response in low-income and middle-income countries (LMICs). Registry data are a powerful tool when operationalised at scale.[1] However, despite funded collaborative efforts, the existing registries in LMICs alone have been insufficient in providing an adequate pandemic response, lamented as recently as May, 2021.[2] In contrast, the African Perioperative Research Group (APORG), an unfunded network, pivoted to respond to the pandemic in Africa. By April, 2020, the African COVID-19 Critical Care Outcomes Study (ACCCOS) was established, and through funding of the Critical Care Society of southern Africa, the data management of the study was supported. Simple pragmatic research with a clear question and few datapoints generated data documenting outcomes with explanatory variables. These data can now be used for risk stratification during the third wave[3] with the ACCCOS risk stratification calculator available on the APORG website. Early ACCCOS findings were available in October, 2020,[4] and these findings were the largest peer reviewed cohort of COVID-19 outcomes from LMICs at the time of the meta-analysis, exceeding the published data from all other LMICs.[3]

ACCCOS acknowledged and highlighted various challenges facing critical care research in Africa.[3] The true burden of disease is often poorly measured, as shown by the 3027 (44·7%) patients referred for critical care support but not admitted in ACCCOS.[3] A single data source cannot determine the relative importance of functionality or resource limitation on the mortality reported in ACCCOS. This is partly because the true denominator is not easily gauged during a pandemic when the normal baselines are disrupted, because the availability and definitions of a critical care bed change due to demand. Pragmatic research is agile to respond to some of these challenges, which might be more difficult for a registry response, especially where registry penetration is poor.

Going forward, initiatives such as the Critical Care Africa network provide a well thought out technological platform for centres in Africa to collect data relevant to their critical care practice to inform clinical research and quality improvement. Data harmonising efforts will allow more informed study of results within their context. Collaboration between networks is necessary to leverage the differing strengths of these networks, to provide a rapid, comprehensive understanding of drivers of outcomes, especially during a pandemic.

We declare no competing interests.

*Bruce M Biccard, David Thomson, Malcolm Miller, Elliott H Taylor, P Dean Gopalan
bruce.biccard@uct.ac.za

Department of Anaesthesia and Perioperative Medicine (BMB) and Division of Critical Care (DT, MM), Groote Schuur Hospital, Faculty of Health Sciences, and Global Surgery Division, Department of Surgery (EHT), University of Cape Town, Cape Town 7925, South Africa; Oxford University Global Surgery Group, Nuffield Department of Surgical Sciences, University of Oxford, Oxford, UK (EHT); Discipline of Anaesthesiology and Critical Care, School of Clinical Medicine, University of KwaZulu Natal, Durban, South Africa (PDG)

1 Ranzani OT, Bastos LSL, Gelli JGM, et al. Characterisation of the first 250 000 hospital admissions for COVID-19 in Brazil: a retrospective analysis of nationwide data. *Lancet Respir Med* 2021; **9:** 407–18.

2 GloPID-R, UKCDR, COVID-19 Clinical Research Coalition Cross-Working Group on COVID-19 Research in LMICs. Priorities for COVID-19 research response and preparedness in low-resource settings. *Lancet* 2021; **397:** 1866–68.

Performance evaluation of a multinational data platform for critical care in Asia. Collaboration for Research, Implementation and Training in Critical Care - Asia Investigators

PAPER

Authors
Pisani L., , Rashan T., Shamal M., Ghose A., Kumar Tirupakuzhi Vijayaraghavan B., Tripathy S., Aryal D., Hashmi M., Nor B., Minh Y.L., Dondorp A. M., Haniffa R., Beane A.

Published in
Wellcome Open Research Journal, October 2021

Link
https://doi.org/10.12688/wellcomeopenres.17122.1

Topic
Universal coverage and equity

Focus country
Multi-countries

Wellcome Open Research

Wellcome Open Research 2021, 6:251 Last updated: 23 MAR 2022

Check for updates

RESEARCH ARTICLE

Performance evaluation of a multinational data platform for critical care in Asia [version 1; peer review: 2 approved]

Collaboration for Research, Implementation and Training in Critical Care - Asia Investigators,
Luigi Pisani[1,2], Thalha Rashan[1], Maryam Shamal[3], Aniruddha Ghose[4], Bharath Kumar Tirupakuzhi Vijayaraghavan[5-7], Swagata Tripathy[8], Diptesh Aryal[9], Madiha Hashmi[10], Basri Nor[11], Yen Lam Minh[12], Arjen M. Dondorp[1], Rashan Haniffa[1], Abi Beane[1]

[1]Mahidol Oxford Tropical Research Unit, Bangkok, Thailand
[2]Doctors with Africa CUAMM, Padova, Italy
[3]NICS-MORU collaboration, Crit Care Asia Afghanistan team, Kabul, Afghanistan
[4]Department of Medicine, Chattogram Medical Centre, Chattogram, Bangladesh
[5]Indian Registry of IntenSive care, IRIS, Chennai, India
[6]Chennai Critical Care Consultants, Chennai, India
[7]Critical Care Medicine,, Apollo Hospitals, Chennai, India
[8]Anaesthesia and Intensive Care Medicine, All India Institute of Medical Sciences, Bhubaneswar, India
[9]Critical Care and Anesthesia, Nepal Mediciti Hospital, Lalitpur, Nepal
[10]Department of Critical Care, Ziauddin University, Karachi, Pakistan
[11]Department of Anaesthesiology and Intensive Care, Kulliyyah (School) of Medicine,, International Islamic University Malaysia (IIUM), Kuala Lumpur, Malaysia
[12]Oxford University Clinical Research Unit, Ho Chi Minh City, Vietnam

v1 **First published:** 01 Oct 2021, **6**:251
https://doi.org/10.12688/wellcomeopenres.17122.1
Latest published: 01 Oct 2021, **6**:251
https://doi.org/10.12688/wellcomeopenres.17122.1

Abstract

Background: The value of medical registries strongly depends on the quality of the data collected. This must be objectively measured before large clinical databases can be promoted for observational research, quality improvement, and clinical trials. We aimed to evaluate the quality of a multinational intensive care unit (ICU) network of registries of critically ill patients established in seven Asian low- and middle-income countries (LMICs).
Methods: The Critical Care Asia federated registry platform enables ICUs to collect clinical, outcome and process data for aggregate and unit-level analysis. The evaluation used the standardised criteria of the Directory of Clinical Databases (DoCDat) and a framework for data quality assurance in medical registries. Six reviewers assessed structure, coverage, reliability and validity of the ICU registry data. Case mix and process measures on patient episodes from June to December 2020 were analysed.
Results: Data on 20,507 consecutive patient episodes from 97 ICUs in

Open Peer Review

Approval Status ✓ ✓

	1	2
version 1 01 Oct 2021	✓ view	✓ view

1. **Paul Young**, Medical Research Institute of New Zealand, Wellington, New Zealand

2. **Stefano Finazzi**, Mario Negri Institute of Pharmacological Research IRCCS, Ranica, Italy

Any reports and responses or comments on the article can be found at the end of the article.

Afghanistan, Bangladesh, India, Malaysia, Nepal, Pakistan and Vietnam were included. The quality level achieved according to the ten prespecified DoCDat criteria was high (average score 3.4 out of 4) as was the structural and organizational performance -- comparable to ICU registries in high-income countries. Identified strengths were types of variables included, reliability of coding, data completeness and validation. Potential improvements included extension of national coverage, optimization of recruitment completeness validation in all centers and the use of interobserver reliability checks.
Conclusions: The Critical Care Asia platform evaluates well using standardised frameworks for data quality and equally to registries in resource-rich settings.

Keywords
case mix; critical care; high-quality clinical database; intensive care units; low and middle income country; ICU; registry; Asia.

This article is included in the Mahidol Oxford Tropical Medicine Research Unit (MORU) gateway.

Corresponding author: Luigi Pisani (luigipisani@gmail.com)

Author roles: Pisani L: Conceptualization, Data Curation, Methodology, Supervision, Writing – Original Draft Preparation, Writing – Review & Editing; **Rashan T**: Data Curation, Formal Analysis, Writing – Original Draft Preparation; **Shamal M**: Investigation, Writing – Original Draft Preparation; **Ghose A**: Investigation, Supervision, Writing – Review & Editing; **Kumar Tirupakuzhi Vijayaraghavan B**: Investigation, Supervision, Writing – Original Draft Preparation, Writing – Review & Editing; **Tripathy S**: Investigation, Writing – Review & Editing; **Aryal D**: Investigation, Writing – Original Draft Preparation, Writing – Review & Editing; **Hashmi M**: Investigation, Writing – Review & Editing; **Nor B**: Investigation, Writing – Review & Editing; **Lam Minh Y**: Investigation, Writing – Review & Editing; **Dondorp AM**: Funding Acquisition, Methodology, Supervision, Writing – Review & Editing; **Haniffa R**: Conceptualization, Funding Acquisition, Methodology, Project Administration, Supervision, Writing – Review & Editing; **Beane A**: Conceptualization, Data Curation, Funding Acquisition, Investigation, Project Administration, Supervision, Writing – Original Draft Preparation, Writing – Review & Editing

Competing interests: No competing interests were disclosed.

Grant information: This work was undertaken as part of the existing Wellcome Innovations Flagship award, Collaboration for Research, Improvement and Training in Critical CARE in ASIA [215522]. The funder had no role in the decision to publish or in the preparation of this manuscript.
The funders had no role in study design, data collection and analysis, decision to publish, or preparation of the manuscript.

Copyright: © 2021 Collaboration for Research, Implementation and Training in Critical Care - Asia Investigators *et al*. This is an open access article distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

How to cite this article: Collaboration for Research, Implementation and Training in Critical Care - Asia Investigators, Pisani L, Rashan T *et al.* **Performance evaluation of a multinational data platform for critical care in Asia [version 1; peer review: 2 approved]** Wellcome Open Research 2021, **6**:251 https://doi.org/10.12688/wellcomeopenres.17122.1

First published: 01 Oct 2021, **6**:251 https://doi.org/10.12688/wellcomeopenres.17122.1

Wellcome Open Research 2021, 6:251 Last updated: 23 MAR 2022

Introduction

The availability of high quality data systems to inform delivery, evaluation and improvement of health care is recognised as a central tenet of high quality health systems[1]. In critical care, where patient populations are heterogeneous, treatments complex and where the sequelae of care requires considerable human and financial resource, intensive care unit (ICU) registries have been instrumental in providing a mechanism for continuous, sustainable, wide scale data collection to enable service evaluation and facilitate national benchmarking of care quality. Until recently, these registries have been concentrated in high income countries, with the notable exceptions of networks in Brazil[2] and Sri Lanka[3]. Absence of these systems in resource constrained countries severely hamper efforts to build accountability for healthcare quality.

The need to invest in systems which provide data to drive research and improvement has been highlighted by recent recommendations as part of a series of strategies to address the imbalance in quality of care that exists internationally[1]. Recent growth in global internet connectivity and mobile technology has given opportunity for the digital health information system to be implemented and scaled in low and middle-income countries (LMICs).

The global coronavirus disease 2019 (COVID-19) pandemic has accelerated the role of registries in driving global research. For example, registries in Brazil, Australia, Europe, and in Asia have been instrumental as part of collaborations for pre-COVID-19 large scale multicentre studies[4,5], observational research on COVID-19[6] and more recently interventional research, as exemplified by the randomized, embedded, multi factorial adaptive platform for community acquired pneumonia (REMAP-CAP) operational through registries in the USA and in South Asia[6].

Whilst registries are increasingly being promoted for their role in enabling greater accountability of healthcare quality, and for their ability to facilitate multi centre clinical trials, the quality of data such systems provide requires rigorous evaluation[7,8]. To date, evaluation of existing vertical programme assessments for digital clinical and research registries, and for the World Health Organisation (WHO) endorsed district health information system platform[9], have focused predominantly on the ongoing challenges of missingness and inaccuracies in reporting[10]. Few evaluations have extended to assess the timeliness, consistency, interoperability and accessibility of the data for external comparison[11,12], despite these dimensions of data quality being essential for clinical research[13].

This study evaluates a network of seven federated registries operational in Asia which together use a single cloud-based platform as part of a collaboration for implementation and research in critical care. Critical Care Asia (CCA) is a collaborative programme of critical care research, training and quality improvement in Asia[14]. The CCA currently connects 97 ICUs in seven countries to provide diverse high-quality data to generate evidence and feedback in near real time for service improvement and research, akin to the foundations of a learning health system[15]. We sought to systematically evaluate the performance of CCA registries in Afghanistan, Bangladesh, India, Malaysia, Nepal, Pakistan and Vietnam using two pre published quality assurance frameworks[16,17]. We hypothesized that the quality of data arising from this federated network of registries would be high and comparable to the quality arising from ICU registries in high-resource settings.

Methods

Ethical considerations

This performance evaluation was classified as an audit and exempted from ethical review by the Oxford Tropical Research Ethics Committee (OxTREC) on June 16th, 2020. The evaluation was conducted on registry data collected between June and December 2020.

Frameworks for assessment of performance

The Directory of Clinical Databases (DoCDat) framework was established to inform researchers and clinicians on currently functioning clinical databases and to provide an independent assessment of their scope and quality[16]. Several high quality national registries in Australia, New Zealand and in the United Kingdom have used this same framework to evaluate data quality previously[11,12]. The framework (Table 1) consists of 10 items; four relating to registry coverage and six relating to reliability and validity of the data. Each item is rated on a scale of 1 to 4, with level 1 representing the least rigorous methods and Level 4 representing the most rigorous. The instrument was shown to have good face and content validity and to have no floor or ceiling effects[16]. A further framework to objectively assess registry quality especially in the development and implementation phase was published in 2002 and is also used in this evaluation (Table 2)[17]. This framework is divided into three main categories, and each category was applied to the central coordinating center and to the local sites. In case of disagreement between reviewers, final scoring was reached by consensus.

Performance review

Features and functions of the platform pertaining to data capture, quality and management were described and made available to a total of six reviewers. To maximize insight into the registry network while minimize potential sources of bias, a variety of scorers were identified. Three reviewers were independent reviewers with established track records in high quality critical care registry implementation and research in both high-income settings and LMICs. Three scorers were members of the CCA coordinating team (LP, TR, AB). Independent reviewers had full access to documentation, reports, training material and platform code, pertinent to the quality assurance features of the registry. Scores of individual reviewers were averaged to derive the aggregated score. Census data was summarized as median and interquartile range, with summary tables for individual registry completeness performed using software Python (version 3.7)[18].

All encounters of care reported through the seven registries during a prespecified period of six months (**June-December**

Table 1. Directory of Clinical Databases (DoCDat) scoring criteria.

Domain	Level 1	Level 2	Level 3	Level 4
A. Extent to which the eligible population is representative of the country	No evidence or unlikely to be representative	Some evidence eligible population is representative	Good evidence eligible population is representative	Total population of country included
B. Completeness of recruitment of eligible population. State when and how completeness was determined	Few (<80%) or unknown	Some (80–89%)	Most (90–97%)	All or almost all (>97%)
C. Variables included in the database	• identifier • admin info • condition or intervention	• identifier • admin info • condition **or** intervention • short term **or** long term outcome	• identifier • admin info • condition • intervention • short term **or** long term outcome • major known confounders	• identifier • admin info • condition • intervention • short term outcome • major known confounders • long term outcome
D. Completeness of data (percentage variables at least 95% complete). State when completeness was last determined:	Few (<50%) or unknown	Some (50–79%)	Most (80–97%)	All or almost all (>97%)
E. Form in which continuous data (excluding dates) are collected (percentage collected as raw data)	Few (<70%) or unknown	Some (70–89%)	Most (90–97%)	All or almost all (>97%) or no continuous data collected
F. Use of explicit definitions for variables	None	Some (<50%)	Most (50–97%)	All or almost all (>97%)
G. Use of explicit rules for deciding how variables are recorded*	None	Some (<50%)	Most (50–97%)	All or almost all (>97%)
H. Reliability of coding of conditions and interventions. State when and how it was most recently tested:	Not tested	Poor	Fair	Good
I. Independence of observations of primary outcome	Outcome not included or independence unknown	Observer neither independent nor blinded to intervention	Independent observer not blinded to intervention	Independent observer blinded to intervention or not necessary as objective outcome (e.g. death or lab test)
J. Extent to which data are validated. State when and how it was last determined:	No validation	Range or consistency checks	Range and consistency checks	Range and consistency checks plus external validation using alternative source

2020) were included. The selection of this time period enabled evaluation of established collaborating registries (Indian Registry of IntenSive care [IRIS][19], Pakistan registry of intensive care [PRICE][20] and Nepal Intensive Care Registry Foundation [NICRF])[6], and the inclusion of newly implemented registries (Afghanistan, Bangladesh, Malaysia and Vietnam). Basic information on these registries is detailed in Table 3.

Registry structure overview

Registry structure for established registries in India, Pakistan and Nepal was already published[15,19,21]. In brief, the CCA platform has a modular structure, where a core dataset of 33 variables captured within the first 24 hours of admission to ICU and 5 variables at discharge, provides episodic information to enable evaluation of case mix, acuity, organ support and outcomes[19,22].

Wellcome Open Research 2021, 6:251 Last updated: 23 MAR 2022

Table 2. Framework of procedures for the assurance of data quality in medical registries according to Arts *et al*. (2002).

CENTRAL COORDINATING CENTER	Score y/n	LOCAL SITES	Score y/n
Prevention during set up and organization of registry			
At the onset of registry		*At the onset of participating in the registry*	
Compose minimum set of necessary data items	yes	Assign a contact person	yes
Define data and data characteristics in data dictionary	yes	Check developed software for data entry and for extraction	yes
Draft a data collection protocol	yes	Check reliability and completion of extraction sources	yes
Define pitfalls in data collection	yes	Standardize correction of data items	yes
Compose data checks	yes	*Continuously*	
Create user-friendly case record forms	yes	Train (new) data collectors	yes
Create quality assurance plan	yes	Motivate data collectors	yes
In case of new participating sites	yes	Make data definitions available	yes
Perform site visit	yes	Place data and initials on completed forms	yes
Train new participants	yes	Keep completed case record forms	yes
Continuously		Data collection close to the source and as soon as possible	yes
Motivate participants	yes	Use the registry data for local purposes	yes
Communicate with local sites	yes	*In case of changes*	
In case of changes (e.g. in data set)		Adjust forms, software, data dictionary, protocol, etc.	yes
Adjust forms, software, data dictionary, protocol, training material, etc.	yes	Communicate with data collectors	yes
Communicate with local sites	yes		
Detection during data collection		*Continuously*	
During import of data into central database		Visually inspect completed forms	yes
Perform automatic data checks	yes	Perform automatic data checks	yes
Periodically and in case of new participants		Check completeness of registration	yes
Perform site visits for data quality audit (registry data-source data) and review local data collection procedures	yes		
Periodically			
Check interobserver and intraobserver variability	no		
Perform analyses of the data	yes		
Actions for quality improvement		*After receiving quality reports*	
After data import and data checks		Check detected errors	yes
Provide local sites with data quality reports	yes	Correct inaccurate data and fill in incomplete data	yes*
Control local correction of data errors	yes	Resolve causes of data errors	yes
After data audit or variability test		After receiving feedback	yes
Give feedback of results and recommendations	yes	Implement recommended changes	yes
Resolve causes of data error	yes	Communicate with personnel	yes

*Procedure may vary between individual registries

Table 3. Characteristics of clinical registries involved in the Critical Care Asia (CCA) network.

	All registries	Afghanistan[#]	Bangladesh	India	Malaysia	Nepal	Pakistan	Vietnam
Patient episodes	**20,507**	553	392	4,675	465	2,951	10,972	1,237
Number of ICUs	**97**	6	2	18	3	8	55	5
Number of beds	**1169**	60	20	213	26	138	557	155
Type of ICUs								
Mixed ICU	**33**	5		13	2	6	7	5
MICU	**19**	1	1	1	1	1	12	
SICU	**20**						19	
CT ICU	**1**						1	
SARI ICU	**15**			1		1	13	
HDU	**2**		1				1	
Other	**7**			3			2	
Completeness of recruitment %	**100**	NA	100	95	100	100	100	100
Units assessing completeness, %	**77**	0	100	48	100	100	95	40
Long term outcomes included	**--**	no	no	yes*	no	no	yes*	no

Data is presented as median (IQR) or n(%).

[#]Data collection for Afghanistan started on 2020-07-02. The remaining registries had 6 months complete collection.

Abbreviations: ICU, intensive care unit; MICU, medical ICU; SICU, surgical ICU; CT ICU, cardio-thoracic ICU; SARI, severe acute respiratory infection; HDU, high dependency unit

*Live in some participating ICUs

Additional modules complement the core data set providing stakeholders with a mechanism for embedding measures to evaluate care processes synonymous with care quality, and undertake observational and interventional research (Figure 1). The registry platform has a customisable user mobile and desktop interface and accessible data entry support tools. Minimum data connectivity requirements (3G data and offline function) along with downloadable data exports facilitate the registries adoption in settings which may previously have failed to implement digital systems due to poor internet coverage or limited access to hardware. Integrated analytics dashboards and reports displaying trends in information, activity and quality indicators provide a mechanism for service reporting and cycles of audit and feedback with the clinical teams[15].

The network has a federated system for registry data storage, whereby national registries house their data and are supported to establish infrastructure and skills to manage and curate data. All anonymised registry and trial data is backed up to a central server. A summary of registry implementation procedures reported using the template for intervention description and replication (TIDieR) checklist is detailed in the extended data[18].

Data collection procedures

Data is recorded prospectively and extracted directly from patient charts by data collectors daily and contemporaneous to clinical care. Laboratory tests are reported in the ICU's routine unit of measurement and harmonised to a single measure. A comprehensive field specification and data collection guide are made available to all stakeholders through the platform. Data collectors are remotely trained prior to commencing data collection using a demo platform and ongoing 24 hr online support is available. Follow up meetings are offered weekly to enable ongoing feedback and improvement regarding data quality and support with registry led research and audit. Census checks with independent admission data are used to monitor cohort inclusion daily or weekly at users' preference. The platform's existing internal data quality mechanisms, field completeness, value range validity and branching logic prompt users to missed or potentially spurious responses.

Results

Assessment of performance using the DoCDat criteria

A summary of the performance of the registries using the DoCDat criteria is shown in Table 4[18], and compared to the

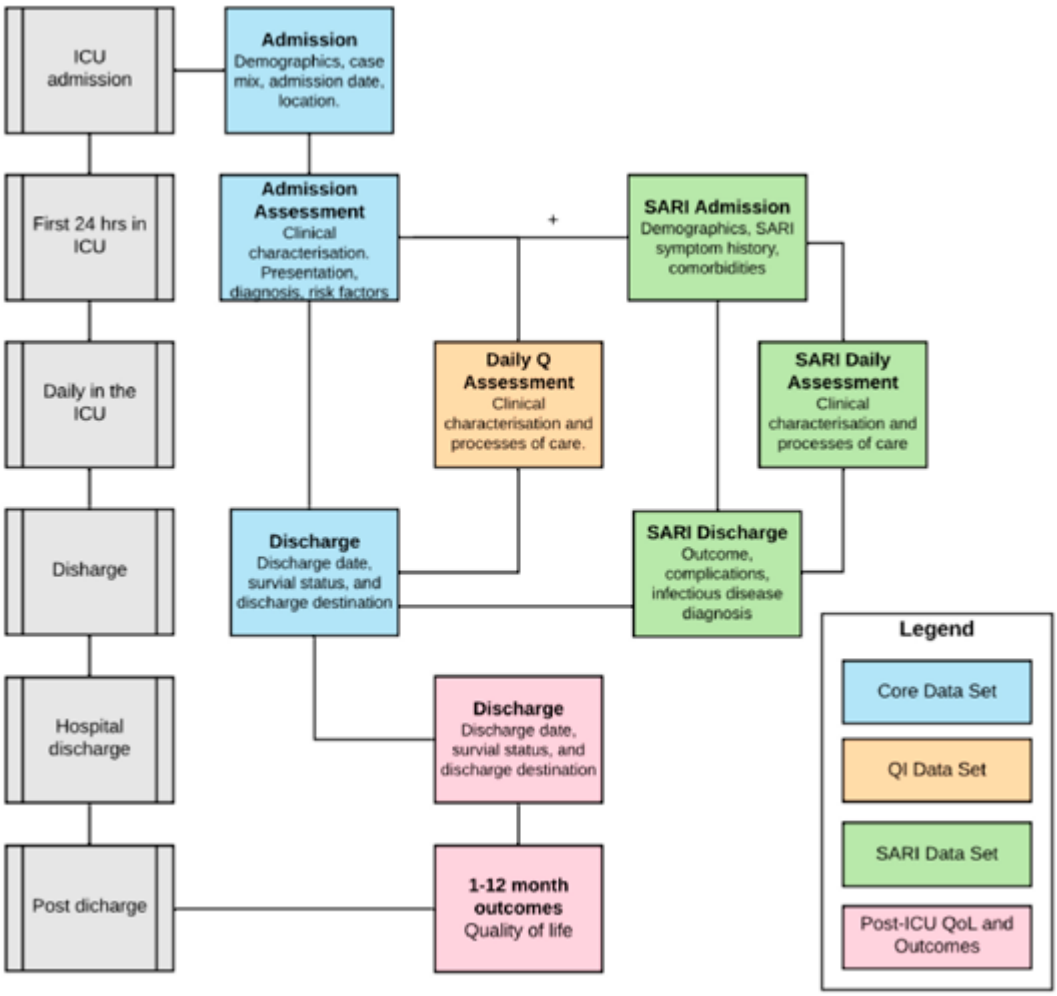


Figure 1. CRIT CARE ASIA registries modular data structure. Abbreviations: Q, quality; QI, quality improvement; ICU, intensive care unit (or any hospital unit involved in the project); SARI, severe acute respiratory infection; QoL, quality of life. Only the CORE data set is standard for all sites, while other data modules are optional.

average evaluation of other existing DoCDat databases[11,16]. The median score achieved by the registries across all criteria was 3.4 (minimum 1.4, maximum 4). Detailed scoring of each criterion is described below, while the score assigned by each external and internal reviewer is detailed in Table 5. An earlier version of this article can be found on medRxiv (https://doi.org/10.1101/2021.07.10.21260243)

A. Representativeness of country. Mean score 1.5. Despite the high number of ICUs in several countries, the geographic spread inside each country was limited for all registries.

B. Completeness of recruitment. Mean score 2.7. Recruitment completeness i.e. the proportion of patients reported in the registry over the number of patients admitted to the ICU was >95% in all participating ICUs (Table 3). Registry team members contact each ICU on a daily or weekly basis as preferred by the registry and validate admission, discharge and bed occupancy. The recruitment completeness was assessed through a dedicated section of the online platform. The process of daily or weekly validation of recruitment completeness was conducted in all but one registry, and in 77% of all ICUs (Table 6).

Table 4. Assessment of the Crit Care Asia (CCA) network registries according to the Directory of Clinical Databases (DoCDat) criteria.

	Crit Care Asia registries score#	DoCDat database*
A. Representativeness of country	1.5 (1-2)	3 (2-4)
B.Completeness of recruitment	2.7 (2-3)	3 (1-4)
C. Variables included	3.3 (3-4)	3 (2-4)
D. Completeness of data	3.8 (3-4)	2 (1-3)
E. Collection of raw data	3.8 (3-4)	4 (4-4)
F. Explicit definitions	4 (4-4)	2 (1-4)
G. Explicit rules	3.8 (3-4)	3 (1-4)
H. Reliability of coding	3.7 (2-4)	1 (1-4)
I. Independence of observations	3.8 (3-4)	4 (2-4)
J. Data validation	3.5 (3-4)	3 (3-4)

Average score of 6 independent reviewers, displayed as average (minimum and maximum scores attributed by individual scorers).

*Extracted from reference[11]

Table 5. Scoring overview of the external and internal reviewers according to the DoCDat criteria.

	External reviewer 1	External reviewer 2	External reviewer 3	Internal reviewer 1	Internal reviewer 2	Internal reviewer 3	Mean
A. Representativeness of country	1	2	2	2	1	1	1.5
B. Completeness of recruitment	3	2	3	3	2	3	2.7
C. Variables included	3	3	3	3	4	4	3.3
D. Completeness of data	4	4	4	3	4	4	3.8
E. Collection of raw data	4	3	4	4	4	4	3.8
F. Explicit definitions	4	4	4	4	4	4	4.0
G. Explicit rules	4	4	4	4	3	4	3.8
H. Reliability of coding	4	4	2	4	4	4	3.7
I. Independence of observations	4	4	4	4	4	3	3.8
J. Data validation	4	4	4	3	3	3	3.5
Overall mean							**3.4**

C. Variables included. Mean score 3.3. All seven registries reported the core data set and were able to derive severity of illness and prediction of mortality using published scores (Acute Physiology and Chronic Health Evaluation [APACHE] II and Tropical Intensive Care Score [TropICS])[23]. Variables included standardised diagnosis and comorbidities (Systematized nomenclature in Medicine - clinical terms [SNOMED CT] and Charlson comorbidity index), and outcomes at ICU and hospital discharge (Table 7). Two registries (IRIS in India and PRICE in Pakistan) also collected medium

Table 6. Completeness of recruitment by individual registry and month.

Month[§]	Eligible censuses	Actually completed censuses	% of completed censuses	% of censuses with number of reported>admitted patients	Completeness of recruitment, median**	Completeness of recruitment, IQR_25	Completeness of recruitment, IQR_75
BANGLADESH							
06/2020	5	5	100	0	83	0	100
07/2020	8	6	75	17	100	85	100
08/2020	10	10	100	20	100	100	100
09/2020	8	8	100	25	100	100	101
10/2020	8	8	100	13	100	100	100
11/2020	10	10	100	0	100	94	100
12/2020	6	6	100	0	100	100	100
INDIA (IRIS)							
06/2020	46	35	76	28	100	79	104
07/2020	40	20	50	25	94	81	101
08/2020	50	20	40	25	100	82	102
09/2020	43	23	53	21	100	87	100
10/2020	44	17	39	41	100	95	109
11/2020	55	23	42	39	100	85	108
12/2020	33	16	49	31	85	60	105
MALAYSIA							
09/2020	3	3	100	33	100	100	150
10/2020	71	70	98	19	100	100	100
11/2020	90	87	97	6	100	100	100
12/2020	93	84	90	11	100	100	100
NEPAL (NICRF)							
06/2020	92	92	100	26.1	100	79	117
07/2020	124	122	98	21	100	100	100
08/2020	124	124	100	20	100	100	100
09/2020	120	120	100	18	100	100	100
10/2020	124	124	100	31	100	100	127
11/2020	148	145	98	19	100	100	100
12/2020	248	248	100	16	100	100	100
PAKISTAN (PRICE)							
09/2020	48	48	100	0	100	100	100
10/2020	241	235	97.5	0.4	100	100	100
11/2020	305	302	99	0.3	100	100	100
12/2020	183	183	100	0	100	100	100
VIETNAM							
11/2020	3	2	66	50	150	125	175

The "census" is the *weekly* comparison of the number of patients admitted to the ICU in a week against the number of patients entered in the registry.

No units were collecting census during the study period in the Afghanistan registry.

[§]Only the months for which a census was reported are visualized in the table

** Number of recruited patients was calculated as number of reported patients divided by the number of admitted patients as identified by the census.

Abbreviations: IRIS, Indian Registry of IntenSive care; PRICE, Pakistan registry of intensive care; NICRF, Nepal Intensive Care Registry Foundation

Table 7. Completeness of data - core variables.

Form		Variable	Availability (%)
Admission	1	Patient name	100
	2	Medical record number	100
	3	Age	100
	4	Gender	100
	5	Date of admission to hospital	100
	6	Time of admission to hospital	100
	7	Date of admission to ICU	100
	8	Time of admission to ICU	100
	9	Readmission to ICU	100
	10	Admission type (operative vs. non operative)	100
	11	Admission diagnosis	100
	12	Comorbidities	100
	13	Confirmed or suspected SARI	99.4
Admission assessment	14	Ventilatory support (mechanical vs self ventilation)	97.6
	15	Route of ventilatory support (ETT vs tracheostomy vs NIV)	100
	16	Cardiovascular support	97.6
	17	Type and dose of vasoactive drug	96.6
	18	Use of sedatives	97.6
	19	Use of antibiotics	97.6
	20	Class of antibiotic	100
	21	Systolic blood pressure	97.6
	22	Diastolic blood pressure	97.6
	23	Respiratory rate	97.6
	24	Heart rate	97.6
	25	Body temperature	97.6
	26	Renal replacement therapy	97.5
	27	Glasgow coma scale	97.5
Discharge	28	Date of discharge	100
	29	Time of discharge	100
	30	Discharge status	100
	31	Discharge destination	100
	32	Cardiopulmonary resuscitation during stay	100
	33	Withdrawal of treatment	100

Abbreviations: ICU, intensive care unit; SARI, severe acute respiratory infection; ETT, endotracheal tube; NIV, non invasive ventilation.

to long term patient centred outcomes (i.e. after hospital discharge) and quality of life indicators such as the Euro quality of Life 5-dimensions tool (EQ5D-3L)[24] and scales for post traumatic stress disorders (PTSD).

D. Completeness of variables. Median score 3.8. All core variables were reported in the seven registries with < 5 % missingness, sustained over the 6-month period (Table 7). Overall, the availability of the core data set was 98.9%. All vital signs had a completeness >97%, while the variable with lowest score regarded type and dose of vasoactive drugs (96.6%).

E. Capture of raw variables. Median score 3.8. Raw data accounts for all fields in the core data set. Weekly meetings and 24/7 remote support between the CCA platform team and collaborating registries were reported using an online project management tool, which provided an audit trail of user queries, responses and platform development in response to recurring themes from user feedback.

F. and G. Explicit rules for how variables are recorded. Median scores 4.0 and 3.8 respectively. A detailed data dictionary complete with field specifications was available for all variables in the dataset and was uniform across the registries.

H. Reliability of coding. Mean score 3.7. The CCA platform's use of SNOMED CT (www.snomed.org) and Observational Medical Outcomes Partnership (OMOP) common data model mapping (www.ohdsi.org), ensures international standardized nomenclature covering both diagnostic conditions and operative procedures in all collaborating registries. However, no intra-rater or inter-rater reliability testing was performed.

I. Independence of observations. Median score 3.8. The primary outcome assessment for all episodes of care, was observed independent of patient care and independent from the clinical team. Similarly, secondary outcomes pertaining to vital status as 30 days- up to one year following ICU admission were captured by investigators blinded to existing encounter data.

J. Data validation. Mean score 3.5. Data is validated internally according to the CCA dataset definitions. Fields are validated for completeness, consistency of response across sibling or parent-child fields. Inbuilt mandatory rules developed based on cycles of testing and analysis in CCA network sites ensure completeness of core dataset, and alerts within the user interface prompt users to complete supplemental fields. Illogicalities and inconsistencies in relational fields are minimised using inbuilt branching logic. Data validation reports, updated every 24hrs, are accessible to end users via the platforms reports interface. Clinicians and administrators can also interrogate the CCA data set directly by downloading reports, viewing data via the real-time dashboards, or by submitting requests for analyses to the CCA registry implementation team. Free text fields are used only to supplement predetermined menus which have been generated from pre-existing guidance e.g. for Center of Disease Control definitions, or for the Acute Physiology and Chronic Evaluation (APACHE) IV diagnostic codes).

Assessment using the framework of procedures proposed by Arts *et al.*[17]

The CCA platform fulfilled all criteria proposed by this framework, with the exception of 1 item (Table 2) pertaining to the central coordinating center checking on interobserver variability. The scoring for this framework was homogeneous across all reviewers.

Discussion

This independent evaluation of federated critical care registries from seven LMICs in Asia performed better than previously reported evaluations of multi centre databases using the DoCDat criteria[2,11]. Key components of the platform were standardised field specification, inbuilt validation at data entry, audit reporting on completeness, consistency and validity checks of the data. The greatest limitation of the registries when evaluated against the criteria were in national geographical coverage and the absence of source verification of data.

The representativeness criteria was the lowest scoring as the CCA network spread is inhomogeneous with large differences across countries. The primary goal of capturing outcomes information is to identify high-performance hospitals or health-care delivery systems in order to uncover the best practices responsible for their superior outcomes and seek to implement them in other settings. A limited coverage across the collaborating registries limits the ability to benchmark care nationally and internationally, but such benchmarking may have limited utility in healthcare systems in developing countries. This is due to both difficulty in capturing outcomes after ICU discharge and infeasibility of complex risk adjusted stratification. Although historically national coverage has been considered a key criterion to enhance data quality, we do not consider this to be the case for a federated network system spanning across several countries. The focus is on the community of practice rather than the extent of coverage, on the actual use of the data for unit level or multicenter quality improvement initiatives, audit and feedback rounds and clinical trials. Yet, efforts to increase expansion inside individual countries continue, with new centers joining the registry on a regular basis.

Some of the challenges faced by the CCA registry are specific to LMICS, others are more common and observed across registries worldwide[11,12]. Completeness of recruitment is still not assessed in one third of the CCA ICUs and limits the exact knowledge of patients missed by the registry. On the other hand, the patient census often was higher than the reported admitted patients on ICU admission books, questioning the reliability of routinary admission books as a representation of the exact count of admitted patients. Staffing and retention of dedicated data collectors are also recognized challenges faced

by registries worldwide[11,12]. Data collection, data entry and verification are frequently carried out by staff from diverse clinical or non-clinical backgrounds with verification of data accuracy that may be seldom performed at unit level. Despite no formal audit of a sample of medical records was performed, similar rates of discrepancies (i.e. around 5%) found in previous registries[11,25]. may be expected from the CCA federated registry system. Limitations and potential flaws in reliability of registry data have been highlighted in the past[26]. Rigorous and regular assessments of registry data such as the one performed in this article may overcome some of these limitations. Continuous audit and analysis at unit, regional and national level also contribute to strengthening data collection and interpretation procedures.

With the increased use of registries for registry-embedded clinical trials and observational research there is a drive for improved data quality[27]. In addition to the mandatory field completeness, range checks, primitive and entity data-type constraints, additional mechanisms are in place for data quality assurance: data version management, access control for curated data sets, role-based access, verified audit trails and source verification of data. Registries can also allow a better understanding of how close standard care arms are to routine care, through the validation of trial data in the context of pre-existing registry data. Finally, data interoperability across multinational registries is currently being facilitated by the increasing integration of international coding systems (e.g. SNOMED), use of Common Data Models and the participation in data sharing initiatives such as the Linking of Global Intensive Care (LOGIC) consortium[28].

The architecture of the CCA registry facilitates ICUs retaining ownership of submitted data. The CCA registry provides contributors with a platform for capture of unit level data using a common data structure, and enables real time analysis to inform clinical care and service delivery via dashboards and collated reports. In fact, ICU beds in Asian hospitals constitute an average 9% of hospital beds, highlighting the importance of reliable and comparable data[29]. Leveraging the same data platform, ICUs can contribute patient and hospital de-identified data to the CCA for benchmarking, multi-centre research purposes and quality improvement. Investigator initiated research can also be started by ICU registry leads within the network and on approval and agreement of clinical and institutional collaborators.

Similarly to the DoCDat criteria, Arts *et al.* suggested the need for transparent data definitions, standardized data collection guidelines and central training of individuals involved in data collection[17]. The CCA failed to meet one of the suggested criteria concerning the interobserver variability checks on collected data. This would require the data collection performed by different individuals with a subsequent check against the source files, a resource-intensive procedure that constitutes a challenge for all quality clinical registries[27]. Yet, all the other domains pertaining to both the central coordinating center and peripheral ICUs were fulfilled. This provides factual endorsement for the federated system experimented by the CCA network of multiple registries with both national and international coordination.

Across the globe, registries are now being leveraged to support large scale multi-centre clinical trials and evaluate complex improvement interventions. Regarding trial recruitment, adapted registry platforms promote rapid onboarding, inform site selection and improve patient recruitment, and can facilitate study monitoring through inbuilt data quality and validation processes[6]. Potential limitations of registry-based trials concern the controlling for confounding and bias[30]. The CCA network is already supporting several of the REMAP-CAP arms trials[6,31,32], while also enabling observational and outcome research[23].

This study has some limitations. The assessment was limited to core data as this dataset was available throughout all registries in the network. While other data domains will presumably share similar infrastructure scoring, the completeness of data may vary. The assessment included registries with diverse size and experience, with aggregate scoring performed without emphasis on single registry's scores and improvement points.

Conclusions

The CCA federated registry system is a rapidly growing network that provides high quality ICU data concerning case mix, processes of care and clinical outcomes from seven Asian countries. The system had a high performance when assessed using rigorous predefined scoring systems tackling completeness, reliability, validity and organizational infrastructure. While representativeness and interobserver reliability checks were identified as potential areas for improvement, overall performance was equal to national registries in high income settings.

Data availability

Underlying data

Figshare: Registries performance CCAA NICSMORU 13-08-21. https://doi.org/10.6084/m9.figshare.15167406.v3[18].

This project contains the following underlying data:

- Registries_performance_CCAA_NICSMORU_13_08_21_patient_data_entered_status.csv
- Registries_performance_CCAA_NICSMORU_13_08_21_census_data.csv
- Registries_performance_CCAA_NICSMORU_13_08_21_unit_infomation.csv
- CORE Data dictionary_CCAA.xlsx

For further information regarding the data and the CCA, please contact the CCA data access committee (DAC@nicslk.com) and quote the manuscript, your institution and provide return correspondence information.

Extended data

Fighsare: TIDieR checklist for 'Performance evaluation of a multinational data platform for critical care in Asia'. https://doi.org/10.6084/m9.figshare.15167406.v3[18].

Data are available under the terms of the Creative Commons Attribution 4.0 International license (CC-BY 4.0).

Archived analysis code as at time of publication: https://doi.org/10.6084/m9.figshare.15167406.v3[18].

License: Creative Commons Attribution 4.0 International license (CC-BY 4.0).

Acknowledgements

We would like to thank the registries quality independent assessors: Jorge Salluh (D'Or Institute for Research and Education, Rio de Janeiro, Brazil), Dave Pilcher (Department of Intensive Care, The Alfred Hospital, Prahran, Melbourne; Australian and New Zealand Intensive Care Research Centre, School of Public Health and Preventive Medicine, Monash University, Melbourne, VIC, Australia), John Victor Peter (Christian Medical College Hospital, Vellore, Tamil Nadu, India).

Collaborators

Collaborators are listed by registry in alphabetical order (Site leads are in **bold**):

AFGHANISTAN:

Ahmad Seyar Quraishi, Meharnegar Haqyar Mohammadi, Ahmad Zekria Sherzai (Wazir Akbar Khan Hospital, Kabul), **Ghulam Rahim Awab**, Noorullah Ahmadzai, Guldad Khan Safi (Nangarhar Regional Hospital, Jalalabad), Mirwais Azizi (Ali Jenah Hospital, Kabul), Asilah Hedayat (Herat Regional Hospital, Herat); **Naseebullah Barekzai**, Dawood Safi (Indira Gandhi Children's Hospital, Kabul).

BANGLADESH:

Aniruddha Ghose, Ranjan Kumar Nath, Selim Kashem Chowdhury, Smriti Kona Debi, Kamrun Akter, Safiqul Mostafa Chy (Chattogram Medical College Hospital, Chattogram).

INDIA (Indian Registry of IntenSive care -- IRIS):

Devachandran Jayakumar, Suresh Babu Masilamani (Apollo Speciality Hospital, Chennai); **Bharath Kumar,** Augustian James, Nagarajan Ramakrishnan, Ramesh Venkataraman, Lakshmi Ranganathan (Apollo Main Hospital, Chennai); **Meghena Mathew,** Revathi Kandeepan (Apollo First Med Hospital, Chennai); **Ebenezer Rabingrarajan,** Madhu Shree, Usha Rani Chandramohan (Apollo Speciality Hospital, Vanagaram); **Jaganathan Selvanayagam,** Thirumalai Sambath (Mehta Hospital, Chennai); **Mathew Pulicken,** Milan Mathew (Pushpagiri Medical College Hospital, Kerala); **Rakesh Lakshmappa**, Karthik Shivani Lokeshappa (Nanjappa Multispecialty Hospital, Karnataka); **Raymond Savio,** Sristi Patodia, Premnath Balakrishnan (Apollo Proton Cancer Center); **Kishore Mangal,** Disha Chandel (Eternal Hospital, Jaipur Rajasthan); **Deepak Vijayan,** Krishna Priya, (KIMS, Kerala); **Rajyabardhan Patnaik,** Kasi Chinni Krishna (ISPAT General Hospital, Rourkela); **Kavita Kamineni,** Saradha Chirravuri (ABC Hospital, Visakhapatnam); **Swagatha Tripathi,** Kasturi Sanyal (AIIMS, Bhuvaneshwar); **Zubair Mohamed**, Anna Paul (Amrita Institute of Medical Sciences).

NEPAL (Nepal Intensive Care registry Foundation -- NICRF):

Diptesh Aryal, Sanjeet K Shrestha, Kishor Khanal, Ashim Regmi, Namrata Rai, Kanchan Koirala, Kaveri Thapa, Krisha Dheke, Manisha Maharjan (Nepal Mediciti Hospital, Lalitpur); **Subhash Acharya**, Kabita Sitoula, Asmita Pokhrel, Namrata Shrestha, Saraswoti Sharma, Bimala Make, Arati Phuyal, Radhika Maharjan, Sabi Bajracharya, Roshni Thapa, Binita Bhattarai (Tribhuvan University Teaching Hospital, Kathmandu); **Sabin Koirala, Hem Paneru,** Sujata Chauhan, Angela Lamichhane, Alina Lamichhane, Sangita G.C, Swastika Phuyal, Crystal Maharjan, Anusha Subedi, Bini Kayastha, Kabita Khadka, Rakshya Karki Pratibha, Paudel XX (Hospital for Advanced Medicine and Surgery HAMS, Kathmandu); **Sushil Khanal,** Samina Amatya, Pujan Rajbhandary, Bina Bhattarai, Sabita Shrestha Sharmila Mali XX (Grande International Hospital); **Basanta Gauli,** Nisha Bhandari, Babita Ghimire, Asmita Kaini (Chitwan Medical College, Chitwan); **Bipin Karki, Pramesh Shrestha,** Roshni Karki, Sabina Dhakal, Mandira Thapa, Sarita Tamang (Om Hospital, Kathmandu); **Shubha Kalyan Shrestha,** Roshni Kafle, Kalpana Gurung (Karuna Hospital, Kathmandu); **Sanjay Lakhey**, Anita Bashya, Prajina Malla, Jeeya Deuja (B&B Hospital, Lalitpur); **Anand Thakur,** Radhika Maharjan, Sachita Maharjan, Subina Maharjan Yashu (Nidan Hospital, Lalitpur); **Raju Shrestha,** Pratima Sigdel, Merina Pradhan (B & C Hospital, Lalitpur).

MALAYSIA:

Mohd Basri Mat-Nor, Azrina Md Ralib, Nurhafizah Zarudin, Fatimah Mohamad (IIUMMC - International Islamic University Malaysia Medical Center, Kuala Lumpur); **Mohd Zulfakar Bin Maslan,**Wan Fadzlina Wan Ahmad Shukeri, Amir Asyraf (Hospital Universiti Sains Malaysia, Kota Bharu); **Noor Airini Ibrahim,**Noor Fazlina (Hospital Pengajar UPM, Pengajar); **Dr Mohd Shahnaz Hasan, Dr Nor'azim Mohd Yunos,** Dr Rafidah Atan, Yip Hing Wa (Universiti Malaya Medical Center, Kuala Lumpur).

PAKISTAN (Pakistan Registry of Intensive Care -- PRICE):

Ashok Kumar, Mukesh Kumar, Quratul Ain Khan, Osama Khalid, Ali Raza, Ali Abbas, Akash Thakrani, Noor Hassan, Ilyas Shehzad, Samad Ali (Ziauddin Group of Hospitals, Karachi); **Dr Attaur Rehman,** Amir Khan, Ahmed Zia, Farhan Khan (Patel Hospital, Karachi); **Nawal Salahuddin, Amin Khawaja, Mohammad Imran, Sobia Masood,** Vinod Kumar (National Institute of Cardiovascular Diseases, Karachi); **Tanvir Alam,**

Noor Hassan (Civil Hospital, Karachi); **Nadeem Muneer,** Vinod Kumar (Jinnah Post-Graduate Medical Center, Karachi); **Aneela Altaf Kidwai, Aftab Ahmed,** Amir Khan (Abbasi Shaheed Hospital, Karachi); **Rashid Nasim Khan,** Jhonsan Shahzad (Darul Sehat Hospital, Karachi); **Saeeda Haider, Junaid Patel, Fivzia Herekar,** Arther John, Yasir Rehman (The Indus Hospital, Karachi); **Fakhir Raza Haidri,** Fawadur Rehman, (SIUT, Karachi); **Muhammad Nasir Khoso,** Noor Hassan (South City Hospital, Karachi); **Saleh Khaskheli,** Muhammad Ibrahim (Peoples Medical University, Nawabshah); **Kashif Memon,** Mohsin Ali (Liaquat University Hospital, Hyderabad); **Maqsood Meher,** Afzal Ahmed (GMMM Teaching Hospital, Sukkur); **Sayed Muneeb Ali, Rana Imran Sikandar,**Imtiaz Ali Shah (Pakistan Institute of Medical Sciences, Islamabad)**; Liaquat Ali, Muhammad Ashraf Zia, Moazzam Tarar, Ahmed Ranjha,** Basit Ali, Shahryar Maqsood (Jinnah Hospital, Lahore); **Ahmed Farooq,** Shahbaz Ikram (Doctors Hospital, Lahore); **Arshad Taqi,** Junaid Anwar (National Hospital & Medical Center, Lahore); **Jodat Saleem, Irfan malik, Rehan Niazi,** Shahryar Maqsood (Lahore General Hospital, Lahore); **Naseem Ali Shah** (Hameed Latif Hospital, Lahore); **Kamran Cheema, Mazhar Ali Naqvi,** Basit Ali (Services Hospital, Lahore); **Iqbal Hussain, Mobin Chaudhary,** Muddasir Qadir (Pakistan Kidney and Liver Institute, Lahore); **Sairah Sadaf,** Anjum Saleem (Sheikh Zayed Medical College, Rahim Yar Khan)**; Muhammad Hayat, Arslan Rahatullah, Muhammad Kamran,** Farman Ali Khan, Imran Khan (North West General Hospital, Peshawar)**; Muhammad Sheharyar, Sajjad Orakzai,** Imran Khan, Zafar Iqbal Khatak (Lady Reading Hospital, Peshawar)**; Imran ul Haq,** Farman Ali Khan (Khyber Teaching Hospital, Peshawar).

VIETNAM:

Vu Dinh Phu, Dong Phu Khiem, Pham Van Phuc, Doan Duy Thanh, Trinh Lan Huong, Dang Van Duong, Tran van Kien, Mac Duy Hung, Vo Duc Linh (National Hospital for Tropical Diseases, Hanoi); **Nguyen Thien Binh**, Nguyen Thi Thu Van, Vy Thi Thu Luan, Lien Thi Xuan Nga, Nguyen Thi Dieu Vy, Vuong My Dung, Cao Thi Lan Huong, Ho Ngoc Bao, Huynh Nhat Anh, Nguyen Hoang Huy, Truong Huynh Tan Phu, Nguyen Hong Ngoc, Tran Thi Kim Anh, Doan Minh Nhut (Trung Vuong Hospital, Ho Chi Minh); **Dinh Minh Duc, Vo Thi Dung,** Huynh Nguyet, Truong Dai Lan Ngoc, Nguyen Thuy Hang, Nguyen Tan Khanh (Dong Thap Hospital, Dong Thap); **Duong Bich Thuy,** (Hospital for Tropical Diseases, Ho Chi Minh City); **Yen Lam Minh,** Doan Bui Xuan Thy, Tran Minh Duc, Louise Thwaites, Nguyen Thanh Ngoc, Luu Phuoc An (Oxford University Clinical Research Unit).

NICS MORU Crit Care Asia Network Registry Coordination Team:

Udara Attanayake, Sri Darshana, Kaumali Gimhani, Judy Ann Gitahi, Pramodya Ishani, Chamira Kodippily, Issrah Jawad, Shiekh Mohiuddin, Upule Pabasara, Dilanthi Priyadarshani, Disna Pujika, Aasiyah Rashan, Sumayyah Rashan, Thalha Rashan, Shoba Sathasivam, Timo Tolppa, Ishara Udayanga.

References

1. Kruk ME, Gage AD, Arsenault C, *et al.*: **High-quality health systems in the Sustainable Development Goals era: time for a revolution.** *Lancet Glob Health.* 2018; **6**(11): e1196–1252.
PubMed Abstract | Publisher Full Text | Free Full Text
2. Zampieri FG, Soares M, Borges LP, *et al.*: **The Epimed Monitor ICU Database®: a cloud-based national registry for adult intensive care unit patients in Brazil.** *Rev Bras Ter Intensiva.* 2017; **29**(4): 418–426.
PubMed Abstract | Publisher Full Text | Free Full Text
3. Haniffa R, Mukaka M, Munasinghe SB, *et al.*: **Simplified prognostic model for critically ill patients in resource limited settings in South Asia.** *Crit Care.* 2017; **21**(1): 250.
PubMed Abstract | Publisher Full Text | Free Full Text
4. Soares M, Bozza FA, Angus DC, *et al.*: **Organizational characteristics, outcomes, and resource use in 78 Brazilian intensive care units: the ORCHESTRA study.** *Intensive Care Med.* 2015; **41**(12): 2149–60.
PubMed Abstract | Publisher Full Text
5. Pisani L, Algera AG, Neto AS, *et al.*: **Epidemiological Characteristics, Ventilator Management, and Clinical Outcome in Patients Receiving Invasive Ventilation in Intensive Care Units from 10 Asian Middle-Income Countries (PRoVENT-iMiC): An International, Multicenter, Prospective Study.** *Am J Trop Med Hyg.* 2021; **104**(3): 1022–1033.
PubMed Abstract | Publisher Full Text | Free Full Text
6. Aryal D, Beane A, Dondorp AM, *et al.*: **Operationalisation of the Randomized Embedded Multifactorial Adaptive Platform for COVID-19 trials in a low and lower-middle income critical care learning health system.** *Wellcome Open Res.* 2021; **6**: 14.
PubMed Abstract | Publisher Full Text | Free Full Text
7. Black N: **High-quality clinical databases: breaking down barriers.** *Lancet.* 1999; **353**(9160): 1205–6.
PubMed Abstract | Publisher Full Text
8. World Health Organization: **WHO Global diffusion of eHealth: making universal health coverage achievable**. World Health Organization Geneva. 2016.
Reference Source
9. **WHO Packages DHIS2**. (accessed May 23, 2021).
Reference Source
10. Hung YW, Hoxha K, Irwin BR, *et al.*: **Using routine health information data for research in low- and middle-income countries: a systematic review.** *BMC Health Serv Res.* 2020; **20**(1): 790.
PubMed Abstract | Publisher Full Text | Free Full Text
11. Stow PJ, Hart GK, Higlett T, *et al.*: **Development and implementation of a high-quality clinical database: the Australian and New Zealand Intensive Care Society Adult Patient Database.** *J Crit Care.* 2006; **21**(2): 133–41.
PubMed Abstract | Publisher Full Text
12. Harrison DA, Brady AR, Rowan K: **Case mix, outcome and length of stay for admissions to adult, general critical care units in England, Wales and Northern Ireland: the Intensive Care National Audit & Research Centre Case Mix Programme Database.** *Crit Care LondEngl.* 2004; **8**(2): R99–111.
PubMed Abstract | Publisher Full Text | Free Full Text
13. MEASURE Evaluation: Routine Health Information Systems: A Curriculum on Basic Concepts and Practice - Syllabus - MEASURE Evaluation. (accessed May 10, 2021).
Reference Source
14. CRIT CARE ASIA: **Establishing a critical care network in Asia to improve care for critically ill patients in low- and middle-income countries.** *Crit Care LondEngl.* 2020; **24**: 608.
Publisher Full Text
15. Beane A, Silva APD, Athapattu PL, *et al.*: **Addressing the information deficit in global health: lessons from a digital acute care platform in Sri Lanka.** *BMJ*

Glob Health. 2019; **4**(1): e001134.
PubMed Abstract | Publisher Full Text | Free Full Text

16. Black N, Payne M: **Directory of clinical databases: improving and promoting their use.** *Qual Saf Health Care.* 2003; **12**(5): 348–52.
PubMed Abstract | Publisher Full Text | Free Full Text

17. Arts DGT, Keizer NFD, Scheffer GJ: **Defining and improving data quality in medical registries: a literature review, case study, and generic framework.** *J Am Med Inform Assoc.* 2002; **9**(6): 600–11.
PubMed Abstract | Publisher Full Text | Free Full Text

18. Beane A: **Registries performance CCAA NICSMORU 13-08-21.** *figshare.* Dataset. 2021.
http://www.doi.org/10.6084/m9.figshare.15167406.v3

19. Adhikari NKJ, Arali R, Attanayake U, *et al.*: **Implementing an intensive care registry in India: preliminary results of the case-mix program and an opportunity for quality improvement and research.** *Wellcome Open Res.* 2020; **5**: 182.
PubMed Abstract | Publisher Full Text | Free Full Text

20. Hashmi M, Beane A, Taqi A, *et al.*: **Pakistan Registry of Intensive CarE (PRICE): Expanding a lower middle-income, clinician-designed critical care registry in South Asia.** *J Intensive Care Soc.* 2019; **20**(3): 190–195.
PubMed Abstract | Publisher Full Text | Free Full Text

21. CRIT Care Asia: Hashmi M, Beane A, *et al.*: **Leveraging a Cloud-Based Critical Care Registry for COVID-19 Pandemic Surveillance and Research in Low- and Middle-Income Countries.** *JMIR Public Health Surveill.* 2020; **6**(4): e21939.
PubMed Abstract | Publisher Full Text | Free Full Text

22. Hashmi M, Taqi A, Memon MI, *et al.*: **A national survey of critical care services in hospitals accredited for training in a lower-middle income country: Pakistan.** *J Crit Care.* 2020; **60**: 273–278.
PubMed Abstract | Publisher Full Text | Free Full Text

23. TirupakuzhiVijayaraghavan BK, Priyadarshini D, Rashan A, *et al.*: **Validation of a simplified risk prediction model using a cloud based critical care registry in a lower-middle income country.** *PLoS One.* 2020; **15**(12): e0244989.
PubMed Abstract | Publisher Full Text | Free Full Text

24. Rabin R, Gudex C, Selai C, *et al.*: **From translation to version management: a history and review of methods for the cultural adaptation of the EuroQol five-dimensional questionnaire.** *Value Health.* 2014; **17**(1): 70–6.
PubMed Abstract | Publisher Full Text

25. Herbert MA, Prince SL, Williams JL, *et al.*: **Are unaudited records from an outcomes registry database accurate?** *Ann Thorac Surg.* 2004; **77**(6): 1960–4; discussion. 1964–1965.
PubMed Abstract | Publisher Full Text

26. Perner A, Bellomo R, Møller MH: **Is research from databases reliable? No.** *Intensive Care Med.* 2019; **45**(1): 115–117.
PubMed Abstract | Publisher Full Text

27. Litton E, Guidet B, de Lange D: **National registries: Lessons learnt from quality improvement initiatives in intensive care.** *J Crit Care.* 2020; **60**: 311–318.
PubMed Abstract | Publisher Full Text

28. Dongelmans DA, Pilcher D, Beane A, *et al.*: **Linking of global intensive care (LOGIC): An international benchmarking in critical care initiative.** *J Crit Care.* 2020; **60**: 305–310.
PubMed Abstract | Publisher Full Text

29. Arabi YM, Phua J, Koh Y, *et al.*: **Structure, Organization, and Delivery of Critical Care in Asian ICUs.** *Crit Care Med.* 2016; **44**(10): e940–948.
PubMed Abstract | Publisher Full Text

30. Frieden TR: **Evidence for Health Decision Making - Beyond Randomized, Controlled Trials.** *N Engl J Med.* 2017; **377**(5): 465–475.
PubMed Abstract | Publisher Full Text

31. Angus DC, Derde L, Al-Beidh F, *et al.*: **Effect of Hydrocortisone on Mortality and Organ Support in Patients With Severe COVID-19: The REMAP-CAP COVID-19 Corticosteroid Domain Randomized Clinical Trial.** *JAMA.* 2020; **324**(13): 1317–1329.
PubMed Abstract | Publisher Full Text | Free Full Text

32. REMAP-CAP Investigators; Gordon AC, Mouncey PR, *et al.*: **Interleukin-6 Receptor Antagonists in Critically Ill Patients with Covid-19.** *N Engl J Med.* 2021; **384**(16): 1491–1502.
PubMed Abstract | Publisher Full Text | Free Full Text

Wellcome Open Research Wellcome Open Research 2021, 6:251 Last updated: 23 MAR 2022

Open Peer Review

Current Peer Review Status:  

Version 1

Reviewer Report 02 February 2022

https://doi.org/10.21956/wellcomeopenres.18913.r46344

© **2022 Finazzi S.** This is an open access peer review report distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Stefano Finazzi
Clinical Data Science Laboratory, Department of Public Health, Mario Negri Institute of Pharmacological Research IRCCS, Ranica, Italy

The authors present a very important and interesting experience about a new platform for data collection of ICU patients in several countries. The quality of the data collection system is assessed by independent reviewers through a few scores. The project is really well-managed and the paper very well-written. All relevant issues were considered and limitations are properly discussed.

Is the work clearly and accurately presented and does it cite the current literature?
Yes

Is the study design appropriate and is the work technically sound?
Yes

Are sufficient details of methods and analysis provided to allow replication by others?
Yes

If applicable, is the statistical analysis and its interpretation appropriate?
Yes

Are all the source data underlying the results available to ensure full reproducibility?
No source data required

Are the conclusions drawn adequately supported by the results?
Yes

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: Clinical data science

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard.

Reviewer Report 29 November 2021

https://doi.org/10.21956/wellcomeopenres.18913.r47253

© 2021 Young P. This is an open access peer review report distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Paul Young
Medical Research Institute of New Zealand, Wellington, New Zealand

This study describes a performance evaluation of the Critical Care Asia Registry using a recognised framework. This technical report is well written and thorough. As outlined, the framework that has been used is well-establish. The greatest uncertainty is probably about whether the data that are entered into the registry are truly an accurate reflection of what is in the source data. This is a concern in all registries but could conceivably be a particularly troublesome issue in lower income countries where resources are more limited. My only significant comment is whether more attention to this point in the Discussion would be appropriate.

Is the work clearly and accurately presented and does it cite the current literature?
Yes

Is the study design appropriate and is the work technically sound?
Yes

Are sufficient details of methods and analysis provided to allow replication by others?
Yes

If applicable, is the statistical analysis and its interpretation appropriate?
Yes

Are all the source data underlying the results available to ensure full reproducibility?
Yes

Are the conclusions drawn adequately supported by the results?
Yes

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: Intensive Care Medicine

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard.

Measuring Effective Coverage for institutional deliveries in a rural district in Uganda: the role of Supportive Supervision data

POSTER PRESENTATIONS

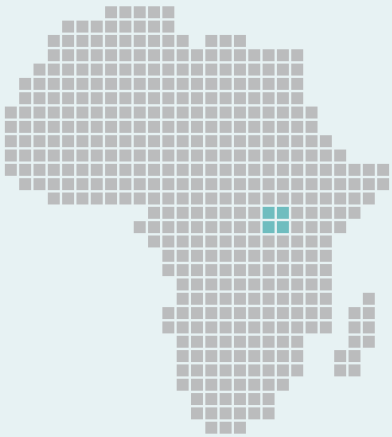
Conference
12th European Congress on Tropical Medicine and International Health (ECTMIH)

Location
Virtual from Bergen, Norway

Presentation date
28 September – 1 October 2021

Authors
Tognon F.

Focus country
Uganda



Mozambican Adolescents and Youths in COVID-19 Pandemic: knowledge and awareness gaps in the provinces of Sofala and Tete

POSTER PRESENTATIONS

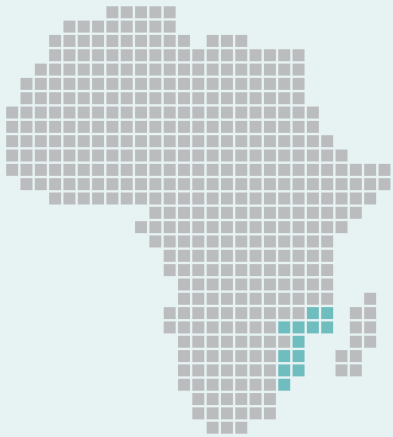
Conference
12th European Congress on Tropical Medicine and International Health (ECTMIH)

Location
Virtual from Bergen, Norway

Presentation date
28 September – 1 October 2021

Authors
Occa E.

Focus country
Mozambique



Improving access to healthcare in Sierra Leone: the role of the newly developed National Emergency Medical Service

ORAL PRESENTATIONS

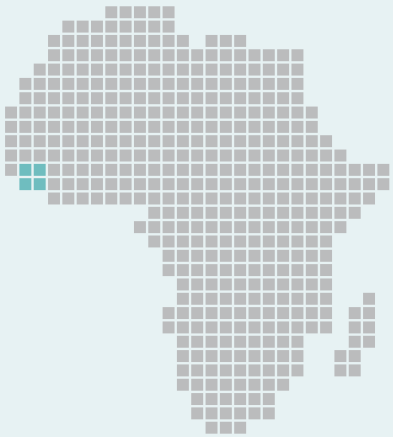
Conference
12th European Congress on Tropical Medicine and International Health (ECTMIH)

Location
Virtual from Bergen, Norway

Presentation date
28 September – 1 October 2021

Authors
Caviglia M.

Focus country
Sierra Leone



Portable Digital Stadiometer for Assessing the Degree of Childhood Malnutrition in Low-Income Countries

ORAL PRESENTATIONS

Conference
IEEE International Humanitarian Technology Conference (IHTC)

Location
Virtual conference

Presentation date
2 – 4 December 2021

Authors
Bonaldo S. et al.

Focus country
Multi-countries

Infectious and tropical diseases

The Reported Few Cases and Deaths of Covid-19 Epidemic in Africa Are Still Data Too Questionable to Reassure About the Future of This Continent

PAPER

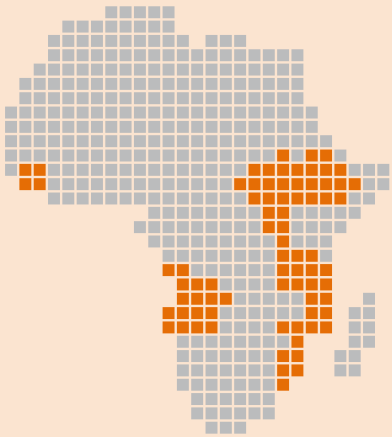
Authors
Dente M.G., Resti C.V., Declich S., Putoto G.

Published in
Frontiers of Public Health,
February 2021

Link
https://doi.org/10.3389/fpubh.2021.613484

Topic
Infectious and tropical diseases

Focus country
Multi-countries



frontiers in Public Health

OPINION
published: 05 February 2021
doi: 10.3389/fpubh.2021.613484

The Reported Few Cases and Deaths of Covid-19 Epidemic in Africa Are Still Data Too Questionable to Reassure About the Future of This Continent

Maria Grazia Dente[1]*, *Carlo Vittorio Resti*[2], *Silvia Declich*[1] and *Giovanni Putoto*[3]

[1] National Center for Global Health, Istituto Superiore di Sanità, Rome, Italy, [2] Public Relations Office, San Camillo-Forlanini Hospital, Rome, Italy, [3] Planning and Operational Research Department, Doctors With Africa Collegio Aspiranti e Medici Missionari (CUAMM), Padova, Italy

Keywords: COVID-19, Africa, surveillance data, containment measures, health service access and utilization

OPEN ACCESS

Edited by:
Jonathan Ling,
University of Sunderland,
United Kingdom

Reviewed by:
Shabir Madhi,
University of the Witwatersrand,
South Africa

***Correspondence:**
Maria Grazia Dente
mariagrazia.dente@iss.it

Specialty section:
This article was submitted to Public Health Policy, a section of the journal Frontiers in Public Health

Received: *02 October 2020*
Accepted: *07 January 2021*
Published: *05 February 2021*

Citation:
Dente MG, Resti CV, Declich S and Putoto G (2021) The Reported Few Cases and Deaths of Covid-19 Epidemic in Africa Are Still Data Too Questionable to Reassure About the Future of This Continent. Front. Public Health 9:613484. doi: 10.3389/fpubh.2021.613484

INTRODUCTION

More than 10 months after the first case of COVID-19 in Africa was detected (in Egypt on February 14), prevalence and mortality are still relatively low and, although there are many hypotheses, the reasons remain unclear (1–3).

Reduced virulence of SARS-CoV-2 in Africa, genetic or trained immunity, and young population (3, 4) are among the main reasons being evaluated.

RELIABILITY OF THE DATA FOR HYPOTHESIS AND CONCLUSIONS

However, it should be considered that conclusions based on the limited available data might be misleading, also considering the fragility of the surveillance and health systems in many African countries and the possible weakness of their data. In addition, data governance in emergency contexts in Africa is historically difficult and some evidence shows that several African countries exert a tight control on public data and information (3, 5), particularly in the case of epidemics.

The WHO African Region reports that complete data on age and gender distribution are presently available only for around 1% of total confirmed cases and that the recent observed decline of cases should be interpreted with caution as many factors could explain this trend, including, but not limited to, changes in testing capacity and strategy, and reporting delays (6). In fact, low numbers of performed tests and high variability within national testing strategies (i.e., due to scarce resources, some countries are testing only symptomatic cases) do not allow monitoring the actual entity of the pandemic in the countries.

Although it increased since the starting of the pandemic, the total tests per population is still <10 per 1,000 in many countries. On December 7, the total daily COVID-19 tests in Africa oscillates between 0 and 1/1000 for around 20 countries with available data (7).

With limited testing, the positive rate might give some suggestions on the progression of the epidemic. Where the number of confirmed cases is high relative to the extent of testing, probably not enough tests are being carried out to properly monitor the outbreak. In such countries, the true number of infections may be far higher than the number of confirmed cases. "And where the positive rate is rising in a country, this can suggest the virus is actually spreading faster than the growth seen in confirmed cases" (7).

Less than 5% of samples positive for COVID-19, at least for the last 2 weeks (assuming that surveillance for suspected cases is comprehensive), is one of the WHO criteria that indicate that the epidemic is under control (8).

In those African countries whose data are available, the positive rate on December 8 oscillates between 2.2 (Togo) and 28.2 (Democratic Republic of Congo), with increasing trend in some cases. However, how these values can be interpreted when very low number of tests are performed (Togo 0.11/1000 and DRC <0.01/1000)? (7).

In countries where data are collected, indications on the entity of this pandemic are provided by the excess of mortality, as reported by the South African Medical Research Council. From 6 May to 14 July, South Africa reported 4.453 COVID-19 deaths, but experienced 17.090 more deaths from all natural causes than would be expected based on historical averages. These excess deaths might be attributed to unreported COVID-19 deaths as well as due to other diseases, as health services are re-orientated, but South African researchers deem that COVID-19 underreporting has the biggest role in these unexplained excess deaths (9).

It is also challenging to understand what worked and what did not without reliable data that allow comparison (10). There has been limited testing of asymptomatic cases or of antibody titers to evaluate successes of early interventions in preventing transmission or possible differences in susceptibility between populations of different regions (3, 11). It is also plausible that not all countries have been able to implement and maintain the same containment and control measures for the epidemic over time. Therefore, comparisons are risky, and it is difficult to identify "winning and effective" strategies without considering specific national situations (12–15) as in the recent attempt done in Mali, Burkina Faso, Senegal, and Guinea (16). Often, as in these four countries, the strategies adopted are very similar to those applied in high-income countries, but the contexts are very different, and this seems to lead to suboptimal results. This is the case of measures that have had a strong impact on the existing social and cultural realities, compromising their acceptability within the communities.

In Nigeria, a multisectoral approach was planned including various levels of lockdowns and ban of gatherings. However, the envisaged mobilization of relevant stakeholders was partially missing, faith leaders were not appropriately engaged, and, despite the ban, they conducted congregation services (17); in Ghana, lockdown measures were activated from the earliest cases, but the epidemic was significant even if with a reported low case fatality ratio (0.6%) (6, 18).

IMPACT OF COVID-19 EPIDEMIC'S CONTAINMENT STRATEGIES AND MEASURES

On the basis of what has been reported and discussed in the previous section, the relatively low number of cases and deaths of COVID-19 reported in some African countries might be really far from the real situation. Moreover, the overall impact of the containment strategies and measures should not be underestimated.

Worldwide, lockdown and containment measures have posed major challenges, and the restrictive provisions needed to detect, test, isolate, and track positive cases of SARS-CoV-2 infection involve a very broad spectrum of activity and deeply affect national socio-economic dynamics.

The need for considerations on the impact of these measures is therefore fundamental and even more stringent as regards fragile states. For example, in order to flatten the outbreak curve, some African governments have imposed severe public health measures based on physical distancing to reduce transmission. However, the repercussions of this approach in poor communities may have been underestimated, and it is plausible that, ultimately, the lives lost due to the lockdown could outweigh those saved by COVID-19. In fact, some unwanted and potentially fatal consequences of social isolation are threatening the livelihood of African citizens, worsening the economic situation and increasing food insecurity, finally affecting also social stability and the genuine efforts of some countries in transition toward possible horizons of democracy (16, 19–23).

There is a need for targeted containment interventions monitored over time based on context-specific evidences that gradually consolidate. For example, outcomes from response to the COVID-19 epidemic in Zimbabwe suggest the restriction of the movement of people between different suburbs and between urban and rural areas while allowing some level of economic activity in association with active surveillance and testing for both imported and community cases (24, 25).

Some recent modeling studies show that before implementing travel restrictions, local COVID-19 incidence, local epidemic growth, and travel volumes should be considered, as restrictions seem to affect epidemic dynamics only in countries with low COVID-19 incidence and large numbers of arrivals from other countries, or where epidemics are at exponential growth (26).

The WHO "Pulse survey on continuity of essential health services during the COVID-19 pandemic" reported that all services were affected, including essential services, in nearly all countries, and more so in lower-income than higher-income countries (27, 28).

In many African countries, COVID-19 is "among" the country's epidemics, along with cholera, measles, malaria, and Ebola (29, 30). The COVID-19 epidemic response has exacerbated these fragile situations by reducing access and service delivery, as consequences of re-orientation of services, reduction of mobility, and fear of using the services. The focus on COVID-19 has diverted the attention away from the common pediatric infectious diseases, reproductive health care, the management of obstetric complications, and the provision of routine immunization services, which has been substantially blocked in at least 68 countries around the world, putting around 80 million children under the age of 1 at risk (31, 32).

Modeling estimations show that if the COVID-19 pandemic results in widespread disruption to health systems, childbirth care and child curative services will be the most affected and would account for the greatest number of additional maternal and child deaths (33).

Large numbers of patients in Africa with HIV and tuberculosis are dependent on functional health services, and if access to treatment is reduced or interrupted, the consequences for individual and public health can be substantial (34, 35).

The phenomenon is well-known, especially in Africa. The results from the modeling estimations done after the West African Ebola outbreak of 2014 are emblematic. They showed how dramatic was the impact on malaria, HIV/AIDS, and tuberculosis mortality rates through reduced access to treatment for varying reductions in treatment coverage. The modeling study indicated that 11,300 deaths from the Ebola virus had been nearly matched by 10,600 excess deaths from other diseases, especially malaria, HIV/AIDS, and tuberculosis (9, 36).

Fortunately, there is now awareness on these critical unwanted consequences, and efforts are ongoing to identify viable solutions (37). At this point, the hope is that health systems will not disrupt, but rather strengthen themselves to face the imminent challenges posed by COVID-19 vaccinations (38).

DISCUSSION

The monitoring of the progression of the COVID-19 pandemic in Africa is presently very challenging, mainly due to the very fragile health systems involved, which are struggling to implement containment strategies and to collect data to monitor the situation.

However, even if over time we had more data to monitor the pandemic in the continent, the overall consequences are easily predictable now, even without further modeling studies.

In this critical situation, the health workforce has also decreased, considering that, as per september 2020, more than 42,000 health workers were infected in Africa since the start of the pandemic with around 880 deaths (2.1% CFR) (6).

In addition, the deterioration of the global economy because of the COVID-19 pandemic predicts an increase in absolute poverty (39, 40) and compromises the achievements of the Sustainable Development Goals (41) with additional harsh repercussions on the African continent.

In this situation, an unprecedented and participatory effort involving all stakeholders is requested to identify strategies that can contain the extent of this current protracted emergency without affecting the delivery of primary health care services. The African continent cannot afford the further weakening of its already fragile health system, and the tightness of the system will both increase the availability of reliable data and help to cope with the other dire consequences of this epidemic. Now, more than ever, effective aid and sound cooperation are to be sustained.

AUTHOR CONTRIBUTIONS

MGD drafted the first version of the article. CVR, SD, and GP revised and integrated it. All authors contributed to the article and approved the submitted version.

ACKNOWLEDGMENTS

We thank the reviewer for his/her useful comments and suggestions.

REFERENCES

1. Nordling L. Africa's pandemic puzzle: why so few cases and deaths? *Science*. (2020) 369:756–7. doi: 10.1126/science.369.6505.756
2. Njenga MK, Dawa J, Nanyingi M, Gachohi J, Ngere I, Letko M, et al. Why is there low morbidity and mortality of COVID-19 in Africa? *Am J Trop Med Hyg*. (2020) 103:564–9. doi: 10.4269/ajtmh.20-0474
3. Mbow M, Lell B, Jochems SP, Cisse B, Mboup S, Dewals BG, et al. COVID-19 in Africa: dampening the storm? COVID-19 in Africa: dampening the storm? *Science*. (2020) 369:624–. doi: 10.1126/science.abd3902
4. Diop BZ, Ngom M, Pougué Biyong C, Pougué Biyong JN. The relatively young and rural population may limit the spread and severity of COVID-19 in Africa: a modelling study. *BMJ Glob Health*. (2020) 5:e002699. doi: 10.1136/bmjgh-2020-002699
5. Quaglio GL, Putoto G, Brant H, Preiser W. COVID-19 in Africa: what is at stake? European Parliamentary Research Service (EPRS). European Science Media Hub (ESMH). Available online at: https://sciencemediahub.eu/2020/05/22/covid-19-in-africa-what-is-at-stake/ (accessed September 11, 2020).
6. WHO AFRO region- Situation reports on COVID-19 outbreak n. 28-8. (2020).
7. Our Word in data. Available online at: https://ourworldindata.org/coronavirus
8. WHO. Public health criteria to adjust public health and social measures in the context of COVID-19-. Available online at: https://apps.who.int/iris/bitstream/handle/10665/332073/WHO-2019-nCoV-Adjusting_PH_measures-Criteria-2020.1-eng.pdf?sequence=1&isAllowed=y (accessed May 12, 2020).
9. Dyer O. Covid-19: excess deaths point to hidden toll in South Africa as cases surge. *BMJ*. (2020) 370:m3038. doi: 10.1136/bmj.m3038
10. Bo Y, Guo C, Lin C, Zeng Y, Li HB, Zhang Y, et al. Effectiveness of non-pharmaceutical interventions on COVID-19 transmission in 190 countries from 23 January to 13 April 2020. *Int J Infect Dis*. (2020) 102:247–53. doi: 10.1016/j.ijid.2020.10.066
11. Nordlingaug L. The pandemic appears to have spared Africa so far. Scientists are struggling to explain why. *Science*. (2020). doi: 10.1126/science.abe2825
12. Rutayisire E, Nkundimana G, Mitonga HK, Boye A, Nikwigize S. What works and what does not work in response to COVID-19 prevention and control in Africa. *Int J Infect Dis*. (2020) 97:267–9. doi: 10.1016/j.ijid.2020.06.024
13. Mukwege D, Cadière GB, Vandenberg O. COVID-19 response in sub-saharan low-resource setting: healthcare soldiers need bullets. *Am J Trop Med Hyg*. (2020). 103:549–50. doi: 10.4269/ajtmh.20-0543
14. Blanton RE, Mock NB, Hiruy HN, Schieffelin JS, Doumbia S, Happi C, et al. African resources and the promise of resilience against COVID-19. *Am J Trop Med Hyg*. (2020) 103:539–41. doi: 10.4269/ajtmh.20-0470
15. Taddele Maru M. Africa's Scorecard in Countering Covid-19. Available online at: https://www.ispionline.it/it/pubblicazione/africas-scorecard-countering-covid-19-26520 (accessed June 12, 2020).
16. Ag Ahmed MA, Ly BS, Millimouno TM, Alami H, Faye CL, Boukary S, et al. Willingness to comply with physical distancing measures against COVID-19 in four African countries. *BMJ Global Health*. (2020) 5:e003632. doi: 10.1136/bmjgh-2020-003632
17. Amzat J, Aminu K, Kolo VI, Akinyele AA, Ogundairo JA, Danjibo MC. Coronavirus outbreak in Nigeria: Burden and socio-medical response during the first 100 days. *Int J Infect Dis*. (2020) 98:218–24. doi: 10.1016/j.ijid.2020.06.067
18. Gyader G. Covid-19 in Africa: The Ghanaian Case. Available online at: https://www.ispionline.it/it/pubblicazione/covid-19-ghanaian-case-26459 (accessed June 12, 2020).

19. Carbone G, Casola C. Covid-19 In Africa: Disruptions and Post-Pandemic Scenarios. Available online at: https://www.ispionline.it/it/pubblicazione/covid-19-africa-disruptions-and-post-pandemic-scenarios-26457 (accessed June 16, 2020).
20. Resti J. Sudan's Revolution: One Year On Ispi. Available online at: https://www.ispionline.it/it/pubblicazione/sudan-transition-democracy-far-behind-26273 (accessed May 22, 2020).
21. Barnett-Howell Z, Mushfiq Mobarak A. Should Low-Income Countries Impose the Same Social Distancing Guidelines as Europe and North America to Halt the Spread of COVID-19? Yale School of Management. (2020).
22. Lambert H, Gupte J, Fletcher H, Hammond L, Lowe N, Pelling M, et al. COVID-19 as a global challenge: towards an inclusive and sustainable future. *Lancet Planet Health*. (2020) 4:e312–4. doi: 10.1016/S2542-5196(20)30168-6
23. UN Policy Brief: The Impact of Covid-19 on Food Security And Nutrition (2020). Available online at: https://reliefweb.int/sites/reliefweb.int/files/resources/sg_policy_brief_on_covid_impact_on_food_security.pdf
24. Katsidzira L, Gwaunza L, Hakim JG. The severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) Epidemic in Zimbabwe: Quo Vadis? *Clin Infect Dis*. (2020) 71:2180–3. doi: 10.1093/cid/ciaa552
25. African Scientific, Research and Innovation council (ASRIC). Afro-Centered Non-Pharmaceutical Interventions for COVID-19. (2020).
26. Russel T, Wu JT, Clifford S, Edmunds WJ, Kucharski AJ, Jit M. Effect of internationally imported cases on internal spread of COVID-19: a mathematical modelling study. *Lancet Public Health*. (2020) 6:e12–20. doi: 10.1016/S2468-2667(20)30263-2
27. WHO. Pulse survey on continuity of essential health services during the COVID-19 pandemic. Interim report. Available online at: https://www.who.int/publications/i/item/WHO-2019-nCoV-EHS_continuity-survey-2020.1
28. The Lancet. Editorial, Covid-19: a new lens for non communicable diseases. *Lancet*. (2020) 396:649. doi: 10.1016/S0140-6736(20)31856-0
29. Nachega JB, Mbala-Kingebeni P, Otshudiema J, Zumla A, Tam-Fum JM. The colliding epidemics of COVID-19, Ebola, and measles in the Democratic Republic of the Congo. *Lancet Glob Health*. (2020) 8:e991–2. doi: 10.1016/S2214-109X(20)30281-3
30. Munyaradzi M. COVID-19 worsens Zimbabwe's health crisis. *Lancet*. (2020) 396:457. doi: 10.1016/S0140-6736(20)31751-7
31. At least 80 million children under one at risk of diseases such as diphtheria, measles and polio as COVID-19 disrupts routine vaccination efforts, warn Gavi, WHO and UNICEF. Available online at: https://www.who.int/news-room/detail/22-05-2020-at-least-80-million-children-under-one-at-risk-of-diseases-such-as-diphtheria-measles-and-polio-as-covid-19-disrupts-routine-vaccination-efforts-warn-gavi-who-and-unicef (accessed May 22, 2020).
32. Hungerford D, Cunliffe NA. Coronavirus disease (COVID-19) – impact on vaccine preventable diseases. *Euro Surveill*. (2020) 25:2000756. doi: 10.2807/1560-7917.ES.2020.25.18.2000756
33. Roberton T, Carter ED, Chou VB, Stegmuller AR, Jackson BD, Tam Y, et al. Early estimates of the indirect effects of the COVID-19 pandemic on maternal and child mortality in low-income and middle-income countries: a modelling study. *Lancet Global Health*. (2020) 8:e901–8. doi: 10.1016/S2214-109X(20)30229-1
34. Divala T. Africa faces difficult choices in responding to COVID-19. *Lancet*. (2020) 395:1611. doi: 10.1016/S0140-6736(20)31056-4
35. The Lancet. An African plan to control COVID-19 is urgently needed. *Lancet*. (2020) 396:1777. doi: 10.1016/S0140-6736(20)32580-0
36. Ogunleye OO, Basu D, Mueller D, Sneddon J, Seaton RA, Yinka-Ogunleye AF, et al. Response to the Novel Corona Virus (COVID-19) pandemic across Africa: successes, challenges, and implications for the future. *Front Pharmacol*. (2020) 11:1205. doi: 10.3389/fphar.2020.01205
37. Sands P. HIV, tuberculosis, and malaria: how can the impact of COVID-19 be minimised? *Lancet Glob Health*. (2020) 8:e1102–3. doi: 10.1016/S2214-109X(20)30317-X
38. Parpia AS, Ndeffo-Mbah ML, Wenzel NS, Galvani AP. Effects of response to 2014-2015 Ebola outbreak on deaths from Malaria, HIV/AIDS, and tuberculosis, West Africa. *Emerg Infect Dis*. (2016) 22:433–41. doi: 10.3201/eid2203.150977
39. Gerszon Mahler D,Lakner C, Castaneda Aguilar RA, Wu H. Updated estimates of the impact of COVID-19 on global poverty. Published on Data Blog. World Bank. Available online at: https://blogs.worldbank.org/opendata/updated-estimates-impact-covid-19-global-poverty (accessed June 8, 2020).
40. ILO Monitor: COVID-19 and the world of work. 5th edition. Available online at: https://www.ilo.org/global/topics/coronavirus/impacts-and-responses/WCMS_749399/lang--en/index.htm (accessed June 30, 2020).
41. The Lancet Public Health. Will the COVID-19 pandemic threaten the SDGs? *Lancet Public Health*. (2020) 5:e460. doi: 10.1016/S2468-2667(20)30189-4

Conflict of Interest: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Copyright © 2021 Dente, Resti, Declich and Putoto. This is an open-access article distributed under the terms of the Creative Commons Attribution License (CC BY). The use, distribution or reproduction in other forums is permitted, provided the original author(s) and the copyright owner(s) are credited and that the original publication in this journal is cited, in accordance with accepted academic practice. No use, distribution or reproduction is permitted which does not comply with these terms.

Mozambican Adolescents and Youths during the COVID-19 Pandemic: Knowledge and Awareness Gaps in the Provinces of Sofala and Tete

PAPER

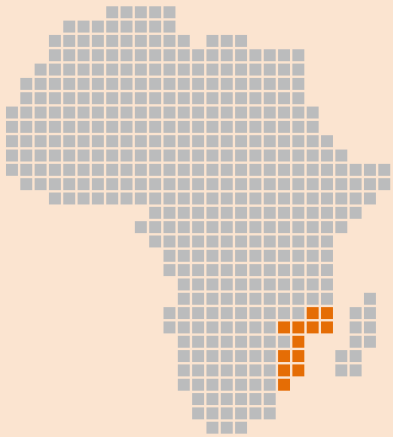
Authors
Marotta C., Nacareia U., Sardon Estevez A., Tognon F., Genna G.D., De Meneghi G., Occa E., Ramirez L., Lazzari M., Di Gennaro F., Putoto G.

Published in
Healthcare,
March 2021

Link
https://doi.org/10.3390/healthcare9030321

Topic
Infectious and tropical diseases

Focus country
Mozambique



healthcare

MDPI

Article

Mozambican Adolescents and Youths during the COVID-19 Pandemic: Knowledge and Awareness Gaps in the Provinces of Sofala and Tete

Claudia Marotta [1], Ussene Nacareia [2], Alba Sardon Estevez [2], Francesca Tognon [1,2], Giselle Daiana Genna [3], Giovanna De Meneghi [3], Edoardo Occa [3], Lucy Ramirez [3], Marzia Lazzari [3], Francesco Di Gennaro [1,*] and Giovanni Putoto [1]

[1] Operational Research Unit, Doctors with Africa CUAMM, 35121 Padua, Italy; marotta.claudia@gmail.com (C.M.); f.tognon@cuamm.org (F.T.); g.putoto@cuamm.org (G.P.)
[2] Dipartimento di Salute della Donna e del Bambino, Università degli Studi di Padova, 35121 Padova, Italy; u.nacareia@cuamm.org (U.N.); a.sardonestevez@cuamm.org (A.S.E.)
[3] Doctors with Africa CUAMM, Beira 2100, Mozambique; giselledaiana.genna@gmail.com (G.D.G.); g.demeneghi@cuamm.org (G.D.M.); e.occa@cuamm.org (E.O.); l.ramirez@cuamm.org (L.R.); m.lazzari@cuamm.org (M.L.)
* Correspondence: francesco.digennaro@inmi.it

check for updates

Citation: Marotta, C.; Nacareia, U.; Estevez, A.S.; Tognon, F.; Genna, G.D.; De Meneghi, G.; Occa, E.; Ramirez, L.; Lazzari, M.; Di Gennaro, F.; et al. Mozambican Adolescents and Youths during the COVID-19 Pandemic: Knowledge and Awareness Gaps in the Provinces of Sofala and Tete. *Healthcare* **2021**, *9*, 321. https://doi.org/10.3390/healthcare9030321

Academic Editors: Daniela Pierannunzio, Silvia Ciardullo and Paola Nardone

Received: 19 February 2021
Accepted: 11 March 2021
Published: 13 March 2021

Publisher's Note: MDPI stays neutral with regard to jurisdictional claims in published maps and institutional affiliations.

Copyright: © 2021 by the authors. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (https://creativecommons.org/licenses/by/4.0/).

Abstract: (1) Background: Mozambique has an average population age of 17 years and adolescents and youths have a pivotal role in SARS-CoV-2 pandemic control. (2) Methods: We conducted a cross-sectional study in order to assess the awareness and information needs with regard to COVID-19 among a sample of adolescents and youths from two different Mozambican provinces. (3) Results: Only 25% of adolescents and youths had a high level of awareness and only 543/2170 participants reported a high level of knowledge regarding COVID-19. In our multivariate model, significant predictors of reporting a high level of knowledge about COVID-19 include female sex (O.R. = 1.47; 95% confidence interval (CI) 1.23–2.89), having a house without a thatched roof (O.R. = 1.85; 95% CI 1.02–2.95) and HIV-positive status (O.R. = 1.56; 95% CI 1.36–2.87). (4) Conclusions: Our study highlights an important and relevant knowledge gap in adolescents and youths with respect to the COVID-19 pandemic. Involving young people and adolescents in the fight against SARS-CoV-2 is an essential strategy, especially in countries where the national average age is young, such as Mozambique, and where this epidemic can aggravate an already fragile health system.

Keywords: SARS-CoV-2; Mozambique; adolescent; Africa; preparedness; global health

1. Introduction

Since the first confirmed case of COVID-19 in Algeria on 25 February 2020, more than four million cases of COVID-19 have been reported in the WHO African Region, along with more than 100,000 deaths [1]. Mozambique—one of the last countries to be affected in Africa—reported its first positive case of COVID-19 on 22 March 2020, a 75-year-old Mozambican man who returned from the United Kingdom (UK). Since then, more than 50,000 confirmed cases of COVID-19 have been recorded in Mozambique and Maputo, the capital of the country, has the highest number of cases of SARS-CoV-2 infection, with more 140 deaths [2,3], and 126 districts out of 128 having announced at least one case of COVID-19 [3]. However, data on COVID-19 in Africa and, in particular, in Mozambique, are scarce [4].

The country continues to expand its testing capacity, having carried out less than 300,000 tests since the start of the pandemic so far (roughly equivalent to the number of tests carried out by European countries in two days), which could imply that there is a strong level of under-reporting of COVID-19 cases [5].

Mozambique, like most African countries, is primarily made up of young people, with a population that has an average age of 17 years [6]. Even though people of any age can contract COVID-19, the young are less likely than older people to become seriously ill; however, the pandemic is still having a huge impact on the lives of this group. Containment measures, such as lockdowns, the closure of schools and physical distancing, pose many challenges, including interruptions to education and daily routines, increasing levels of domestic violence, stress and mental health issues [7]. Moreover, the role of young people is well established as pivotal to pandemic control, due to the fact that this age group has a higher number of asymptomatic cases, thereby acting as potential vectors of SARS-CoV-2 infection within communities and families [8]. However, if young people are empowered, inspired, engaged, and given the opportunity to lead, they will rise to these challenges, help create community resilience, and drive social change during the pandemic. Furthermore, young people are more frequently exposed to social media and television than other age groups.

Among the important aspects when referring to Mozambique and to the complexity of the effects that the pandemic could have in this context are the high levels of endemic HIV, tuberculosis and malaria in the country. On the one hand, the presence of these diseases reflects the presence of risk factors for a worse outcome following SARS-CoV-2 infection and, on the other hand, highlights how the response to the COVID-19 pandemic can shift and drastically reduce the economic and human resources provided for the battle against these major killers (HIV, TB and malaria) [9–12]. Moreover, especially for HIV, as has already occurred in other cases in the past [13], this may also lead to a decline in HIV care, with a risk of lower levels of clinical follow-up, a challenge in obtaining antiretroviral medications, clinical worsening in the short and long term and, more generally, a reduction in disease control [14].

The purpose of our research is therefore to study awareness and understanding of SARS-CoV-2 in young, HIV-positive people from two provinces in Mozambique: Sofala and Tete. The knowledge gap we expect to document and identify could be helpful in informing targeted interventions.

2. Materials and Methods

2.1. Study Setting, Design and Population

Since 1978, Doctors with Africa—CUAMM have had the goal of enhancing the provision of specific facilities for adolescents and young people in Mozambique (10–24 years), from creating healthcare units, *Servico amigo do adolescente e jovem* (SAAJ), schools and communities, building relationships between these services, and providing technical assistance to the health authorities of the Provincial Directorate of Health of Tete and Sofala.

As part of the COVID-19 emergency response, between April and July 2020, Doctors with Afr—CUAMM conducted a survey study using a cross-sectional methodology [15] in order to intercept the awareness and information needs regarding COVID-19 among a sample of adolescents and youths attending 10 SAAJs supported by Doctors with Afr—CUAMM:

- Three in the Province of Tete, one for each of the following districts: Angonia, Moatize and Tete City;
- Seven in the Province of Sofala, all in the district of Beira City, where only adolescents and youths living with HIV were considered.

The eligible population included all persons aged 10–24 years who were enrolled on the lists of the SAAJ.

Exclusion criteria were the unavailability of a telephone number contained within the SAAJ registry, no response after at least three attempts (two attempts in the morning/afternoon and one attempt in the evening), refusal to answer the questionnaire, and institutionalization (convent, prison, hospital, etc.).

A standardized questionnaire was administered through a telephone interview by healthcare activists. The telephone numbers of participants were collected through the patient lists of adolescent services (SAAJs) within the health centers.

Training was provided to all interviewers to standardize the procedures and to ensure the quality of data collection. At the beginning of the interview, informed consent was obtained and the survey aims were explained, as well as the methods used to ensure the confidentiality of the data. At the end of the interview, participants received health advice if requested.

The collected data were entered in a dedicated database and a quality control check of the data entry was performed before data analysis.

The questionnaire was made up of questions with multiple and open-text answers, divided into four sections: (I) socio-demographic information, (II) knowledge of COVID-19 signs and symptoms, (III) knowledge of preventive measures and risk factors, and (IV), for HIV patients, a final section, consisting of questions on the challenges of antiretroviral treatment in the context of the COVID-19 pandemic.

2.2. Statistical Analysis

Descriptive analysis was performed to define the distribution of the characteristics of the sample and a $\chi 2$ test (with Fisher's correction if less than five cases were present in a cell) was applied for categorical variables. The study outcome was having a "high level of knowledge on COVID-19". The role of HIV status against the level of knowledge was also investigated within the analysis.

Participants' level of knowledge with regard to COVID-19 was classified as low–medium and high on the basis of answers provided to the questions about COVID-19 signs and symptoms, risk factors/transmission and prevention measures. A logistic regression model was implemented as follows. A high level of knowledge on COVID-19 was considered as a dependent variable and each one of the available factors at the baseline evaluation as independent variables (univariate analysis). In the multivariate analysis, factors with a p-value < 0.10, as assessed by univariate analysis, were included. Multicollinearity among covariates was assessed through the variance inflation factor, taking a value of 2 as cut-off to exclude a covariate. However, no variables were excluded according to this pre-specified criterion. Odds ratios (O.R.s) as adjusted odds ratios (adj-O.R.s) with 95% confidence intervals (CIs) were used to measure the strength of the association between factors at the baseline (exposure) and high level of knowledge about COVID-19 (outcome). All statistical tests were two-tailed and statistical significance was assumed for a p-value < 0.05. Statistical analyses were performed with GraphPad Prism version 8.0 (GraphPad Software, Inc., San Diego, CA, USA).

3. Results

Between April and July, a total of 2170 Mozambiquan adolescents and youths agreed to participate in the study and were interviewed: 1580 (F 964, 61%) were from Tete and 590 (F 445, 75%) were from Sofala province. Demographic and socio-economic characteristics, compared by province, are shown in Table 1.

On the basis of the answers provided to questions regarding signs and symptoms, risk factors/transmission and prevention measures for SARS-CoV-2 infection, participants' awareness was measured.

Since participants from Sofala Province were all HIV positive, extra questions about difficulties in antiretroviral treatment supply during COVID-19 were provided. While 99.7% of them reported that they had received antiretroviral drugs during the pandemic, 90% were not able to estimate the length in days of the coverage provided by the medicine supplied to them (Table 2).

Table 1. Demographic and socio-economic characteristics and level of knowledge about COVID-19 signs and symptoms, risk factors/transmission and prevention measures, compared by participants being HIV positive (Sofala province) or not (Tete).

			Total n. 2170 n (%)	**Province of Tete n. 1580 n (%)**	**Province of Sofala n. 590 n (%)**
Demographic information	Sex	M	761 (35)	616 (39)	145 (25)
		F	1409 (65)	964 (61)	445 (75)
	Age	10–14 y	91 (4)	6 (0.4)	85 (14)
		15–19 y	145 (7)	0 (0)	145 (25)
		20–24 y	1934 (89)	1574 (99.6%)	360 (61%)
	District	Tete City	429 (20)	429 (27)	-
		Angonia	752 (35)	752 (48)	-
		Moatize	399 (18)	399 (25)	-
		Beira City	590 (27)	0 (0)	590 (100)
	HIV status	positive	590 (100)	-	590 (100)
Socio-economic factors	Number of family members, median		4.9	4.8	5.1
	House without water supply		548 (25)	490 (31)	58 (10)
	House without latrine		170(78)	1339 (85)	365 (62)
	Thatched roof		385 (18)	372 (24)	13 (2)
	Sand floor/non-washable floor		501 (23)	433 (28)	68 (12)
	Availability of soap and water for hand washing		1752 (81)	1182 (81)	570 (97)
	Awareness about COVID-19 pandemic		2155(99)	1570 (99)	585 (99)
Level of knowledge	Signs and symptoms	Low	858(39)	711 (45)	147 (25)
		Medium	898(41)	632 (40)	266 (45)
		High	544(20)	237 (15)	307 (20)
	Risk factors/transmission	Low	747(35)	600 (38)	147 (25)
		Medium	878(40)	648 (41)	230 (39)
		High	545(25)	332 (21)	213 (36)
	Prevention measures	Low	740(34)	600 (38)	140 (24)
		Medium	829(38)	660 (42)	229 (40)
		High	541(25)	320 (20)	221 (37)
	Source of information on COVID-19	Health center	505(23)	415 (26)	90 (15)
		Media (TV/radio/Internet/ social media)	1559(72)	1072 (68)	487 (83)
		Other people	105(5)	93 (6)	13 (2)

A total of 543 (25%) participants reported a high level of knowledge about COVID-19.

No difference was documented between participants reporting different levels of knowledge as regards having a house with a sand floor (p-value: 0.078) and awareness about the COVID-19 pandemic (p-value: 0.12). On the contrary, older age (age group 20–24 y 75%; p-value: 0.006), being male (79%, p-value: 0.001), living in a house without a water supply (93%, p-value: <0.0001), without a latrine (94%, p-value: <0.0001), with a thatched roof (91%, p-value: <0.0001) and with the availability of soap and water for hand washing (86%, p-value: <0.0001) were more frequent in participants with a low–medium level of knowledge of COVID-19 (Table 3).

Table 2. Antiretroviral treatment during COVID-19 pandemic.

		Sofala Provinces (n. 590)
Received antiretroviral drugs during the pandemic	Yes	588 (99.7%)
	No	2 (0.3%)
Coverage of medicines (days)	30 days	25 (4%)
	60 days	1 (0%)
	90 days	34% (6%)
	Not known	530 (90%)

Table 3. Comparison between levels of knowledge reported by participants.

				Level of Knowledge		*p*-Value
			Total n. 2170 n (%)	**High n.543 n (%)**	**Low–Medium n.1627 n (%)**	
Demographic information	Sex	M F	761 (35) 1409 (65)	159(21) 384(27)	602(79) 1025(73)	0.001
	Age	10–14 y 15–19 y 20–24 y	91 (4) 145 (7) 1934 (89)	10 (10) 39(27) 494(25)	81(90) 106 (73) 1440 (75)	0.006
	HIV status	positive	590 (100)	328 (56)	262 (44)	<0.0001
Socio-economic factors	Number of family members, median		4.9	4.9	5.1	-
	House without water supply		548 (25)	41(7)	507(93)	<0.0001
	House without latrine		1704 (78)	98(6)	1606(94)	<0.0001
	House with thatched roof		385 (18)	43(9)	342(91)	<0.0001
	House with sand floor/non-washable floor		501 (23)	110(22)	391(78)	0.078
	Availability of soap and water for hand washing at home		1752 (81)	251 (14)	1501(86)	<0.0001
	Awareness about COVID-19 pandemic		2155(99)	562 (26)	1593 (74)	0,12
	Source of information on COVID-19	Health center	506(23)	198 (39)	308 (61)	<0.0001
		Media (TV/radio/Internet/social media)	1559(72)	342(22)	1217 (78)	
		Other people	105(5)	4 (4)	101 (96)	

The multivariate model considered the effects of age, HIV status, living in a house without a latrine, with a thatched roof, with the availability of soap and water for hand washing and different sources of health information. Significant predictors of reporting a high level of knowledge of COVID-19, reported in Table 4, include: female sex (O.R. = 1.47; 95% CI 1.23–2.89), having a house without a thatched roof (O.R. = 1.85; 95% CI 1.02–2.95) and HIV-positive status (O.R. = 1.56; 95% CI 1.36–2.87).

Table 4. Predictors of high level of knowledge about COVID-19.

		OR	95% CI	*p*-Value
Age		0.986	0.912–1.624	0.287
Sex	Male	ref	1.23–2.89	0.003
	Female	1.47		
HIV status	Negative	ref	1.36–2.87	0.010
	Positive	1.56		
House without latrine	No	ref	0.85–2.37	0.168
	Yes	1.03		
House without thatched roof	No	ref	1.02–2.95	0.001
	Yes	1.85		
Availability of soap and water for hand Washing at home	No	ref	0.27–2.14	0.776
	Yes	0.85		
Source of health information	Media	ref	0.61–2.10	0.230
	Health center	1.34		

4. Discussion

Our study evaluates the knowledge and awareness gaps with regard to SARS-CoV-2 in 2170 Mozambican adolescents and youths from two different provinces (Sofala and Tete), and four districts (Tete City, Angonia, Moatize, Beira City). Despite the fact that the pandemic has been ongoing for a year at this point, there was still a huge knowledge gap. In fact, only 25% of adolescents and youths had a high level of awareness and, similarly, only 25% of participants reported a high level of knowledge about COVID-19. Older age, being male, living in a house without a water supply, without a latrine, with a thatched roof and with the availability of soap and water for hand washing were more frequent in participants reporting a low–medium level of knowledge about COVID-19. In the multivariate model, significant predictors of a high level of knowledge about COVID-19 were being female, having a house without a thatched roof and having a HIV-positive status. Furthermore, 72% of respondents reported that they seek information about SARS-CoV-2 from the media. As for the sub-sample, made up of HIV-positive adolescents and youths (590/2170), when asked about the coverage of drugs, 90% of them declared that they did not remember the quantity of medication available to them in order to avoid a possible lack of a follow-up visit due to the pandemic.

Few data are available on the knowledge of COVID-19 among adolescents and youths, especially in African countries [16]. At-risk populations' demographic characteristics play a vital role in the type and intensity of measures necessary to curb the spread of the virus. Improving the knowledge of an infectious disease is usually considered the first approach to any implementable health mitigation strategy, including increasing public awareness of preventive measures to stop transmission [17]. For these reasons, adolescents can be an important resource in mitigating strategies and community outreach in a pandemic, especially in the African context. As several authors report, SARS-CoV-2 infection in adolescents is more often asymptomatic and/or paucisymptomatic, but they play a central role in the spread of the virus, as they are vehicles for infection within communities and families [18,19]. Furthermore, African countries—especially Mozambique—are primarily made up of young people. In fact, considering that Mozambique has an average age of 17 years, investigating the level of knowledge of young people with regard to COVID-19 allows us to indirectly assess the level of awareness of the pandemic in the general population as a whole. Our data are similar to a study carried out in the South West Region of Cameroon, where almost 50% of the study population showed a low level of knowledge

about COVID-19, while a study from Nigeria showed a higher level of knowledge. The authors correlate this difference with the composition of the study sample, which was made up of participants of a high socio-economic level [20,21]. Furthermore, in our study, in both provinces investigated, adolescents and young people claimed to receive information on SARS-CoV-2 from the media, such as the radio, TV and Internet. As other studies from the US and China have underlined, the role of social media can be twofold: on the one hand, it allows information to be disseminated to a large extent, but, on the other hand, information from these sources are not verified and there is a high risk of misinformation, which can negatively impact any mitigation strategies against the pandemic [22–24]. Therefore, it is recommended that specific programs be developed to target young people, with effective communication strategies with regard to preventative measures against COVID-19, in order to allow for greater dissemination and adherence within communities. In our multivariate analysis, a high level of knowledge was associated with being female and HIV-positive status. With regard to HIV status, this could be explained by the fact that HIV-positive adolescents are targeted by programs with a focus on the importance of behaviors, health measures, and therapy adherence. Moreover, community activists play a huge role in guarantying health education and awareness within the community in order to fight against the lost-to-follow-up phenomenon [13,25]. For these reasons, it could be hypothesized that, for this population, keeping in contact with a health personnel, both through outpatient services and/or outreach initiatives by health activists, gave them the chance to be informed about COVID-19 as well as HIV.

Attention should be paid to the findings regarding medicine coverage, since many HIV-positive youths declared that they did not have enough medicine, or could not remember the exact timeframe of the coverage provided by the medicine they had. This can be difficult to interpret, as the number of patients lost to follow-up is high in Mozambique, and we do not know how much the COVID-19 pandemic has affected the interruption of HIV services and therapeutic continuity, which can have devastating effects due to the worsening of the clinical stage and resistance to medium-term therapeutic treatments and drugs. Moreover, several sources have shown that the COVID-19 outbreak is accelerating, with a transition to widespread community transmission [26–28].

We recognize that there are some limitations to our study: first of all, we presented data from a convenience sample (a non-representative sample), related only to two provinces in Mozambique, and unbalanced for variables such as age and gender. This should be considered when generalizing these results, as their external validity could be weak. On the contrary, this data collection represents an important struggle when considering the complexity of the rural settings studied. Moreover, more variables on factors that potentially influence knowledge and awareness, such as socioeconomic characteristics, e.g., income, educational status and evaluation of personal experiences of COVID-19, as well as the role of schools in health education, could have been collected and considered in the analysis.

Further research, implementing other study designs focusing on the determinants that emerged through our preliminary descriptive analysis, should be considered.

5. Conclusions

In conclusion, our study outlines an important and relevant knowledge gap in a sample of Mozambican adolescents and youths with respect to the COVID-19 pandemic. An urgent need to reinforce education on preventive measures and intensify sensitization campaigns has emerged. The active engagement of young people and adolescents in the fight against SARS-CoV-2 could be an essential strategy, especially in countries where the national average age is very low, such as Mozambique, and where the pandemic can aggravate the already fragile health system, in a country that is already struggling with "chronic epidemics", such as those of malaria, HIV and tuberculosis.

Interestingly, the WHO's Regional Office for the Eastern Mediterranean produced a youth engagement framework, Youth for Health, which identifies three key objectives in any initiative intended to engage young people: empowerment, action and [29] par-

ticipation. In the same direction, field experiences with regard to adolescent and youth engagement, reported in other countries such as Guinea Bissau [30], could be widely implemented after adapting them to the present context.

It is also recommended that public policies to reduce misinformation and misunderstandings about COVID-19 are designed, alongside the creation of communication strategies to avoid stigma or discrimination against people living with HIV/AIDS and/or those who have contracted COVID-19 in order to prevent people who suffer from these diseases from presenting themselves, without prejudice, to health facilities for proper monitoring and treatment. Moreover, maintaining outpatient services for HIV patients to guarantee the continuity of antiretroviral treatments and avoid devastating effects on HIV control in the short, medium and long term is crucial.

Author Contributions: Conceptualization F.D.G., E.O.; methodology C.M., G.D.G., L.R., G.D.M.; data curation U.N., A.S.E., F.T., G.D.G., E.O., M.L.; writing—original draft preparation F.D.G., G.P., C.M.; writing—review and editing G.P., F.T. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Institutional Review Board Statement: This study was conducted following the Declaration of Helsinki, as well as national and institutional standards.

Informed Consent Statement: Written informed consent was obtained from the patient(s) with regard to the publication of this paper.

Data Availability Statement: Not applicable.

Acknowledgments: We thank all the activists of the associations who made this project possible. We also thank the beneficiaries, who are always and will be our compass in our clinical, research and cooperation activities.

Conflicts of Interest: The authors declare no conflict of interest.

References

1. World Health Organization (WHO). WHO Coronavirus Disease (COVID-19) Dashboard. Available online: https://covid19.who.int/ (accessed on 16 February 2021).
2. Ministry of Health of Mozambique (MISAU) Mozambique. COVID-19: Boletins Diários COVID 19 N 335. Available online: https://www.misau.gov.mz/index.php/covid-19-boletins-diarios (accessed on 17 February 2021).
3. World Health Organization (WHO). Mozambique Country Profile. Available online: https://covid19.who.int/region/afro/country/mz (accessed on 30 January 2021).
4. Moodley, K.; Rennie, S.; Behets, F.; Obasa, A.E.; Yemesi, R.; Ravez, L.; Kayembe, P.; Makindu, D.; Mwinga, A.; Jaoko, W. Allocation of Scarce Resources in Africa During COVID-19: Utility and Justice for the Bottom of the Pyramid? *Dev. World. Bioeth.* **2020**, *21*, 36–43. [CrossRef]
5. National Institute of Health of Mozambique (INS) COVID-19. Available online: https://covid19.ins.gov.mz/ (accessed on 12 February 2021).
6. United Nations Population Fund (UNFPA). Adolescents and Youth Dashboard—Mozambique. Available online: https://www.unfpa.org/data/adolescent-youth/MZ (accessed on 28 January 2021).
7. Singh, S.; Roy, D.; Sinha, K.; Parveen, S.; Sharma, G.; Joshi, G. Impact of COVID-19 and Lockdown on Mental Health of Children and Adolescents: A Narrative Review with Recommendations. *Psychiatry Res.* **2020**, *293*, 113429. [CrossRef]
8. Magaço, A.; Munguambe, K.; Nhacolo, A.; Ambrósio, C.; Nhacolo, F.; Cossa, S.; Macete, E.; Mandomando, I. Challenges and Needs for Social Behavioural Research and Community Engagement Activities during the COVID-19 Pandemic in Rural Mozambique. *Glob. Public Health* **2020**, *16*, 1–5. [CrossRef] [PubMed]
9. Dzinamarira, T.; Dzobo, M.; Chitungo, I. COVID-19: A Perspective on Africa's Capacity and Response. *J. Med. Virol.* **2020**, *92*, 2465–2472. [CrossRef]
10. Di Gennaro, F.; Marotta, C.; Locantore, P.; Pizzol, D.; Putoto, G. Malaria and COVID-19: Common and Different Findings. *Trop. Med. Infect. Dis.* **2020**, *5*, 141. [CrossRef]
11. Sands, P. HIV, Tuberculosis, and Malaria: How Can the Impact of COVID-19 be Minimised? *Lancet Glob. Health* **2020**, *8*, e1102–e1103. [CrossRef]
12. Marotta, C.; Giaquinto, C.; Di Gennaro, F.; Chhaganlal, K.D.; Saracino, A.; Moiane, J.; Maringhini, G.; Pizzol, D.; Putoto, G.; Monno, L.; et al. Pathways of Care for HIV Infected Children in Beira, Mozambique: Pre-post Intervention Study to Assess Impact of Task Shifting. *BMC Public Health* **2018**, *18*, 703. [CrossRef]

13. Pozniak, A.; Atzori, A.; Marotta, C.; Di Gennaro, F.; Putoto, G. HIV Continuity of Care After Cyclone Idai in Mozambique. *Lancet HIV* **2020**, *7*, e159–e160. [CrossRef]
14. Hogan, A.B.; Jewell, B.L.; Sherrard-Smith, E.; Vesga, J.F.; Watson, O.J.; Whittaker, C.; Hamlet, A.; Dphil, J.A.S.; Winskill, P.; Verity, R.; et al. Potential Impact of the COVID-19 Pandemic on HIV, Tuberculosis, and Malaria in Low-income and Middle-income Countries: A Modelling Study. *Lancet Glob. Health* **2020**, *8*, e1132–e1141. [CrossRef]
15. Check, J.; Schutt, R.K. *Research Methods in Education*; Sage Publications: Thousand Oaks, CA, USA, 2012; pp. 159–185.
16. Addae, E.A. COVID-19 Pandemic and Adolescent Health and Well-being in Sub-Saharan Africa: Who Cares? *Int. J. Health Plan. Manag.* **2021**, *36*, 219–222. [CrossRef] [PubMed]
17. Götzinger, F.; Santiago-García, B.; Noguera-Julián, A.; Lanaspa, M.; Lancella, L.; Carducci, C.F.I.; Gabrovska, N.; Velizarova, S.; Prunk, P.; Osterman, V.; et al. COVID-19 in Children and Adolescents in Europe: A Multinational, Multicentre Cohort Study. *Lancet Child Adolesc. Health.* **2020**, *4*, 653–661. [CrossRef]
18. Chen, Y.; Klein, S.L.; Garibaldi, B.T.; Li, H.; Wu, C.; Osevala, N.M.; Li, T.; Margolick, J.B.; Pawelec, G.; Leng, S.X. Aging in COVID-19: Vulnerability, Immunity and Intervention. *Ageing Res. Rev.* **2021**, *65*, 101205. [CrossRef]
19. Kronbichler, A.; Kresse, D.; Yoon, S.; Lee, K.H.; Effenberger, M.; Shin, J.I. Asymptomatic Patients as a Source of COVID-19 Infections: A Systematic Review and Meta-analysis. *Int. J. Infect. Dis.* **2020**, *98*, 180–186. [CrossRef]
20. Nicholas, T.; Mandaah, F.V.; Esemu, S.N.; Vanessa, A.B.T.; Gilchrist, K.T.D.; Vanessa, L.F.; Shey, N.D. COVID-19 Knowledge, Attitudes and Practices in a Conflict Affected Area of the South West Region of Cameroon. *Pan. Afr. Med. J.* **2020**, *35*, 1–8. [CrossRef]
21. Reuben, R.C.; Danladi, M.M.; Saleh, D.A.; Ejembi, P.E. Knowledge, Attitudes and Practices towards COVID-19: An Epidemiological Survey in North-Central Nigeria. *J. Commun. Health* **2020**, 10071–10900. [CrossRef]
22. Olum, R.; Chekwech, G.; Wekha, G.; Nassozi, D.R.; Bongomin, F. Coronavirus Disease-2019: Knowledge, Attitude, and Practices of Health Care Workers at Makerere University Teaching Hospitals, Uganda. *Front. Public Health* **2020**, *8*, 1–9. [CrossRef] [PubMed]
23. Hager, E.; Odetokun, I.A.; Bolarinwa, O.; Zainab, A.; Okechukwu, O.; Al-Mustapha, A.I. Knowledge, Attitude, and Perceptions Towards the 2019 Coronavirus Pandemic: A Bi-national Survey in Africa. *PLoS ONE* **2020**, *15*, e0236918. [CrossRef] [PubMed]
24. Xu, H.; Gan, Y.; Zheng, D.; Wu, B.; Zhu, X.; Xu, C.; Liu, C.; Tao, Z.; Hu, Y.; Chen, M.M.; et al. Relationship Between COVID-19 Infection and Risk Perception, Knowledge, Attitude, and Four Nonpharmaceutical Interventions During the Late Period of the COVID-19 Epidemic in China: Online Cross-sectional Survey of 8158 Adults. *J. Med. Internet Res.* **2020**, *22*. [CrossRef] [PubMed]
25. Nyakarahuka, L.; Skjerve, E.; Nabadda, D.; Sitali, D.C.; Mumba, C.; Mwiine, F.N.; Lutwama, J.J.; Balinandi, S.; Shoemaker, T.; Kankya, C. Knowledge and Attitude Towards Ebola and Marburg Virus Diseases in Uganda Using Quantitative and Participatory Epidemiology Techniques. *PLoS Negl. Trop. Dis.* **2017**, *11*, e0005907. [CrossRef]
26. Chenneville, T.; Gabbidon, K.; Hanson, P.; Holyfield, C. The Impact of COVID-19 on HIV Treatment and Research: A Call to Action. *Int. J. Environ. Res. Public Health* **2020**, *17*, 4548. [CrossRef]
27. Di Gennaro, F.; Marotta, C.; Pizzol, D.; Chhaganlal, K.; Monno, L.; Putoto, G.; Saracino, A.; Casuccio, A.; Mazzucco, W. Prevalence and Predictors of Malaria in Human Immunodeficiency Virus Infected Patients in Beira, Mozambique. *Int. J. Environ. Res. Public Health* **2018**, *15*, 2032. [CrossRef] [PubMed]
28. Kanwugu, O.N.; Adadi, P. HIV/SARS-CoV-2 Coinfection: A Global Perspective. *J. Med. Virol.* **2021**, *93*, 726–732. [CrossRef] [PubMed]
29. World Health Organitation (WHO). WHO EMRO | Engaging Young People in the Response to COVID-19 in WHO's Eastern Mediterranean Region. Available online: http://www.emro.who.int/pdf/media/news/engaging-young-people-in-the-response-to-covid-19-in-whos-eastern-mediterranean-region.pdf?ua=1 (accessed on 2 February 2021).
30. United Nation (UN). Engaging Women and Youth in Fighting COVID-19. Available online: https://www.unv.org/Success-stories/Engaging-women-and-youth-fighting-COVID-19 (accessed on 28 May 2020).

Modeling the interplay between demography, social contact patterns, and SARS-CoV-2 transmission in the South West Shewa Zone of Oromia Region, Ethiopia

PAPER

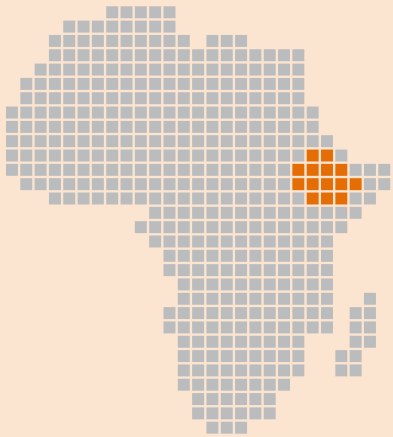
Authors
Trentini F., Guzzetta G., Galli M., Zardini A., Manenti F., Putoto G., Marziano V., Gamshie W. N., Tsegaye A., Greblo A., Melegaro A., Ajelli M., Merler S. & Poletti P.

Published in
BMC Medicine,
April 2021

Link
https://doi.org/10.1186/s12916-021-01967-w

Topic
Infectious and tropical diseases

Focus country
Ethiopia



Trentini *et al. BMC Medicine* (2021) 19:89
https://doi.org/10.1186/s12916-021-01967-w

BMC Medicine

RESEARCH ARTICLE Open Access

Modeling the interplay between demography, social contact patterns, and SARS-CoV-2 transmission in the South West Shewa Zone of Oromia Region, Ethiopia

Filippo Trentini[1], Giorgio Guzzetta[1], Margherita Galli[1,2], Agnese Zardini[1,3], Fabio Manenti[4], Giovanni Putoto[4], Valentina Marziano[1], Worku Nigussa Gamshie[5], Ademe Tsegaye[6], Alessandro Greblo[4], Alessia Melegaro[7,8], Marco Ajelli[9,10], Stefano Merler[1] and Piero Poletti[1*]

Abstract

Background: COVID-19 spread may have a dramatic impact in countries with vulnerable economies and limited availability of, and access to, healthcare resources and infrastructures. However, in sub-Saharan Africa, a low prevalence and mortality have been observed so far.

Methods: We collected data on individuals' social contacts in the South West Shewa Zone (SWSZ) of Ethiopia across geographical contexts characterized by heterogeneous population density, work and travel opportunities, and access to primary care. We assessed how socio-demographic factors and observed mixing patterns can influence the COVID-19 disease burden, by simulating SARS-CoV-2 transmission in remote settlements, rural villages, and urban neighborhoods, under school closure mandate.

Results: From national surveillance data, we estimated a net reproduction number of 1.62 (95% CI 1.55–1.70). We found that, at the end of an epidemic mitigated by school closure alone, 10–15% of the population residing in the SWSZ would have been symptomatic and 0.3–0.4% of the population would require mechanical ventilation and/or possibly result in a fatal outcome. Higher infection attack rates are expected in more urbanized areas, but the highest incidence of critical disease is expected in remote subsistence farming settlements. School closure contributed to reduce the reproduction number by 49% and the attack rate of infections by 28–34%.

Conclusions: Our results suggest that the relatively low burden of COVID-19 in Ethiopia observed so far may depend on social mixing patterns, underlying demography, and the enacted school closures. Our findings highlight that socio-demographic factors can also determine marked heterogeneities across different geographical contexts within the same region, and they contribute to understand why sub-Saharan Africa is experiencing a relatively lower attack rate of severe cases compared to high-income countries.

Keywords: COVID-19, SARS-CoV-2, Mixing patterns, Contact data, Rural, Urban, Contact matrix, Transmission model, Epidemic

* Correspondence: poletti@fbk.eu
[1]Center for Health Emergencies, Bruno Kessler Foundation, Trento, Italy
Full list of author information is available at the end of the article

© The Author(s). 2021 **Open Access** This article is licensed under a Creative Commons Attribution 4.0 International License, which permits use, sharing, adaptation, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons licence, and indicate if changes were made. The images or other third party material in this article are included in the article's Creative Commons licence, unless indicated otherwise in a credit line to the material. If material is not included in the article's Creative Commons licence and your intended use is not permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder. To view a copy of this licence, visit http://creativecommons.org/licenses/by/4.0/. The Creative Commons Public Domain Dedication waiver (http://creativecommons.org/publicdomain/zero/1.0/) applies to the data made available in this article, unless otherwise stated in a credit line to the data.

Background

Despite limited access to healthcare [1, 2] and relatively milder social distancing restrictions compared to those imposed in most high-income countries [3, 4], coronavirus disease 2019 (COVID-19) mortality rates have been relatively low throughout Africa [5]. As of January 24, 2021, the World Health Organization (WHO) reports 2,462,083 diagnosed cases and 57,902 deaths in the continent [5]. However, severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) transmission dynamics have been highly heterogeneous across different African countries in terms of timing and implemented interventions [6].

In sub-Saharan Africa, Ethiopia is second only to South Africa in terms of the number of recorded cases and deaths, with an overall case fatality ratio (CFR) of about 1.5% compared to about 2.2% in the rest of the world [5]. The first COVID-19 case was confirmed on March 13, 2020, and, less than a month later, the Ethiopian Prime Minister declared a state of emergency in the country on April 8, 2020 [7]. Since then, rigorous contact tracing, isolation, and compulsory quarantine have been established [8, 9]. Borders and school closure were implemented, public institutions and firms operated at minimum capacity or under complete closure, and people were advised to stay at home [8]. However, in November 2020, schools reopened in the entire country, and social gatherings were allowed again. As of January 24, 2021, 133,298 SARS-CoV-2 infections and 2063 deaths [5] were ascertained in the entire country, with thousands of cases reported in all the 12 regions of Ethiopia [9]. In Ethiopia, a syndromic surveillance is carried out to identify SARS-CoV-2 infected individuals. Samples from suspected cases and case contacts are collected at different health facilities displaced in the country (including health centers serving the most rural areas) and cases are confirmed via real-time reverse transcription–polymerase chain reaction (RT-PCR) test. Collected samples are analyzed by 38 national, regional, hospital, and private laboratories [10]. Both suspected and laboratory-confirmed cases are admitted to isolation centers and discharged after a negative laboratory test [9]. Although swab testing was initially applied to both symptomatic patients and all close contacts of cases, it is possible that, due to limited resources and the increased number of cases in the country, only symptomatic case contacts are currently tested. Active monitoring of cases conducted by the Ethiopian Public Health Institute suggested that 52% of the identified positive cases were asymptomatic [11]. As of January 10, 2021, the overall rate for positive laboratory test results since the first detection of the epidemic in the country was 6.9% [9].

The possible spread of SARS-CoV-2 in rural areas of the country is especially dangerous because of the sparse presence of well-resourced health facilities implying long travel distances for remote populations, which is an important barrier to universal access to primary care [2]. Moreover, the healthcare workforce in Ethiopia is 5 times lower than the minimum threshold defined by the WHO for Sustainable Development Goals health targets [12] and far below the African average [13].

Recent modeling studies investigated the impact of control measures, such as self-isolation and temporary lockdowns, in a number of sub-Saharan African countries, highlighting the difficulties in defining effective, feasible, and sustainable strategies for suppression or mitigation of COVID-19 epidemics [14–17]. In this work, we aim to assess how demographic factors and age-specific mixing patterns can influence the impact of COVID-19 epidemics across different geographical contexts of the South West Shewa Zone (SWSZ) of the Oromia Region of Ethiopia, characterized by different levels of access to healthcare. So far, 21,133 cases were reported in the Oromia Region. The interventions implemented to control the epidemic were part of the national strategy designed by the Ministry of Health targeting all districts of the country, including the SWSZ. National measures undertaken between April and mid-September 2020 included the suspension of teaching activities at schools and universities. More stringent measures, including interruption of economic activities, restrictions on the use of public transport, and social gatherings (churches, mosques, markets, etc.), were partially adopted as well [8].

Methods

Study design

We conducted a survey based on individual interviews to estimate age-specific mixing patterns in four districts (*woreda*) of the SWSZ. About 40% of the SWSZ population is below 15 years of age and about 68% lives in remote rural settlements, 18% in rural villages, and 14% in the largest town of the area (Woliso Town, 53,065 inhabitants). The districts targeted by our study encompass a population of 449,460 inhabitants and represent the main catchment area of the St. Luke Hospital located in Woliso Town, a well-resourced health facility acting as the referral hospital for the entire Zone [2].

The study consists in a cross-sectional survey with two-stage stratified random sampling by location and age group. The survey was conducted in eight different sites, choosing two neighborhoods (*kebele*) for each district under study, in such a way to capture contact patterns in areas characterized by different population densities, work and travel opportunities, and access to the healthcare infrastructure. Three types of geographical contexts were considered: remote settlements (consisting of scattered subsistence farming settlements),

rural villages (consisting of concentrated clusters of households served by a main road, and better access to main public services), and urban neighborhoods inside Woliso Town (significantly higher population density and full access to public services [18]).

For each site, a target sample size of 105 study participants was set on the basis of findings from previous contact surveys [19, 20] to provide the desired precision in the mean number of contacts (see Additional File 1: Sections 1 and 2 [20–22]). Households and study participants were randomly sampled using predefined quotas for each site, sex, and age group. A household was defined as a group of individuals living under the same roof and sharing the same kitchen on a daily basis. One individual per household was interviewed. If the study participant was a student, additional shorter interviews were performed to complement the data with information about close contacts occurring at school.

Data collection

Participants were asked to recall information on the frequency, location, and type of social encounters from the day preceding their interview, providing the age (or age range when the exact age was unknown) and their relationship for each listed contact. A contact was defined as an interaction between two individuals, either physical (when involving skin-to-skin contact) or non-physical (when involving a two-way conversation with five or more words in the physical presence of another person, but no skin-to-skin contact) [19, 20]. The participants' age, sex, education, and occupational status were recorded along with details on their household composition.

In the SWSZ, schools may host up to 100 students within a single class. To avoid inaccurate reporting of the number of school contacts, participants were only asked to count the total number of physical contacts they had at school in the previous day, without further details. Information on the age of students attending the targeted schools for different grades was also collected. Interviews were carried out between November and December 2019, i.e., prior to the COVID-19 pandemic. Schools were regularly open during the survey period.

Contact patterns and data analysis

For each type of geographical context, we computed the mean number of contacts reported by respondents after grouping by age (six 10-year age groups from 0 to 59 years and one age group for individuals aged 60 years or older) and by contact setting (households, schools, and the general community). Since for many study participants it was difficult to distinguish encounters occurred because of their job from other random contacts, all social interactions occurring outside family and schools were aggregated with contacts occurring in the general community. Age-specific contact matrices were computed considering both physical and non-physical contacts and were adjusted for reciprocity as in [19]. Variability due to sampling of study participants was explored by computing 1000 bootstrapped contact matrices [23], where each bootstrap consisted in sampling with replacement a number of interviews equal to the original sample size, choosing the age of the participant with probability proportional to the Ethiopian age distribution [24]. The proportions of the SWSZ population living in remote settlements, rural villages, and in urban neighborhoods were used as sampling weights to compute an average contact matrix for the entire SWSZ. Full details about the study design, data collection, and the analysis of contact patterns are provided in the Additional File 1: Sections 1–7 and in the Additional File 2.

Transmission model

We simulated SARS-CoV-2 spread in the SWSZ, using an age-structured Susceptible-Infectious-Recovered (SIR) compartmental model with three consecutive stages of infectiousness, in such a way to reproduce a gamma-distributed generation time of mean 6.6 days [25–27]. The model was run separately for each geographical context (i.e., the remote, rural and urban neighborhoods), using estimates of the population age structure and of the age-specific contact matrix computed from survey data (see Additional File 1: Sections 4–6). These data were collected in the absence of any restrictions imposed to control the infection spread. Because school closure in all of Ethiopia was mandated much before the exponential growth of reported COVID-19 cases, transmission of SARS-CoV-2 in the SWSZ was simulated by removing contacts occurring at school and considering only household and community contacts. In the model, 1000 values of the per-contact transmission rate were considered by matching the reproduction number computed through the next-generation matrix approach [28] with random samples from the posterior distribution of the reproduction number estimated from the curve of reported cases in Ethiopia during the phase of exponential growth [5, 29]. As the same public measures and restrictions were applied across different geographical contexts in Ethiopia, heterogeneous transmission of SARS-CoV-2 was assumed to be driven by differences in the demographic and contact structures in urban, rural, and remote neighborhoods. The same per-contact transmission rate was therefore assumed across different settings of the SWSZ and estimated using the sum of contact matrices obtained for the urban, rural, and remote neighborhoods, weighted by the percentage of SWSZ population living in each geographical context. We included school

contacts to estimate the theoretical SARS-CoV-2 transmission potential in the absence of a school closure mandate.

We considered susceptibility to SARS-CoV-2 infection to vary with age. We adopted the posterior distributions estimated in Zhang et al. [23] for the relative probability of developing infection upon effective exposure to an infectious case, where the age group 15–64 years is taken as a reference; an average relative susceptibility of 0.33 (95% CI 0.24–0.47) was considered for children under 15 years of age and of 1.47 (95% CI 1.16–2.06) for older adults (above 65 years) [23]. These estimates are aligned with other independent studies (reviewed in Viner et al. [30]). We assumed the same infectiousness across individuals of different ages (see Additional File 1: Section 4 [31]).

We computed projections of the number of SARS-CoV-2 infections, cases with respiratory symptoms or fever, and COVID-19 critical cases (either requiring mechanical ventilation or resulting in a fatal outcome), based on available estimates of the age-specific risks [32]. By comparing estimates obtained when including and excluding school contacts for the entire duration of the epidemic, we computed the overall percentage of infections, symptomatic, and critical cases that could be averted by school closure.

To explore the robustness of our findings with respect to model assumptions, five separate sensitivity analyses were carried out assuming (1) a Susceptible-Exposed-Infectious-Recovered (SEIR) model structure, (2) a 20% increase or a 20% decrease of the net reproduction number, (3) different per-contact transmission rates across geographical settings, (4) homogeneous susceptibility by age, and (5) a lower infectiousness of children (see Additional File 1: Section 8). As the probability of developing symptoms after infection markedly increases with age [32, 33], the latter sensitivity is similar to exploring the effect of differential infectiousness among symptomatic and asymptomatic cases.

Results

Social contact data

A total of 938 study participants were interviewed with 43% of them living in rural remote settlements, 35% in rural villages, and 22% from urban neighborhoods (Table 1). Two hundred twenty-seven participants were students, 22.9% of whom were between 5 and 9 years of age, 71.8% between 10 and 19 years, and 4.9% older. School attendance rates among the study participants aged 5–18 years were 67%, 80%, and 77% in remote, rural, and urban sites, respectively. The median class size ranged from 70 children per class in rural villages to 90 in remote settlements. Only 27% of our study participants reported travels outside their village in the last month; 87.3% reported they were never admitted to the local hospital (see Additional File 1: Section 7).

Age and sex were also recorded for all the 4635 household members of the 938 study participants. The mean household size in remote settlements was 5.5 (95% CI 5.3–5.7), significantly larger (Tukey test $p < 0.001$) than in rural villages (4.6, 95% CI 4.4–4.8) and in urban neighborhoods (4.4, 95% CI 4.2–4.6), while no significant difference in the household size was found between the latter two settings (Tukey test $p = 0.48$).

Overall, 5690 non-school contacts were reported by the 938 study participants (median 6 contacts per person, range 1–26, see Table 2). Of these, 79.9% were physical and 43.0% involved a single social interaction during the day.

For all sites, contacts outside school were predominantly reported between family members (46.1%), neighbors (25.2%), and other relatives outside the household (13.1%), while the remaining 15.5% of contacts occurred with friends, schoolmates outside school, or other unspecified categories. Individuals with a recent history of travel outside their neighborhood did not report an increased number of contacts, except for urban residents (t test $p = 0.004$). The mean number of contacts (excluding school contacts) reported by participants was lower in rural villages (5.73, 95% CI 5.44–6.02) with respect to both urban neighborhoods (6.35, 95% CI 5.96–6.73) and remote settlements (6.19, 95% CI 5.87–6.51). In particular, the mean number of daily contacts reported by the elderly (60+ years old) was much higher in remote settlements and urban neighborhoods than in rural villages (7.7 and 5.8 vs. 3.6, see Table 2).

Students reported 1372 additional contacts in schools, resulting in a mean number of 6.1 (95% CI 4.98–7.16) daily physical contacts per child (median 3, interquartile range 0–10). There were limited differences in the mean number of school contacts across geographical contexts (6.31, 95% CI 4.13–8.50 in remote settlements; 5.70, 95% CI 4.19–7.21 in rural towns; 6.54, 95% CI 4.25–8.84 in urban neighborhoods).

The analysis of contacts by age clearly shows that subjects below 30 years of age tend to interact mostly with individuals of similar age (assortative mixing). The highest contact rates were found between school aged children (10–19 years), between young adults (20–39 years), and between children below 10 years and their parents (Fig. 1, and Additional File 1: Sections 6 and 7). A marked intergenerational mixing both within households and in the community was found, especially in remote settlements.

The average overall number of daily contacts reported by our study participants (7.5 contacts), the share of contacts experienced with household members (46.1% including all ages), and the proportion of school contacts

Table 1 Characteristics of study participants and relative percentages in the Ethiopian population

	Number of study participants				
	Overall	Remote	Rural	Urban	
Variable*	*n* (%)	*n* (%)	*n* (%)	*n* (%)	Ethiopia (%) [24]
Total					
	938 (100.0)	400 (42.6)	326 (34.8)	212 (22.6)	–
Age					
< 10 years	382 (40.7)	160 (40)	137 (42)	85 (40.1)	27.3
10–19 years	198 (21.1)	85 (21.2)	66 (20.2)	47 (22.2)	24.1
20–29 years	92 (9.8)	40 (10)	32 (9.8)	20 (9.4)	18.4
30–39 years	117 (12.5)	50 (12.5)	42 (12.9)	25 (11.8)	12.0
40–49 years	59 (6.3)	26 (6.5)	18 (5.5)	15 (7.1)	7.9
50–59 years	40 (4.3)	17 (4.2)	13 (4)	10 (4.7)	4.9
60 years +	50 (5.3)	22 (5.5)	18 (5.5)	10 (4.7)	5.3
Occupation					
Pre-school	309 (32.9)	129 (32.2)	109 (33.4)	71 (33.5)	–
Student	226 (24.1)	85 (21.2)	87 (26.7)	54 (25.5)	–
Manual/office/shop worker	62 (6.6)	5 (1.2)	30 (9.2)	27 (12.7)	–
Housewife	137 (14.6)	66 (16.5)	47 (14.4)	24 (11.3)	–
Agriculture**	112 (11.9)	84 (21)	25 (7.7)	3 (1.4)	–
Unemployed/retired	44 (4.7)	9 (2.3)	12 (3.7)	23 (10.8)	–
Other	48 (5.1)	22 (5.5)	16 (4.9)	10 (4.7)	–
Sex					
Female	478 (51)	206 (51.5)	170 (52.1)	102 (48.1)	50.0
Male	460 (49)	194 (48.5)	156 (47.9)	110 (51.9)	50.0

* No missing data for any of the three listed variables
** The percentage of male adults (18–64 years old) working in agriculture is 45.2%; in the remote, the rural, and the urban settings, this percentage is 81%, 28%, and 7%, respectively

for children between 5 and 21 years of age (40.3%) are in line with estimates obtained by similar studies conducted in Zimbabwe, Uganda, and Kenya [19, 20, 34], where the number of contacts per day was found in the range 7–11, the proportion of contacts at home was 50–66%, and around 50% of contacts of school-aged children were recorded between schoolmates. The potential high level of mixing between the elderly and both young adults and children has been already highlighted for Ethiopia by the synthetic contact matrices estimated in Prem et al. [35].

Effect of demography and age-specific contacts on COVID-19 epidemics

From the epidemic curve of reported cases, we estimated a net reproduction number R of 1.62 (95% CI 1.55–1.70) over approximately 6 weeks of exponential growth starting from May 1, 2020, when schools were closed in the entire country (see Additional File 1: Section 4). We relied on this estimate of R to simulate COVID-19 epidemics in the SWSZ considering no school contacts. If school contacts are included, we estimate R to increase up to 3.15 (95% CI 2.22–4.20, see Additional File 1: Section 4), which is comparable with estimates of the basic reproduction number from other parts of the world [36–39].

Our simulation results show that, had schools remained closed for the entire duration of the epidemic and had no other interventions been enacted, 12.1% (95% CI 10.8–13.5), 12.1% (95% CI 10.6–13.6), and 13.1% (95% CI 11.6–15.0) of the population residing in rural, remote, and urban settings respectively would have developed respiratory symptoms or fever because of COVID-19. The fraction of critical cases (requiring mechanical ventilation and/or resulting in a fatal outcome) is estimated between 0.28% and 0.41% of the overall population (Fig. 2). The highest prevalence of critical cases (between 4.4% and 5.4% on average) is expected within subjects aged 60 years or older. This age segment represents only about 5% of the total population in SWSZ but is expected to represent 7 to 14% of symptomatic cases and 43 to 63% of all critical cases.

Remote settlements are expected to suffer a higher overall burden of critical cases (0.40% of the total

Table 2 Mean number of recorded daily contacts, excluding contacts at school, by age, across different geographical contexts

Variable	Mean number of contacts per day (excluding school contacts)			
	Overall mean (95% CI)	Remote mean (95% CI)	Rural mean (95% CI)	Urban mean (95% CI)
Total				
	6.07 (5.88–6.26)	6.19 (5.87–6.51)	5.73 (5.44–6.02)	6.35 (5.96–6.73)
Age				
< 10 years	5.57 (5.32–5.83)	5.67 (5.23–6.12)	5.21 (4.84–5.58)	5.96 (5.46–6.47)
10–19 years	6.48 (6.02–6.94)	6.33 (5.6–7.06)	6.30 (5.63–6.98)	7.00 (5.96–8.04)
20–29 years	5.77 (5.28–6.26)	5.8 (5.04–6.56)	5.72 (4.84–6.6)	5.80 (4.82–6.78)
30–39 years	6.99 (6.41–7.57)	6.84 (5.96–7.72)	7.05 (6.00–8.09)	7.20 (6.05–8.35)
40–49 years	6.86 (6.08–7.65)	7.23 (5.85–8.61)	6.67 (5.51–7.82)	6.47 (5.01–7.92)
50–59 years	5.80 (4.90–6.70)	5.76 (4.66–6.87)	5.77 (3.95–7.59)	5.90 (3.74–8.06)
60 years +	5.84 (4.69–6.99)	7.73 (5.54–9.91)	3.56 (2.84–4.27)	5.80 (4.26–7.34)
Sex				
Male	6.15 (5.87–6.43)	6.15 (5.69–6.61)	6.02 (5.55–6.49)	6.34 (5.77–6.9)
Female	5.99 (5.73–6.24)	6.23 (5.79–6.67)	5.46 (5.11–5.82)	6.36 (5.84–6.89)
Occupation				
Pre-school	5.42 (5.17–5.66)	5.51 (5.11–5.91)	5.08 (4.72–5.44)	5.76 (5.24–6.29)
Student	6.57 (6.10–7.04)	6.51 (5.63–7.38)	6.24 (5.61–6.88)	7.20 (6.25–8.15)
Manual/office/shop worker	7.23 (6.34–8.12)	7.0 (3.72–10.28)	7.47 (6.06–8.87)	7.0 (5.78–8.22)
Housewife	5.76 (5.34–6.17)	5.67 (5.06–6.28)	5.43 (4.75–6.1)	6.67 (5.68–7.65)
Agriculture	7.02 (6.35–7.68)	7.35 (6.53–8.16)	5.92 (4.86–6.98)	7.00 (5.04–8.96)
Unemployed/retired	5.18 (4.4–5.96)	6 (3.88–8.12)	4.42 (3–5.83)	5.26 (4.25–6.27)
Others	5.83 (5.26–6.4)	6 (5.14–6.86)	5.69 (4.68–6.7)	5.7 (4.42–6.98)
Setting				
Household	2.8 (2.68–2.92)	2.94 (2.74–3.15)	2.48 (2.28–2.67)	3.02 (2.8–3.24)
Community	3.27 (3.09–3.45)	3.25 (2.95–3.54)	3.25 (2.97–3.53)	3.33 (2.98–3.67)
Traveled to a different neighborhood in the month prior the interview				
Yes	6.21 (5.83–6.59)	6.08 (5.34–6.81)	5.66 (5.16–6.16)	7.22 (6.46–7.97)
No	6.01 (5.79–6.23)	6.22 (5.86–6.57)	5.76 (5.4–6.13)	5.93 (5.51–6.35)
Contacts outside neighborhood (%)				
0–14 years	0.67% (0.4–1.04)	0.38% (0.14–0.94)	0.19% (0.03–0.77)	1.80% (1.03–3.09)
15–59 years	3.98% (3.23–4.89)	4.54% (3.36–6.07)	3.3% (2.19–4.9)	3.91% (2.47–6.07)
60 years+	2.74% (1.28–5.53)	1.18% (0.20–4.63)	0.00% (0.00–0.00)	10.34% (4.28–21.84)

population, 95% CI 0.37–0.41%) compared to rural villages (0.33%, 95% CI 0.31–0.35%) and urban neighborhoods (0.31%, 95% CI 0.29–0.33%). This difference is explained by a higher proportion of the elderly in the population (see Additional File 1: Sections 6 and 7), but also by their higher number of daily contacts and the higher intergenerational mixing (Fig. 1c) compared to the other settings, which results in a higher attack rate of infections, symptomatic cases, and critical disease in this age group (Fig. 2). Urban neighborhoods, where the highest contact rates at younger ages were recorded, are expected to have the highest attack rate of infections (57.3%, 95% CI 49.6–66.7) and symptomatic cases (13.1%, 95% CI 11.6–15.0). However, since a large proportion of the overall number of infections (81.8%, 95% CI 76.1–85.3) is concentrated on children and younger adults (up to 40 years of age), this does not result in a high overall proportion of critical disease. Finally, rural villages have lower attack rates among the elderly because of the significantly lower number of contacts reported by that age group in this geographical context (Fig. 1f, Table 2).

Figure 3 shows the impact of maintaining the school closure mandate on the burden of COVID-19 in the

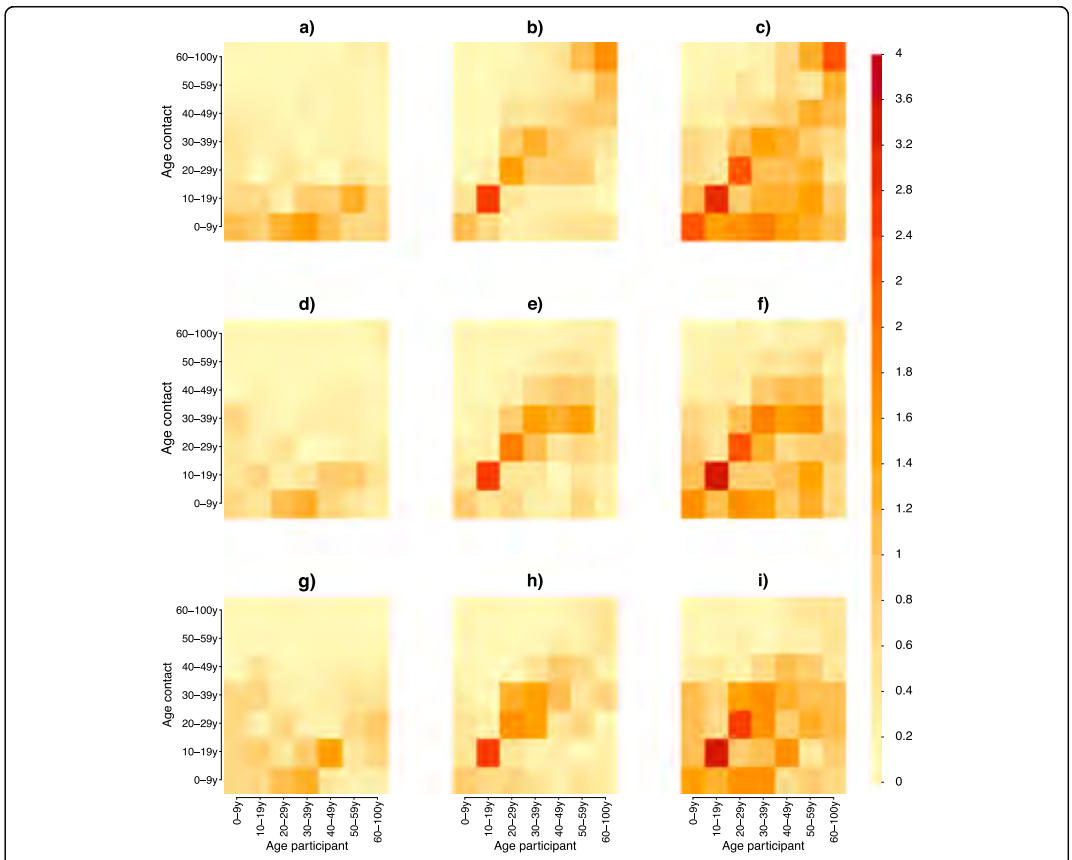


Fig. 1 Contact matrix representing the mean number of daily contacts reported by a participant in the age group *i* with individuals in the age group *j* in household (**a**), in the general community (**b**), and both (**c**) in remote settlements. **d**–**f**, **g**–**i** The same quantities estimated for rural villages and for the urban neighborhoods, respectively

SWSZ in terms of percentages of infections, symptomatic, and critical cases averted with respect to a hypothetical scenario of an unmitigated SARS-CoV-2 epidemic. According to our estimates, the beneficial impact of school closure would consist of 26.9% (95% CI 20.7–32.8), 29.9% (95% CI 19.5–38.7), and 25.1% (95% CI 18.2–30.8) averted symptomatic cases and 10.6% (95% CI 8.1–13.7), 6.3% (95% CI 3.8–10.3), and 8.1% (95% CI 4.7–12.1) averted critical cases respectively in rural, remote, and urban contexts. As expected, the larger effect of the intervention in terms of averted infections is observable in younger ages, while the indirect effect of school closure on the elderly is highlighted by the expected high fractions of averted critical cases among individuals aged 50 or over.

A comparison of model estimates obtained in our baseline analysis with those obtained in the sensitivity analyses is provided in Fig. 4. These results suggest that our estimates on the overall fraction of critical cases expected by maintaining the school closure mandate are robust against all alternative assumptions considered, ranging between 0.25–0.37%, 0.23–0.42%, and 0.25–0.34% for rural villages, remote settlements, and urban areas, respectively.

Discussion

Our analysis explored the effect of demographics and social contact patterns on COVID-19 burden in the South West Shewa Zone of the Oromia Region, Ethiopia. Data collected with an interview-based survey highlighted differences in demographic structure and in age-specific contacts between urban neighborhoods, rural villages, and remote settlements and were used to inform an epidemic model simulating the transmission dynamic of

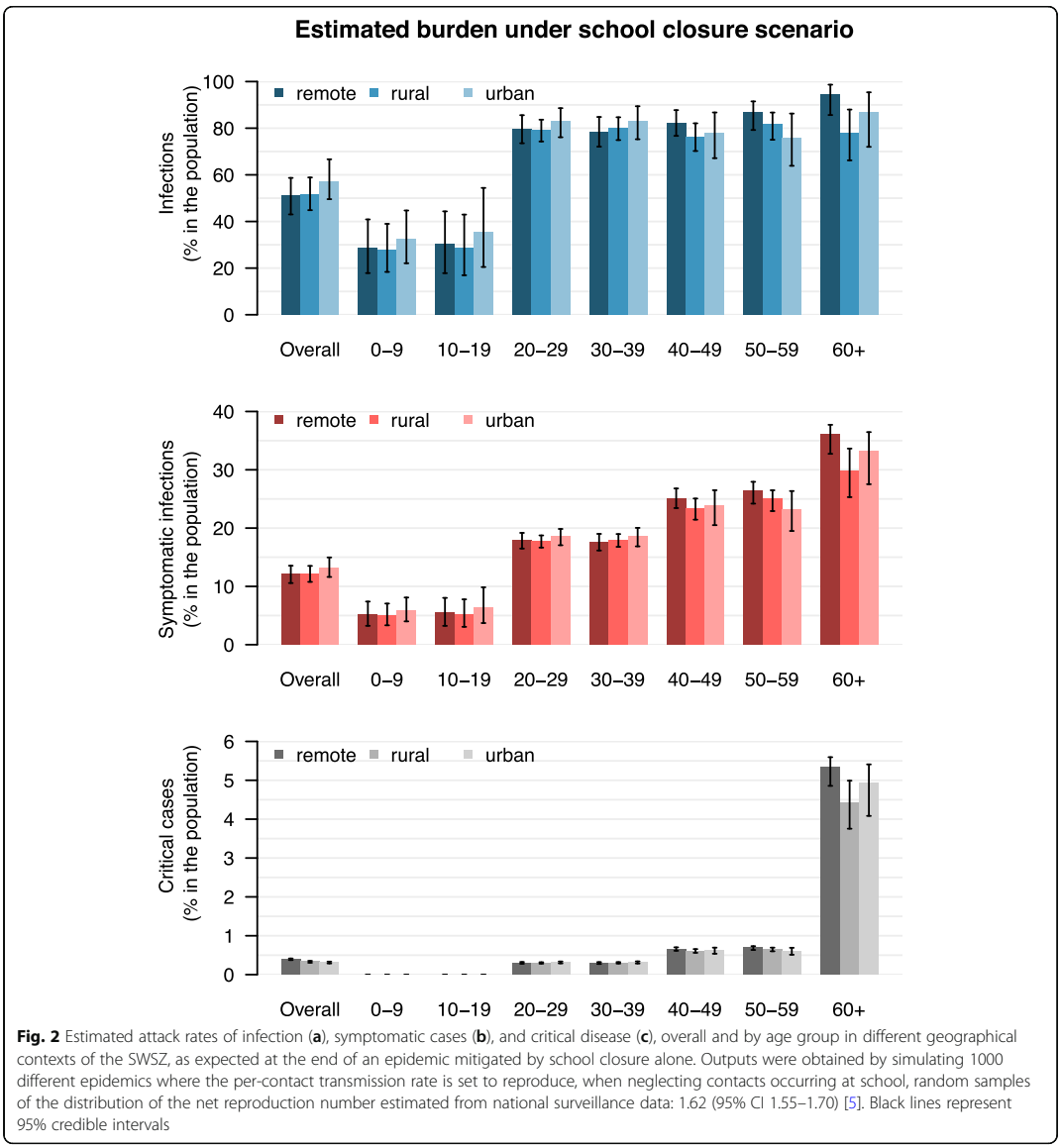


Fig. 2 Estimated attack rates of infection (**a**), symptomatic cases (**b**), and critical disease (**c**), overall and by age group in different geographical contexts of the SWSZ, as expected at the end of an epidemic mitigated by school closure alone. Outputs were obtained by simulating 1000 different epidemics where the per-contact transmission rate is set to reproduce, when neglecting contacts occurring at school, random samples of the distribution of the net reproduction number estimated from national surveillance data: 1.62 (95% CI 1.55–1.70) [5]. Black lines represent 95% credible intervals

SARS-CoV-2. On the basis of the trajectory of COVID-19 cases observed in the country up to June 12, 2020, we estimated that between 3.1 and 4.0 patients per 1000 inhabitants may experience critical disease (i.e., requiring mechanical ventilation and/or resulting in a fatal outcome) at the end of an epidemic mitigated by school closure alone. Considering the low availability and accessibility of healthcare, especially in remote and rural settlements, and the lack of intensive care units to treat critical patients [2, 40], it is possible that a large fraction of those cases would result in a fatal outcome, adding up to the already high background mortality rate in the region (estimated at about 6.4 per 1000 per year [41]).

Considering the extreme scenario where all critical cases would result in a fatal outcome, we obtain an estimate of the infection-fatality ratio (IFR) ranging between 0.55% in urban neighborhoods and 0.78% in remote settlements. Such estimates are generally lower than the

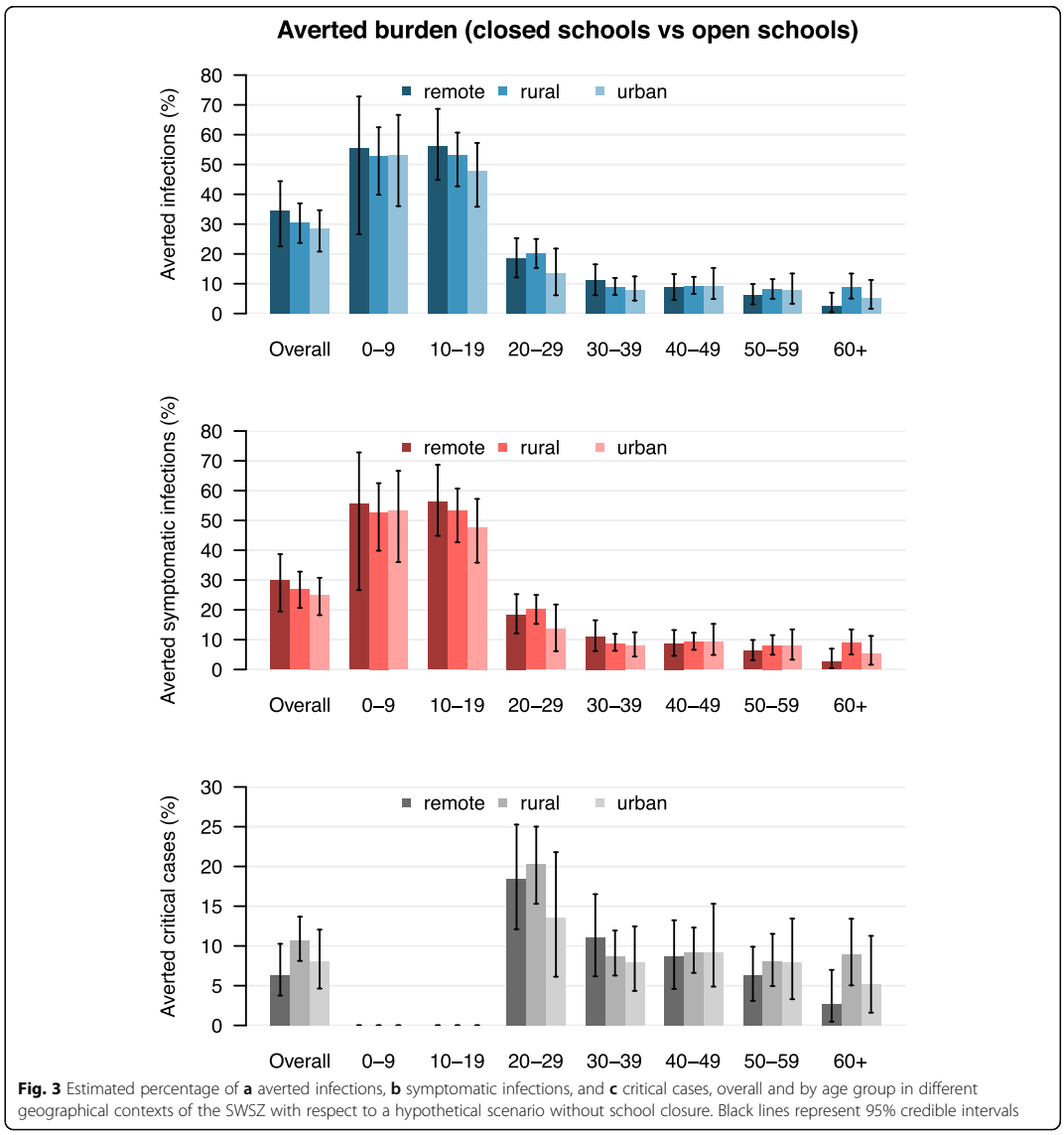


Fig. 3 Estimated percentage of **a** averted infections, **b** symptomatic infections, and **c** critical cases, overall and by age group in different geographical contexts of the SWSZ with respect to a hypothetical scenario without school closure. Black lines represent 95% credible intervals

IFR estimated from serological studies for higher income countries [42, 43]. This difference is partially due to the younger age structure of the Ethiopian population, where only 5% of individuals are older than 60 years (compared to over 20% in most of Europe [44]). However, by simply adjusting the age-specific IFR to the local demographics, Ghisolfi et al. [45] estimated a fourfold reduction in the overall IFR in Eastern Africa with respect to European countries, which is around 2 times lower than our estimates. In fact, our simulations not only account for the demography of the population, but also for its mixing patterns. Indeed, we found that in the SWSZ the effect of a younger population is partially compensated by high infection attack rates in the elderly, which derive from the intense intergenerational mixing and the larger number of contacts observed among the elderly. In particular, we show that these characteristics are especially marked in remote settlements, where the highest incidence of critical disease is expected to occur. Although our analysis is limited to the SWSZ, we expect

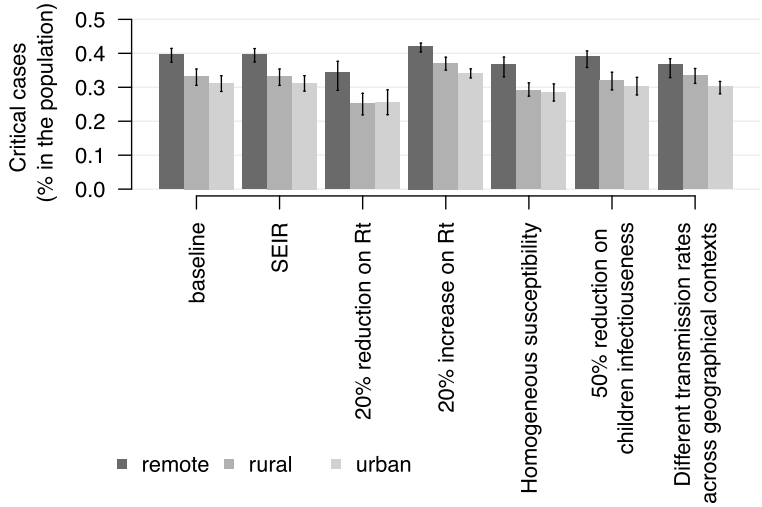


Fig. 4 Comparison of the estimated overall percentage of critical cases in different geographical contexts of the SWSZ in the baseline and sensitivity analyses. Black lines represent 95% credible intervals

that similar arguments may be generalizable to settings with similar socio-demographic conditions.

Our results suggest that, in the SWSZ, school closures might have reduced by 48.9% the SARS-CoV-2 reproduction number and by 28.3–34.6% the infection attack rate that would have been expected in the absence of any intervention. In line with observations from other settings [23], school closure was estimated to be insufficient to prevent the spread of the infection. Recently published studies have shown that the lockdown implemented in Kenya reduced individuals' social interactions by 60–70% compared to the pre-pandemic period [15], but it is difficult to extrapolate these data to Ethiopia, where social distancing measures were comparatively milder. Data on how contacts outside school may have changed in Ethiopia during the COVID-19 epidemic are still lacking.

To properly interpret the results presented in our study, it is important to consider the following limitations. First, the target study population may be not representative of all Ethiopia and in particular of epidemic patterns observed in highly urbanized areas such as the capital Addis Ababa. Second, the net reproduction number was estimated from national surveillance data [5]. This data reports cases aggregated at the country level and may suffer from a number of biases: it does not account for reporting delays; the growth over time in the number of cases may partly be ascribable to the increase in testing capacity; total cases represent the superimposition of different, asynchronous epidemics in multiple parts of the country, a majority of which coming from the highly urbanized Addis Ababa area [9]. More in general, estimates of time-varying reproduction numbers from data where the symptoms' onset time-series is approximated with the notification date series may inaccurately describe the early infection dynamics and could fail in assessing the impact of containment measures. However, we show that, when assuming no restriction to school contacts, the reproduction number estimated by the model is in the range 2.43–3.52, comparable with estimates of the SARS-CoV-2 basic reproduction number from other countries [36–39]. Moreover, our conclusions remain robust when considering a 20% increase or a 20% decrease of the reproduction number. In this case, we estimated an attack rate of critical cases ranging from 0.25 to 0.37 for rural villages and from 0.34 to 0.42 for remote settlements (see Fig. 4). Third, the model lacks spatial structure. The finding from the survey that about 97% of recorded contacts have occurred within the participant's neighborhood of residence (Table 2) suggests that local containment or confinement of COVID-19 outbreaks in rural regions of Ethiopia may be favored by low human mobility. On the other hand, the observation of a large number of cases in all regions of Ethiopia [9] may imply that a significant widespread diffusion of the epidemic, possibly sustained by a high fraction of asymptomatic infections (Fig. 2), is ongoing. Fourth, the role played by children in the transmission of SARS-CoV-2 infections is still poorly understood and highly debated [23, 46]. In the main analysis, we assumed that the probability of transmission is homogeneous across all ages. As

asymptomatic infections are more prevalent at younger ages, this also reflects the assumption that symptomatic and asymptomatic cases are characterized by the same infectiousness. However, an alternative assumption in which children are assumed half as infectious as adults would result in similar attack rates of critical cases (see Additional File 1: Section 8). These results are also robust with respect to the assumption of a homogeneous susceptibility across age groups (see Additional File 1: Section 8). Finally, in absence of direct data from sub-Saharan Africa, the age-specific susceptibility and proportions of infections resulting in symptomatic cases or critical disease were estimated from data from China or Europe [23, 32]. However, the high prevalence of co-morbidities which are uncommon in higher income countries (e.g., malnutrition [47], tuberculosis, and malaria) and inequalities in the access to primary care represent additional vulnerabilities for African settings [2] and may result in an underestimation of the expected disease burden. Since the number of COVID-19-related deaths may be under ascertained in low-income countries, further research is warranted regarding the disease severity in sub-Saharan populations, potentially leveraging excess mortality data once they will become available.

Conclusions

This study provides novel data on mixing patterns in rural Ethiopia and highlights the potential impact of COVID-19 epidemics in less urbanized regions of the country. We provide estimates on the potential burden of COVID-19 in the SWSZ under the assumption of a mitigated, but not controlled epidemic. We conclude that, although the overall mortality might be generally lower in sub-Saharan Africa compared to high-income settings, thanks to younger demographics [45, 48, 49], this effect may be partially offset in rural areas by higher attack rates in elderly individuals, due to high rates of intergenerational mixing. The observed contact patterns suggest that elderly individuals in remote settlements may be even more exposed to the risk of infection (and thus of critical disease), which is especially worrisome in light of the major obstacles in access to healthcare for those populations [2].

Supplementary Information

Supplementary information accompanies this paper at https://doi.org/10.1186/s12916-021-01967-w.

Additional file 1. Appendix.

Additional file 2. Questionnaire used for conducting the contact study.

Acknowledgements
The authors thank Meselech Lemech Baruda, Yirgedu Dilgasu Tolesa, and Desalegn Abebe Yimer, who helped with the management of the fieldwork related to the collection of contact data.

Authors' contributions
FT, FM, GP, MA, SM, and PP conceived and designed the study. FT, VM, WNG, AT, AG, and PP collected the data. FT, MG, AZ, and PP analyzed the data. FT, GG, MG, and AZ performed the experiments. FT, GG, and PP drafted the first version of the manuscript. All authors contributed to the interpretation of the results and edited and approved the final manuscript.

Funding
This work was supported by the Italian Ministry of Foreign Affairs and International Cooperation within the project entitled "Rafforzamento del sistema di sorveglianza e controllo delle malattie infettive in Etiopia"—AID 011330. The funders had no role in the study design, data collection and analysis, interpretation, or preparation of the manuscript.

Availability of data and materials
Data analyzed during this study will be included in this published article as supplementary information files.

Declarations

Ethics approval and consent to participate
The study was approved by the Ethical Clearance Committee of Oromia Regional Health Bureau. Written informed consent was sought for literate individuals aged 18 years or more and from a parent or carer for younger individuals. In addition, assent was sought from all participants under 18 years of age. Verbal consent was sought from illiterate participants and participants who cannot read in the Oromyffa language. For these participants, a written confirmation of verbal consent from a witness elected by the study participant was sought.

Consent for publication
Not applicable

Competing interests
MA has received research funding from Seqirus. The funding is not related to COVID-19. All other authors declare that they have no competing interests.

Author details
[1]Center for Health Emergencies, Bruno Kessler Foundation, Trento, Italy. [2]University of Udine, Udine, Italy. [3]University of Trento, Trento, Italy. [4]Doctors with Africa CUAMM, Padova, Italy. [5]Doctors with Africa CUAMM, Woliso, Ethiopia. [6]Doctors with Africa CUAMM, Addis Ababa, Ethiopia. [7]Dondena Centre for Research on Social Dynamics and Public Policy, Bocconi University, Milan, Italy. [8]Department of Social and Political Sciences, Bocconi University, Milan, Italy. [9]Department of Epidemiology and Biostatistics, Indiana University School of Public Health, Bloomington, IN, USA. [10]Laboratory for the Modeling of Biological and Socio-technical Systems, Northeastern University, Boston, MA, USA.

Received: 12 November 2020 Accepted: 19 March 2021
Published online: 30 April 2021

References

1. Gilbert M, Pullano G, Pinotti F, Valdano E, Poletto C, Boëlle PY, D'Ortenzio E, Yazdanpanah Y, Eholie SP, Altmann M, Gutierrez B, Kraemer MUG, Colizza V. Preparedness and vulnerability of African countries against importations of COVID-19: a modelling study. Lancet. 2020;395(10227):871–7. https://doi.org/10.1016/S0140-6736(20)30411-6.
2. Poletti P, Parlamento S, Fayyisaa T, Feyyiss R, Lusiani M, Tsegaye A, Segafredo G, Putoto G, Manenti F, Merler S. The hidden burden of measles in Ethiopia: how distance to hospital shapes the disease mortality rate. BMC Med. 2018;16(1):177. https://doi.org/10.1186/s12916-018-1171-y.
3. Massinga Loembé M, Tshangela A, Salyer SJ, Varma JK, Ouma AEO, Nkengasong JN. COVID-19 in Africa: the spread and response. Nat Med. 2020;26(7):999–1003. https://doi.org/10.1038/s41591-020-0961-x.
4. International Monetary Fund. Policy responses to COVID-19. 2020. https://www.imf.org/en/Topics/imf-and-covid19/Policy-Responses-to-COVID-19 (Accessed 25 Jan 2020).

5. World Health Organization. WHO Coronavirus Disease (COVID-19) Dashboard. 2020. https://covid19.who.int/WHO-COVID-19-global-data.csv (Accessed 25 Jan 2021).
6. Makoni M. COVID-19 in Africa: half a year later. Lancet Infect Dis. 2020; 20(10):1127. https://doi.org/10.1016/S1473-3099(20)30708-8.
7. World Health Organization. Covid-19 Response Bullettin Ethiopia. 2020. https://www.afro.who.int/sites/default/files/2020-04/ETHIOPIA_COVID-19%20response%20bulletin_10APR2020%20%28002%29.pdf (Accessed 8 Jan 2021).
8. Mohammed H, Oljira L, Roba KT, Yimer G, Fekadu A, Manyazewal T. Containment of COVID-19 in Ethiopia and implications for tuberculosis care and research. Infect Dis Poverty. 2020;9(1):131. https://doi.org/10.1186/s40249-020-00753-9.
9. Ethiopian Institute of Public Health. COVID-19 pandemic preparedness and response in Ethiopia - weekly bulletin. https://www.ephi.gov.et/images/novel_coronavirus/EPHI_PHEOC_COVID-19_Weekly_Bulletin_37_English_01192021.pdf (Accessed 24 Jan 2021).
10. UNICEF. Ethiopia COVID-19 Situation Report No. 3. 2020. https://www.unicef.org/ethiopia/sites/unicef.org.ethiopia/files/2020-04/UNICEF%20Ethiopia%20COVID-19%20Situation%20Report%20No.%203%20-%2027%20March-3%20April%202020.pdf (Accessed 25 Jan 2021).
11. Ethiopian Institute of Public Health. COVID-19 pandemic preparedness and response in Ethiopia - weekly bulletin. https://www.ephi.gov.et/images/novel_coronavirus/EPHI_-PHEOC_COVID-19_Weekly-bulletin_6_English_06082020.pdf (Accessed 18 Jan 2021).
12. World Health organization. Health workforce requirements for universal health coverage and the Sustainable Development Goals. Human Resource for Health Observers Series No. 17. WHO; 2016. https://apps.who.int/iris/bitstream/handle/10665/250330/9789241511407-eng.pdf;jsessionid=1E48420C3A268CA43F1E9F9AB59BA0AE?sequence=1 (Accessed 25 Jan 2021).
13. Haileamlak A. How can Ethiopia mitigate the health workforce gap to meet universal health coverage? Ethiop J Health Sci. 2018;28(3):249–50. https://doi.org/10.4314/ejhs.v28i3.1.
14. van Zandvoort K, Jarvis CI, Pearson CAB, et al. Response strategies for COVID-19 epidemics in African settings: a mathematical modelling study. BMC Med. 2020;18(1):324. https://doi.org/10.1186/s12916-020-01789-2.
15. Quaife M, van Zandvoort K, Gimma A, et al. The impact of COVID-19 control measures on social contacts and transmission in Kenyan informal settlements. BMC Med. 2020;18(1):316. https://doi.org/10.1186/s12916-020-01779-4.
16. Brand SP, Aziza R, Kombe IK, et al. Forecasting the scale of the COVID-19 epidemic in Kenya. MedRxiv. 2020; published online April 16. https://doi.org/10.1101/2020.04.09.20059865 (preprint).
17. Walker PGT, Whittaker C, Watson OJ, Baguelin M, Winskill P, Hamlet A, Djafaara BA, Cucunubá Z, Olivera Mesa D, Green W, Thompson H, Nayagam S, Ainslie KEC, Bhatia S, Bhatt S, Boonyasiri A, Boyd O, Brazeau NF, Cattarino L, Cuomo-Dannenburg G, Dighe A, Donnelly CA, Dorigatti I, van Elsland S, FitzJohn R, Fu H, Gaythorpe KAM, Geidelberg L, Grassly N, Haw D, Hayes S, Hinsley W, Imai N, Jorgensen D, Knock E, Laydon D, Mishra S, Nedjati-Gilani G, Okell LC, Unwin HJ, Verity R, Vollmer M, Walters CE, Wang H, Wang Y, Xi X, Lalloo DG, Ferguson NM, Ghani AC. The impact of COVID-19 and strategies for mitigation and suppression in low- and middle-income countries. Science. 2020;369(6502):413–22. https://doi.org/10.1126/science.abc0035.
18. United States Department of Agriculture. Economic Research Service. https://www.ers.usda.gov/topics/rural-economy-population/rural-classifications/ (Accessed 25 Jan 2021)
19. Melegaro A, Del Fava E, Poletti P, et al. Social contact structures and time use patterns in the Manicaland Province of Zimbabwe. PLoS One. 2017; 12(1):e0170459. https://doi.org/10.1371/journal.pone.0170459.
20. le Polain de Waroux O, Cohuet S, Ndazima D, Kucharski AJ, Juan-Giner A, Flasche S, Tumwesigye E, Arinaitwe R, Mwanga-Amumpaire J, Boum Y II, Nackers F, Checchi F, Grais RF, Edmunds WJ. Characteristics of human encounters and social mixing patterns relevant to infectious diseases spread by close contact: a survey in Southwest Uganda. BMC Infect Dis. 2018;18(1): 172. https://doi.org/10.1186/s12879-018-3073-1.
21. Cohen, J., 2013. Statistical power analysis for the behavioral sciences. Academic press, DOI: https://doi.org/10.4324/9780203771587.
22. Horby P, Thai PQ, Hens N, Yen NTT, Mai LQ, Thoang DD, Linh NM, Huong NT, Alexander N, Edmunds WJ, Duong TN. Social contact patterns in Vietnam and implications for the control of infectious diseases. PLoS One. 2011;6(2):e16965. https://doi.org/10.1371/journal.pone.0016965.
23. Zhang J, Litvinova M, Liang Y, Wang Y, Wang W, Zhao S, Wu Q, Merler S, Viboud C, Vespignani A, Ajelli M, Yu H. Changes in contact patterns shape the dynamics of the COVID-19 outbreak in China. Science. 2020;368(6498): 1481–6. https://doi.org/10.1126/science.abb8001.
24. United Nations Department of Economic and Social Affairs. 2019 UN World Population Prospects. https://population.un.org/wpp/DataQuery/ (Accessed 18 Jan 2021).
25. Cereda D, Tirani M, Rovida F, et al. The early phase of the COVID-19 outbreak in Lombardy, Italy. *arxiv* 2020; published online March 20. http://arxiv.org/abs/2003.09320 (preprint).
26. Marziano V, Guzzetta G, Rondinone BM, Boccuni F, Riccardo F, Bella A, et al. Retrospective analysis of the Italian exit strategy from COVID-19 lockdown. Proc Natl Acad Sci U S A. 2021;118(4):e2019617118.
27. Guzzetta G, Poletti P, Ajelli M, Trentini F, Marziano V, Cereda D, et al. Potential short-term outcome of an uncontrolled COVID-19 epidemic in Lombardy, Italy, February to March 2020. Eurosurveillance. 2020;25(12): 2000293.
28. Diekmann O, Heesterbeek JA, Metz JA. On the definition and the computation of the basic reproduction ratio R0 in models for infectious diseases in heterogeneous populations. J Math Biol. 1990;28(4):365–82. https://doi.org/10.1007/BF00178324.
29. Wallinga J, Lipsitch M. How generation intervals shape the relationship between growth rates and reproductive numbers. Proc Biol Sci. 2007; 274(1609):599–604.
30. Viner RM, Mytton OT, Bonell C, Melendez-Torres GJ, Ward J, Hudson L, Waddington C, Thomas J, Russell S, van der Klis F, Panovska-Griffiths J. Susceptibility to SARS-CoV-2 infection amongst children and adolescents compared with adults: a systematic review and meta-analysis. JAMA Pedriatr. 2020;175(2):143–56. https://doi.org/10.1001/jamapediatrics.2020.4573.
31. Lavezzo E, Franchin E, Ciavarella C, Cuomo-Dannenburg G, Barzon L, Del Vecchio C, et al. Suppression of a SARS-CoV-2 outbreak in the Italian municipality of Vo'. Nature. 2020;584(7821):425–9.
32. Poletti P, Tirani M, Cereda D, et al. Association of Age With Likelihood of Developing Symptoms and Critical Disease Among Close Contacts Exposed to Patients With Confirmed SARS-CoV-2 Infection in Italy. JAMA Netw Open. 2021;4(3):e211085. https://doi.org/10.1001/jamanetworkopen.2021.1085.
33. Buitrago-Garcia D, Egli-Gany D, Counotte MJ, Hossmann S, Imeri H, Ipekci AM, Salanti G, Low N. Occurrence and transmission potential of asymptomatic and presymptomatic SARS-CoV-2 infections: a living systematic review and meta-analysis. PLoS Med. 2020;17(9):e1003346. https://doi.org/10.1371/journal.pmed.1003346.
34. Kiti MC, Kinyanjui TM, Koech DC, Munywoki PK, Medley GF, Nokes DJ. Quantifying age-related rates of social contact using diaries in a rural coastal population of Kenya. PLoS One. 2014;9(8):e104786. https://doi.org/10.1371/journal.pone.0104786.
35. Prem K, Cook AR, Jit M. Projecting social contact matrices in 152 countries using contact surveys and demographic data. PLoS Comput Biol. 2017;13(9): e1005697. https://doi.org/10.1371/journal.pcbi.1005697.
36. Riccardo F, Ajelli M, Andrianou XD, et al. Epidemiological characteristics of COVID-19 cases and estimates of the reproductive numbers 1 month into the epidemic, Italy, 28 January to 31 March 2020. Euro Surveill. 2020;25(49): 2000790.
37. Munayco CV, Tariq A, Rothenberg R, Soto-Cabezas GG, Reyes MF, Valle A, Rojas-Mezarina L, Cabezas C, Loayza M, Chowell G, Peru COVID-19 working group. Early transmission dynamics of COVID-19 in a southern hemisphere setting: Lima-Peru: February 29th-March 30th, 2020. Infect Dis Model. 2020;5: 338–45. https://doi.org/10.1016/j.idm.2020.05.001.
38. Muniz-Rodriguez K, Fung IC, Ferdosi SR, Ofori SK, Lee Y, Tariq A, Chowell G. Severe acute respiratory syndrome coronavirus 2 transmission potential, Iran, 2020. Emerg Infect Dis. 2020;26(8):1915–7. https://doi.org/10.3201/eid2608.200536.
39. Park M, Cook AR, Lim JT, Sun Y, Dickens BL. A systematic review of COVID-19 epidemiology based on current evidence. J Clin Med. 2020;9(4):967. https://doi.org/10.3390/jcm9040967.
40. Murthy S, Leligdowicz A, Adhikari NK. Intensive care unit capacity in low-income countries: a systematic review. PLoS One. 2015;10(1):e0116949. https://doi.org/10.1371/journal.pone.0116949.

41. The World Bank. World Bank Open Data. https://data.worldbank.org/indicator/SP.DYN.CDRT.IN?locations=ET (Accessed 25 Jan 2021).
42. Pollán M, Pérez-Gómez B, Pastor-Barriuso R, Oteo J, Hernán MA, Pérez-Olmeda M, Sanmartín JL, Fernández-García A, Cruz I, Fernández de Larrea N, Molina M, Rodríguez-Cabrera F, Martín M, Merino-Amador P, León Paniagua J, Muñoz-Montalvo JF, Blanco F, Yotti R, Blanco F, Gutiérrez Fernández R, Martín M, Mezcua Navarro S, Molina M, Muñoz-Montalvo JF, Salinero Hernández M, Sanmartín JL, Cuenca-Estrella M, Yotti R, León Paniagua J, Fernández de Larrea N, Fernández-Navarro P, Pastor-Barriuso R, Pérez-Gómez B, Pollán M, Avellón A, Fedele G, Fernández-García A, Oteo Iglesias J, Pérez Olmeda MT, Cruz I, Fernandez Martinez ME, Rodríguez-Cabrera FD, Hernán MA, Padrones Fernández S, Rumbao Aguirre JM, Navarro Marí JM, Palop Borrás B, Pérez Jiménez AB, Rodríguez-Iglesias M, Calvo Gascón AM, Lou Alcaine ML, Donate Suárez I, Suárez Álvarez O, Rodríguez Pérez M, Cases Sanchís M, Villafáfila Gomila CJ, Carbo Saladrigas L, Hurtado Fernández A, Oliver A, Castro Feliciano E, González Quintana MN, Barrasa Fernández JM, Hernández Betancor MA, Hernández Febles M, Martín Martín L, López López LM, Ugarte Miota T, de Benito Población I, Celada Pérez MS, Vallés Fernández MN, Maté Enríquez T, Villa Arranz M, Domínguez-Gil González M, Fernández-Natal I, Megías Lobón G, Muñoz Bellido JL, Ciruela P, Mas i Casals A, Doladé Botías M, Marcos Maeso MA, Pérez del Campo D, Félix de Castro A, Limón Ramírez R, Elías Retamosa MF, Rubio González M, Blanco Lobeiras MS, Fuentes Losada A, Aguilera A, Bou G, Caro Y, Marauri N, Soria Blanco LM, del Cura González I, Hernández Pascual M, Alonso Fernández R, Merino-Amador P, Cabrera Castro N, Tomás Lizcano A, Ramírez Almagro C, Segovia Hernández M, Ascunce Elizaga N, Ederra Sanz M, Ezpeleta Baquedano C, Bustinduy Bascaran A, Iglesias Tamayo S, Elorduy Otazua L, Benarroch Benarroch R, Lopera Flores J, Vázquez de la Villa A. Prevalence of SARS-CoV-2 in Spain (ENE-COVID): a nationwide, population-based seroepidemiological study. Lancet. 2020;396(10250):535–44. https://doi.org/10.1016/S0140-6736(20)31483-5.
43. Poletti P, Tirani M, Cereda D, et al. Age-specific SARS-CoV-2 infection fatality ratio and associated risk factors, Italy, February to April 2020. Euro Surveill. 2020;25(31):2001383.
44. Eurostat. Population Structure and Ageing. https://ec.europa.eu/eurostat/statistics-explained/index.php/Population_structure_and_ageing#The_share_of_elderly_people_continues_to_increase (Accessed 25 Jan 2021).
45. Ghisolfi S, Almås I, Sandefur JC, von Carnap T, Heitner J, Bold T. Predicted COVID-19 fatality rates based on age, sex, comorbidities and health system capacity. BMJ Glob Health. 2020;5(9):e003094. https://doi.org/10.1136/bmjgh-2020-003094.
46. Bi Q, Wu Y, Mei S, Ye C, Zou X, Zhang Z, Liu X, Wei L, Truelove SA, Zhang T, Gao W, Cheng C, Tang X, Wu X, Wu Y, Sun B, Huang S, Sun Y, Zhang J, Ma T, Lessler J, Feng T. Epidemiology and transmission of COVID-19 in 391 cases and 1286 of their close contacts in Shenzhen, China: a retrospective cohort study. Lancet Infect Dis. 2020;20(8):911–9. https://doi.org/10.1016/S1473-3099(20)30287-5.
47. Endris N, Asefa H, Dube L. Prevalence of malnutrition and associated factors among children in rural Ethiopia. Biomed Res Int. 2017;2017:6587853.
48. Dowd JB, Andriano L, Brazel DM, Rotondi V, Block P, Ding X, Liu Y, Mills MC. Demographic science aids in understanding the spread and fatality rates of COVID-19. Proc Natl Acad Sci U S A. 2020;117(18):9696–8. https://doi.org/10.1073/pnas.2004911117.
49. Hilton J, Keeling MJ. Estimation of country-level basic reproductive ratios for novel coronavirus (SARS-CoV-2/COVID-19) using synthetic contact matrices. PLoS Comput Biol. 2020;16(7):e1008031. https://doi.org/10.1371/journal.pcbi.1008031.

Publisher's Note

Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

Ready to submit your research? Choose BMC and benefit from:

- fast, convenient online submission
- thorough peer review by experienced researchers in your field
- rapid publication on acceptance
- support for research data, including large and complex data types
- gold Open Access which fosters wider collaboration and increased citations
- maximum visibility for your research: over 100M website views per year

At BMC, research is always in progress.

Learn more biomedcentral.com/submissions

BMC

Beyond viral suppression: Quality of life among stable ART clients in a differentiated service delivery intervention in Tanzania

PAPER

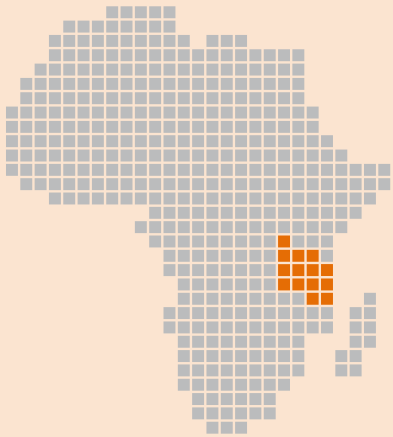
Authors
Okere N. E., Censi V., Machibya C., Costigan K., Katambi P. , Martelli G., de Klerk J., Hermans S., Gomez G. B., Pozniak A., Rinke de Wit T. & Naniche D.

Published in
Springer Link,
May 2021

Link
https://doi.org/10.1007/s11136-021-02889-z

Topic
Infectious and tropical diseases

Focus country
Tanzania



Quality of Life Research (2022) 31:159–170
https://doi.org/10.1007/s11136-021-02889-z

Beyond viral suppression: Quality of life among stable ART clients in a differentiated service delivery intervention in Tanzania

Nwanneka Ebelechukwu Okere[1] · Veronica Censi[2] · Clementina Machibya[3] · Kathleen Costigan[4] · P. Katambi[3] · Giulia Martelli[2] · Josien de Klerk[1] · Sabine Hermans[1] · Gabriela B. Gomez[5] · Anton Pozniak[6] · Tobias Rinke de Wit[1] · Denise Naniche[7]

Accepted: 18 May 2021 / Published online: 30 May 2021
© The Author(s) 2021

Abstract

Background With antiretroviral therapy, more people living with HIV (PLHIV) in resource-limited settings are virally suppressed and living longer. WHO recommends differentiated service delivery (DSD) as an alternative, less resource-demanding way of expanding HIV services access. Monitoring client's health-related quality of life (HRQoL) is necessary to understand patients' perceptions of treatment and services but is understudied in sub-Saharan Africa. We assessed HRQoL among ART clients in Tanzania accessing two service models.

Methods Cross-sectional survey from May–August 2019 among stable ART clients randomly sampled from clinics and clubs in the Shinyanga region providing DSD and clinic-based care. HRQoL data were collected using a validated HIV-specific instrument—Functional Assessment of HIV infection (FAHI), in addition to socio-demographic, HIV care, and service accessibility data. Descriptive analysis of HRQoL, logistic regression and a stepwise multiple linear regression were performed to examine HRQoL determinants.

Results 629 participants were enrolled, of which 40% accessed DSD. Similar HRQoL scores *[mean (SD), p-value]*; FAHI total [152.2 (22.2) vs 153.8 (20.6), p 0.687] were observed among DSD and clinic-based care participants. Accessibility factors contributed more to emotional wellbeing among DSD participants compared to the clinic-based care participants (53.4% vs 18.5%, $p = < 0.001$). Satisfactory (> 80% of maximum score) HRQoL scoring was associated with (OR [95% CI], p-value) being male (2.59 [1.36–4.92], p 0.004) among clinic participants and with urban residence (4.72 [1.70–13.1], p 0.001) among DSD participants.

Conclusions Similar HRQoL was observed in DSD and clinic-based care. Our research highlights focus areas to identify supporting interventions, ultimately optimizing HRQoL among PLHIV.

Keywords Quality of life · FAHI · Wellbeing · Emotional · Social · Differentiated service delivery

Abbreviation

ART	Anti-Retroviral Therapy
ARV	Antiretroviral
AUC	Area Under Curve
AYPLHIV	Adolescent and Young People Living with HIV
CF	Cognitive Functioning
CI	Confidence Interval
CHW	Community Health Worker

✉ Nwanneka Ebelechukwu Okere
n.okere@aighd.org

[1] Department of Global Health, Amsterdam Institute for Global Health and Development, Amsterdam UMC, University of Amsterdam, Amsterdam, Netherlands

[2] Doctors with Africa (CUAMM), Test & Treat Project Shinyanga, Shinyanga, Tanzania

[3] Ngokolo Health Centre, Catholic Diocese of Shinyanga, Shinyanga, Tanzania

[4] Bugisi Health Centre, Catholic Diocese of Shinyanga, Shinyanga, Tanzania

[5] Department of Global Health and Development London School of Health and Tropical Medicine United Kingdom, London, UK

[6] Chelsea and Westminster Hospital NHS Foundation Trust, London, UK

[7] Barcelona Institute for Global Health, University of Barcelona, Barcelona, Spain

CTC	Care and Treatment Centre
DSD	Differentiated Service Delivery
EWB	Emotional Wellbeing
FAHI	Functional Assessment of HIV Infection
FGWB	Functional and Global Wellbeing
HIC	High Income Country
HIV	Human Immunodeficiency Syndrome
HCW	Health Care Worker
HRQoL	Health-Related Quality of Life
LMIC	Low- and Middle-Income Country
NACP	National AIDS Control Program
NIMR	National Institute for Medical Research
MOHCDGEC	Ministry of Health, Community Development, Gender, Elderly, and Children Tanzania
PLHIV	People Living with HIV
PWB	Physical Wellbeing
QoL	Quality of Life
ROC	Receiver Operative Characteristics
SD	Standard Deviation
SSA	Sub-Saharan Africa
SWB	Social Wellbeing
T & T	Universal Test & Treat
VL	Viral Load
VLS	Viral Load Suppression
WHO	World Health Organization

Background

Access to effective antiretroviral therapy (ART) has contributed to an increased number of people living with HIV (PLHIV) being virally suppressed and living longer [1–4]. However, the physical consequences of long-term exposure to ARVs have yet to be fully elucidated and evidence associates PLHIV on ART with an increased risk of cardiovascular disease, liver disease, and various malignancies [5–8]. While PLHIV report significantly lower health-related quality of life (HRQoL) when compared to the general population in high-income countries (HIC) [9], HRQoL among PLHIV is understudied in low and middle-income countries (LMIC), especially in sub-Saharan Africa (SSA). With an increasing number of PLHIV on ART who are aging in SSA, monitoring of HRQoL becomes a priority in this setting [10, 11].

HRQoL is a multidimensional concept depicting an individual's subjective perception of current health status and outlook of the future [12, 13]. HRQoL studies assess individuals' perception of their health and how it affects or is affected by other aspects of life [13]. Among PLHIV, ART impacted HRQoL positively, especially in LMIC when ART start was guided by CD4 thresholds [1, 14, 15]. Subsequent studies predicted factors associated with good HRQoL among PLHIV e.g. being married, absence of co-morbidities, higher education, living in an urban setting, status disclosure, being on ART longer, being employed, fewer pills, and good adherence [16–21]. Conversely, factors found to be associated with lower HRQoL included stigma, same-sex relationships, being symptomatic, illiteracy and not being sexually active [18, 19, 22–24]. HRQoL studies among virally suppressed PLHIV are limited in LMIC [9, 23, 25].

In SSA, HRQoL studies have mostly been conducted among clients who access ART in clinical settings [24, 26–28]. Differentiated service delivery (DSD) is a patient-centered approach which offer virally suppressed PLHIV alternative models of HIV care both within clinic (e.g. multiple month scripting, fast-track refills, adherence/ART clubs etc.) and out-of-clinic (e.g. community ART, community drug distribution points, ART clubs etc.) [29–33]. DSD models benefit both the health system by reducing over-crowding in clinics, improving work efficiency among healthcare workers (HCW), and clients, by fostering self-management, peer support, and reducing time spent seeking care. Out-of-clinic DSD models limit contact with the formal health system and rely upon community health workers (CHW) who are trained volunteers for service delivery. Most evaluations of such models focused on adherence and quality of care yet change in delivery models of care may also affect HRQoL.

With 1.6 million PLHIV and a prevalence of 4.6% among adults in 2018, it was estimated that only 62% of PLHIV on ART in Tanzania are virally suppressed [34]. Though studies show favorable patient-related outcomes with DSD interventions elsewhere, there is a dearth of evidence within the Tanzanian context [35–37]. Additionally, it was not clear how limited contact with the health system, more peer support, less frequent travels impacted the QoL of clients. Our study therefore aimed to assess HRQoL among stable ART clients accessing ART care in a flagship Test and Treat (T&T) project in north-western Tanzania. We compared HRQoL scores and determinants of HRQoL between stable ART clients receiving either standard clinic-based care or ART clubs DSD care.

Methods

Study setting and population

The T&T project is hosted by the Catholic Diocese of Shinyanga which covers both Shinyanga and Simiyu regions in north-western Tanzania. Besides Shinyanga urban, Kahama urban, and Bariadi districts, the regions are largely rural. Project sites are four HIV care and treatment centers (CTC) referred to as hubs, two hubs each in the Shinyanga (Ngokolo and Bugisi) and Simiyu (Songambele and Mwamapala)

regions. Standard of HIV care in Tanzania is clinic-based and includes one clinic visit every one to three months for consultation, health screening, routine labs and ART refill. DSD in ART clubs was rolled out in the T&T project from July 2018, details of which have been described elsewhere [38]. Briefly, ART clubs are CHW managed groups of 15–30 clients living within the same locality who meet every 3 months for routine health screening and ART distribution. Club members have a clinical consultation every year. Data were collected from May to August 2019. Participants were recruited at the two hubs in the Shinyanga region and their related ART clubs. Eligibility criteria included being adults ≥ 18 years and stable on ART according to the Tanzanian guidelines: on ART 1st line regimen ≥ 6-months, viral load < 50 copies/ml, and no current chronic illness [39]. At the hubs, participants were randomly sampled from a list of all eligible clients who had a clinic appointments within the data collection period. Eligible participants were approached as they attended clinic appointments. All clubs that had a meeting during the data collection period and were at least 6 months or older, were visited. At the clubs, all members were approached as stability was an eligibility criterion for DSD participation. Those clients who gave written consent, completed the interviewer-administered questionnaire.

Data collection

We used an HIV-specific HRQoL tool that has been validated for the low literacy Swahili population, the Kiswahili translation of the Functional Assessment of HIV Infection (FAHI) [40]. Outcomes of interest were the total and domain-specific FAHI scores. The FAHI is a 47-item tool with five domains namely physical wellbeing (PWB) – 10 items, emotional wellbeing (EWB) – 10 items, functional & global wellbeing (FGWB) – 13 items, social wellbeing (SWB)-8 items, and cognitive functioning (CF) – 3 items [41]. Scores ranged for each item between 0 and 4. We derived (a) domain scores by summing respective item scores – ranges for PWB and EWB were 0 to 40, FGWB 0 to 52, SWB 0 to 32, and CF 0 to12; (b) total FAHI scores by summing all five domain scores – ranging between 44 and 176—note that three items in the PWB domain were not scored as recommended by the FAHI scoring document [42]; (c) FAHI proportional score by calculating each individual score as a proportion of the maximum possible total or domain scores; and (d) a dichotomous (satisfactory/less than satisfactory FAHI HRQoL) variable for total and domains. We considered a score in the highest quintile i.e. ≥ 80% of FAHI total or domain scores as satisfactory to capture all participants who report at least ≥ 4 on the 5-point FAHI tool. This represents all those who report at least above "Somewhat" (i.e. 3 – the midpoint) for all items in all domains of the FAHI instrument.

Secondary outcomes were factors associated with satisfactory HRQoL and domain scores. Three categories of additional data were collected to assess these factors: socio-demographic (location, sex, age, educational level, marital status, employment status, and income level), HIV care (duration on ART, CD4 count at ART start and recency of viral load result) and service access (location, time spent during clinic visit/club meeting[wait time], time spent traveling to clinic/club[travel time] and frequency of service delivery). Data entry, collation, and cleaning were done using EpiData [43].

Sample size and statistical analysis

Our sample size calculation was based on EQ-index scores and extrapolated to proportional FAHI scores. We assumed a difference in proportional scores of 0.10 (0.80 to 0.90) between the clinic and DSD participants, a standard deviation of 0.40 as determined by Louwagie et al. in South Africa, and a 10% refusal rate requiring thus a minimum of 542 participants overall with 271 participants per service delivery group to have 80% power to reject the null hypothesis of no difference [1].

Categorical variables were presented as percentages and continuous variables as means (± standard deviation) or medians (± interquartile range) as appropriate. Comparisons between clinic and DSD participants were done using Mann Whitney or Kruskal Wallis tests. Association between socio-demographic, HIV care, and service access factors and satisfactory FAHI HRQoL were examined using logistic regression. Sex, age, marital status, and variables showing significant bivariate association at the p-value of < 0.1 were included in the multivariable model. A 3-step hierarchical multiple linear regression was used to quantify the contribution of the three-factor categories to the variance of FAHI scores observed. Socio-demographic variables were entered in the model in the first step, followed by HIV care variables and lastly, service access variables.

We examined variables for multicollinearity using tolerance values and variance inflation factor (VIF) statistics. We generated a Receiver Operative Characteristic (ROC) i.e. area under the curve (AUC) to test the discriminative ability of the model (with all covariates included) to categorize observations as satisfactory/less than satisfactory HRQoL. We assessed the 33 and 28 missing observations dropped from the clinic and DSD in step 3 hierarchical linear models, respectively, to observe any significant differences in mean FAHItotal. All analyses were performed using STATA software version 16.0.

Ethical approval for the study was obtained from the National Institute for Medical Research (NIMR; approval number NIMR/HQ/R.8c/Vol. I/674).

Results

Characteristics of the study population

Of 667 PLHIV approached to participate, 641 consented to participate (response rate of 96.1%), and 629 were included in the final analysis (12 excluded due to missing data). While the overall majority of participants were female (63%), there were significantly more men in clinic-based care compared to DSD, and DSD participants were also significantly older (see Table 1). The mean numbers of years-on-ART and mean CD4 count at ART start were significantly longer (4.9 vs 4.1 years, $p < 0.001$) and higher (398.1 vs 341.4 cells/mm^3, $p < 0.001$) for DSD participants. They also spent shorter time on travel (84.7 vs 34.3 min, $p < 0.001$) and during club meetings (140.2 vs 83.8 min, $p < 0.001$). There were more DSD participants in the urban area (60.6% vs 39.4%). Table 1 provides details on the characteristics of study participants according to the service delivery model.

FAHI total and domain scores by service access model

Clinic and DSD participants show comparable mean HRQoL scores across domains with only slight differences in the physical and emotional wellbeing domains (36.4 vs 35.5, max-40 $p < 0.01$) and (32.1 vs 32.8, max-40 $p < 0.05$) (Fig. 1a). No differences were observed in satisfactory HRQoL percentages across domains except for FGWB where more clinic participants revealed satisfactory HRQoL as compared to DSD. Satisfactory HRQoL overall was highest in the CF domain (89.2 vs 93.6) and lowest in the EWB (68.8 vs 68.5) and SWB (74.1 vs71.7) domains (Fig. 1b).

Associations between sociodemographic, HIV care, and service access factors and satisfactory overall HRQoL

Satisfactory overall HRQoL was associated with being male ((odds ratio 2.59, 95% confidence interval 1.36–4.92) among clinic participants and with living in an urban setting (4.72, 1.70–13.1) in DSD care (see—Table 2). Less than satisfactory HRQoL was observed with increasing age among clinic participants, and with increasing income, and increased meeting duration among DSD participants. HIV care factors were generally not associated with satisfactory overall HRQoL.

Associations between sociodemographic, HIV care and service access factors and satisfactory domain HRQoL

Compared to being single, satisfactory HRQoL was associated with being married in the PWB domain for both clinic and DSD. Being married or separated, divorced, or widowed was positively associated with satisfactory HRQoL for both clinic and DSD participants in the SWB domain and only among DSD participant in the FGWB domain. Living in an urban area was significantly associated with satisfactory HRQoL for both clinic and DSD participants in the EWB domains and only among DSD participants in the SWB and PWB domains. Across domains, declining age was generally not associated with satisfactory HRQoL. Significantly less satisfactory HRQoL was only seen among clinic participants aged over 65 years in the PWB and FGWB domains. Surprisingly, less satisfactory HRQoL was linked with increased income levels in the EWB domain among clinic and DSD participants. Generally, HIV care factors were not associated with satisfactory HRQoL. Among service access factors, DSD participants alone reported less than satisfactory HRQoL for spending longer time during service access in the PWB, EWB, and SWB domains (Table 2 and Additional file 1 [for additional results of FGWB & CF domains]).

Contribution of sociodemographic, HIV care, and service access factors to variance observed in HRQoL.

Table 3 shows the contribution of sociodemographic, HIV care, and service access factors to the variance observed in HRQoL scores. The analyses revealed that among clinic participants, the variance in overall HRQoL score FAHI total explainable by sociodemographic variables in the first step was 10.2%. The addition of HIV care variables in the second step increased the variance explained to 14.5%. Finally, service access variables in the third step brought the total to 14.9%. For DSD participants, the variance explained was 22.9%, 28.9%, and 43.5% in the first, second, and third steps, respectively. Across all domains, the variance in HRQoL explainable by the 3-step hierarchical model for clinic participants was modest (see Table 3). The highest was reported in the EWB domain i.e. 8.5%, 11.4%, and 18.5%, and lowest in the CF domain i.e. 5.9%, 9.1%, and 9.8%, respectively. A much higher proportion of variance was explained in overall FAHI 43.5%, PWB 30.2%, EWB 53.4%, and SWB 35.1% among DSD participants. Additional file 2 shows the details of the hierarchical linear regression with coefficients of all covariate in each step.

Table 1 Socio-demographic, HIV care, and service access-related characteristics according to service delivery model

	Clinic-based ($n=378$)	DSD ($n=251$)	p-value*
Sociodemographic information			
Location, *n* (%)			
Bugisi (Rural)	324 (65.8)	168 (34.1)	< 0.001
Ngokolo (Urban)	54 (39.4)	83 (60.6)	
Sex (*n*, %)			
Female	224 (59.3)	172 (68.5)	0.018
Male	154 (40,7)	79 (31.5)	
Age in years, median (IQR)	39.3 (33.3–48.1)	44.7 (37.6–54.0)	< 0.001
Age-groups, *n*, (%)			
< 25	25 (6.61)	6 (2.40)	< 0.001
25–34	96 (25.1)	35 (13.9)	
35–44	137 (36.2)	91 (36.3)	
45–54	75 (19.8)	62 (24.7)	
55–64	33 (8.73)	40 (15.9)	
≥ 65	13 (3.4)	17 (6.8)	
Educational level, *n* (%)			
No education	97 (25.7)	60 (23.9)	0.744
Primary	261 (69.1)	180 (71.7)	
≥ Secondary	20 (5.3)	11 (4.4)	
Marital status (*n*, %)			
Single	94 (24.9)	80 (31.9)	0.092
Married	144 (38.1)	78 (31.1)	
Separated/Divorced/Widowed	140 (37.0)	93 (37.1)	
Employment status (*n*, %)			
Unemployed	53 (14.0)	60 (23.9)	0.002
Income level (TSH), median (IQR)	87,000 (50,000- 172,000)	80,000 (50,000- 150,000)	
< 100,000	206 (54.5)	148 (59.0)	0.315
100,000–300,000	116 (30.7)	63 (25.1)	
> 300,000	56 (14.8)	40 (15.9)	
HIV care information			
Years on ART, median [IQR]	4.1 [2.1–5.8]	4.9 [2.2–7.3]	0.001
Years on ART group around the mean			
≤ 4.4 years	219 (57.9)	130 (51.8)	0.316
> 4.4 years	150 (39.7)	114 (45.4)	
Missing	9 (2.38)	7 (2.79)	
CD4 at ART start in cells/mm^3, median [IQR]	341.4 [155–449]	398.1 [184.5–513.5]	0.003
CD4 at ART start groups			
< 200	126 (33.3)	63 (25.1)	0.07
≥ 200	236 (62.4)	173 (68.9)	
Missing	16 (4.23)	15 (5.98)	
Viral load in copies/ml, median [IQR]	10 [10]	10 [10]	0.876
Viral load group			
< 50 copies/ml	375 (99.2)	237 (94.4)	< 0.001
≥ 50	-	9 (3.6)	
Missing	3 (0.8)	5 (2.0)	
Time since last VL record, n (%)			
≤ 6 months	179 (47.4)	113 (45.0)	< 0.001
6 months – 1 year	170 (44.9)	85 (33.9)	
> 1 year	26 (6.9)	49 (19.5)	
Missing	3 (0.8)	4 (1.6)	

Table 1 (continued)

	Clinic-based ($n=378$)	DSD ($n=251$)	p-value*
Service access information			
Time spent in clinic/club in minutes, median [IQR]	140.2 [60–180]	83.8 [30–120]	< 0.001
Length of stay, *n* (%)			
Short (≤ 1 h 30 min)	129 (34.1)	177 (70.5)	< 0.001
Long (> 1 h 30 min)	246 (65.1)	71 (28.3)	
Missing	3 (0.8)	3 (1.2)	
Time spent traveling to clinic/club in minutes, median [IQR]	84.7 [30–120]	34.3 [10–30]	< 0.001
Travel time group, n (%)			
Short (≤ 1 h)	214 (56.6)	232 (92.4)	< 0.001
Long (> 1 h)	161 (42.4)	17 (6.8)	
Missing	3 (0.8)	2 (0.8)	
Frequency of visits/meetings, n (%)			
More (≤ every 2 months)	355 (93.9)	121 (48.2)	< 0.001
Less (> every 2 months)	23 (6.1)	130 (51.8)	

*p-values presented are calculated using Mann Whitney U or Kruskal Wallis tests as appropriate. *n* number, *%* percentage, *SD* standard deviation, *TSH* Tanzanian shilling, *IQR* interquartile range, *ART* antiretroviral treatment, *VL* viral load

Internal consistency and Goodness of fit statistics

In the present study, Cronbach alpha was 0.68, 0.73, 0.67, 0.71, and 0.81 for the PWB, EWB, FGWB, SWB, and CF domains, respectively, indicating acceptable internal consistency. Tolerance values ranged from 0.16 to 0.84 while the VIF values were from 1.19 to 6.3 suggesting that multicollinearity had no impact on the variables included. The AUC for our logistic regression model was 0.81 showing the acceptable ability of our model to discriminate – the effective range is usually from 0.5 to 1. There was no significant difference in mean FAHI total scores when the step 3 models in the hierarchical regression were compared with step 1 models.

Discussion

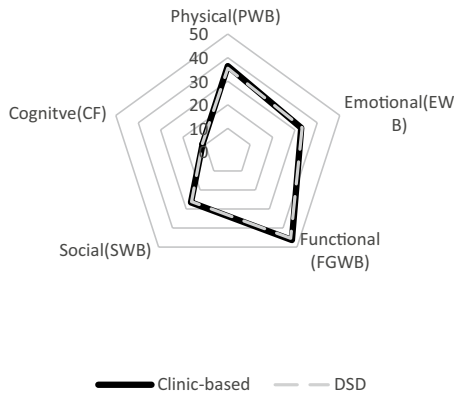
Our study compared factors influencing HRQoL among stable ART clients accessing care at either HIV clinics or DSD clubs in the Shinyanga region of Tanzania. Most participants in our study rate their HRQoL as satisfactory. Our results revealed that service access factors contributed considerably to HRQoL among DSD participants. We found that time spent during clinic/club and the settings of service delivery were factors significantly associated with perceived HRQoL.

Understanding HRQoL in African studies is relevant in the current era of expanded treatment" and DSD. Previous HRQoL studies compared HIV positive and negative people and/or PLHIV not on and on ART [2, 2]. Similar HRQoL among stable clients seen in our study strengthens the case for DSD which may likely impact positively on care delivery to unstable clients concurrently who are more likely to have special needs [44, 45]. The complex effect of service access factors on overall HRQoL suggests that other non-measured factors are likely also to influence HRQoL.

Service access factors are more commonly studied about patient satisfaction and retention in care than in HRQoL but both are likely to be related. The shorter time spent accessing service observed as positively associated with HRQoL in our study may reflect the value placed on other meaningful engagements made possible by the time saved from care seeking in this setting. Being predominantly farmers, reduction of productivity loss due to care seeking likely impacts HRQoL. In Malawi and Uganda, reduced time spent in DSD models was reported as a favorable outcome predicting retention and satisfaction [46, 47]. Reduced travel time has also been identified as beneficial for DSD participants and enabling its success, although it was not independently associated with HRQoL in our study [48, 49].

As per HRQoL domains, the literature reveals that social and psychological/emotional domains score the lowest in most HRQoL studies among PLHIV [16, 21, 25, 50–54] which is in line with our findings. Reasons adduced for this include stigma and discrimination due to fear and lack of awareness as HIV continues to isolate those infected from meaningful relationships. The slight difference in the PWB domain scores is likely not clinically significant as HRQoL was generally not associated with most covariates except for those age > 65 years or married in the clinic. The variance explainable due to service access factors was notably largest i.e. 53.4% in the EWB domain suggesting some significance of the contribution of DSD in supporting participants who

(a) Mean FAHI HRQoL domain scores



(b) Proportion of individuals with satisfactory HRQoL

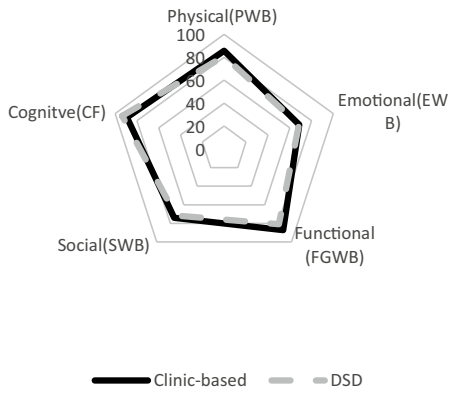


Fig. 1 FAHI HRQoL scores by service access model. Mean FAHI HRQoL domain scores (b) Proportion of individuals with satisfactory HRQoL. *PWB* Physical wellbeing, *EWB* Emotional wellbeing, *FGWB* Functional and Global wellbeing, *SWB* Social wellbeing, *CF* Cognitive Functioning

likely face different psychological, emotional, and social dilemmas. [16, 17, 51].

While our finding that being male was associated with a more satisfactory HRQoL aligns with evidence from Tanzania, Burkina Faso, Ghana, and Ethiopia [18, 55–57], other studies reveal either no association [23, 25, 58] or favor higher HRQoL among women [22, 50, 59]. Although these studies did not target stable clients, they illustrate the complexity of associations between gender and HRQoL. We note across studies that women living in male dominated settings (as is the case in our study) tend to report lower HRQoL when compared with settings where women have social support.

Similar to findings with gender, age reveals intricacies of associations in literature, showing evidence of declining HRQoL with age [54, 55, 57, 59] among PLHIV, as well as improvement or no association [18, 23, 60]. Given that DSD participants in our study were significantly older, our finding a trend of declining HRQoL with age mainly among clinic participants suggests a protective effect of DSD on HRQoL with increasing age. Older adults may enjoy fewer social ties than younger adults and thus reap a larger emotional benefit from DSD. As the PLHIV population on ART ages and comorbidities increase, emotional support will become increasingly important and DSD could serve as a springboard for additional interventions.

Context such as place of residence has been associated with HRQoL in LMIC [20, 21]. Our study showed that urban participants had higher HRQoL scores across most domains than did their rural counterparts. Better living conditions, greater awareness about HIV, and the anonymity people generally enjoy living in an urban setting likely creates a less-stigmatizing space for PLHIV. Our findings that educational level, employment, and income level was not associated with HRQoL however differs from reports in the literature which associates a better HRQoL among PLHIV with a higher level of education [18, 20, 53–55]; with employment [19, 59, 61] and relatedly to higher income levels [19, 62]. The prevailing socio-economic circumstances which are similar among participants irrespective of setting could provide an explanation.

Despite viral suppression, HIV infection predicts suboptimal HRQoL [9, 25]. The assumption of 'normalcy' in all areas as PLHIV attain viral suppression may be ambitious especially in the context of stigma, living in socio-economically difficult circumstances, or with other chronic illnesses. The need to do more in these areas has been advocated especially for PLHIV in the rural areas, for women, and adolescents, and young people living with HIV [18, 24, 25, 61, 63].

Strengths and limitations

Our study is among few HRQoL studies conducted recently in SSA in the era of DSD. It provides useful insights into factors influencing HRQoL in an African population. Our participants were drawn from different geographical settings that mimic the reality of our population and generated valuable information about the impact of DSD in these settings. Though observational with

Table 2 Logistic regression with robust variance: Multivariable association between sociodemographic, HIV care, and service access variables and satisfactory FAHI QoL scores#

	FAHItotal		PWB		EWB		SWB	
	Clinic	DSD	Clinic	DSD	Clinic	DSD	Clinic	DSD
Sociodemographic	Odds ratios and confidence intervals							
Sex	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
Female	2.59**	1.11	1.02	0.71	1.39	0.87	1.98*	1.95
Male	1.36–4.92	0.49–2.51	0.51–2.04	0.31–1.62	0.83–2.33	0.36–2.12	(1.14–3.43)	(0.89–4.27)
Age								
18–25	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
25–35	0.16	1.15	0.17	2.12	0.61	0.18	0.33	1.32
	0.02–1.43	0.01–22.62	0.02–1.55	0.11–39.4	0.20–1.83	0.00–1.45	(0.08–1.34)	(0.11–15.78)
35–45	0.0.09*	1.33	0.17	2.86	0.62	0.43	0.21*	1.19
	0.01–0.78	0.07–23.91	0.02–1.52	0.18–46.3	0.21–1.84	0.00–3.28	(0.05–0.84)	(0.11–12.91)
45–55	0.06*	0.62	0.16	1.29	0.49	0.16	0.26	0.67
	0.01–0.59	0.03–11.3	0.02–1.56	0.08–20.7	0.15–1.58	0.00–1.27	(0.06–1.09)	(0.06–7.40)
55–65	0.08*	0.55	0.25	1.78	0.81	0.14	0.33	1.08
	0.01–0.85	0.03–10.5	0.02–2.82	0.10–31.3	0.21–3.05	0.00–1.11	(0.07–1.63)	(0.09–12.82)
> 65	0.04*	0.36	0.05*	0.58	0.58	1.19	0.35	0.76
	0.00–0.52	0.02–7.96	0.00–0.59	0.03–11.2	0.11–2.98	0.01–1.17	(0.06–2.12)	(0.05–10.43)
Education								
None	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
Primary	1.18	0.8	0.74	0.65	0.98	0.87	1.33	0.23**
	0.62–2.20	0.33–1.93	0.35–1.52	0.26–1.61	0.57–1.69	0.32–2.36	(0.76–2.31)	(0.09–0.58)
≥ Secondary	0.43	1	0.31	1	0.77	1	0.96	0.59
	0.12–1.60		0.07–1.32		0.24–2.52		(0.28–3.30)	(0.05–6.44)
Marital status								
Single	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
Married	1.98	2.22*	2.22*	3.92*	1.77	1.49	4.08**	4.93**
	0.96–4.07	0.89–5.50	1.01–4.89	1.37–11.2	0.95–3.30	0.53–4.12	(2.11–7.87)	(2.06–11.75)
Separ/Divorc/Wid	1.72	1.53	1.54	1.53	1.26	0.73	1.91*	6.35**
	0.85–3.49	0.62–3.79	0.71–3.30	0.63–3.76	0.68–2.33	0.26–2.00	(1.04–3.52)	(2.60–15.53)
Employment								
Unemployed vs Employ			Ref.	Ref.				
			1.44	0.39				
			0.58–3.56	0.14–1.14				
Income level								
< 100,000	Ref.	Ref.			Ref.	Ref.		
100,000–300,000	0.45*	0.43			0.48**	0.6		
	0.24–0.84	0.18–1.02			0.28–0.82	0.22–1.62		
> 300,000	1.09	0.28*			0.46*	0.23*		
	0.43–2.79	0.11–0.78			0.23–0.91	0.07–0.77		
Location								
Bugisi	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
Ngokolo	1.88	4.72**	3.05	3.94*	4.81**	17.1**	0.94	3.79**
	0.74–4.81	1.70–13.13	0.94–9.89	1.34–11.5	1.86–12.42	4.63–62.8	(0.45–1.98)	(1.62–8.86)
Wait time mins	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
< 90 min	0.9	0.23**	0.89	0.43*	0.64	0.05**	0.75	0.24**
> 90 min)	0.47–1.73	0.11–0.47	0.44–1.79	0.21–0.92	0.37–1.10	0.02–0.12	(0.42–1.32)	(0.12–0.48)

*p < 0.01; **p < 0.001. # See Additional file 1 for table with FGWB and CF domain results.

Table 3 Contribution of sociodemographic, HIV care, and service access factors to variance observed in HRQoL scores

Variance explained by three-factor categories (N = clinic vs DSD)												
	FAHItotal		PWB		EWB		FGWB		SWB		CF	
	Clinic	DSD	Clinic	DSD	Clinic	DSD	Clinic	DSD	Clinic	DSD	Clinic	DSD
*Step 1 R^2 (n = 378 vs 251)	0.102	0.229	0.103	0.205	0.085	0.184	0.119	0.222	0.118	0.217	0.059	0.058
^Step 2 R^2 (n = 351 vs 226)	0.145	0.289	0.146	0.243	0.114	0.268	0.169	0.253	0.139	0.258	0.091	0.086
#Step 3 R^2 n = 345 vs 223	0.149	0.435	0.149	0.302	0.185	0.534	0.167	0.297	0.148	0.351	0.098	0.099
AIC Step 3	8.803	8.692	5.969	6.077	6.603	6.415	6.258	6.63	6.723	6.523	4.034	4.081

*Step 1—Contribution of sociodemographic factors to variance observed; ^Step 2—Contribution of HIV care factors to variance observed and #Step 3 – Contribution of service access variables to variance observed from Hierarchical Multiple Linear Regression. Additional file 2 shows the regression coefficients for variables included in the models in steps 1–3.

known biases, the analytical design of our study allowed for comparisons that produced a rich resource useful for informing implementation and policy.

Clinic participants were selected for stability as defined by the Tanzanian guideline at the time of data collection while DSD participants were assumed to be stable. This might have biased our results in favor of clinic participants, however, viral load-related variables were similar in both groups and not independently associated with HRQoL in our study.

The project sites were mission clinics which may limit the generalizability of our findings. However, we might expect that larger differences in HRQoL scores would be found when comparing DSD and clinics outside the mission hospital setting, as better funding and service which characterize our setting likely obscured the effect of DSD.

Conclusion

Our results reveal comparable HRQoL between clinic and DSD participants. The similarity was also observed across HRQoL domains only differing in the PWB and EWB domains where clinic participants score higher. Better HRQoL was associated with being male among clinic participants and with being married, urban residence and shorter duration of wait during service access among DSD participants. While DSD shows promise in improving acceptability among clients and, therefore, the sustainability of such services, our research highlights future areas to explore to further improve HRQoL among PLHIV. Service providers will need to engage PLHIV and the community at large to identify supporting interventions relevant for adapting acceptable DSD interventions to maximize their benefit.

Supplementary Information The online version contains supplementary material available at https://doi.org/10.1007/s11136-021-02889-z.

Acknowledgements The Shinyanga and Simiyu Test & Treat program in Tanzania is supported by Gilead Sciences (USA) and the Diocese of Shinyanga through the Good Samaritan Foundation (Vatican). The implementation of the project is by Doctors with Africa CUAMM and the Diocese of Shinyanga within the framework set out in the national guidance of the Tanzanian Ministry of Health, Community Development, Gender, Elderly and Children (MoHCDGEC) through the National AIDS Control Program (NACP). The scientific evaluation of the project is under the guidance of Principal Investigators Prof Anton Pozniak and Dr. Bernard Desderius and is performed by the Amsterdam Institute for Global Health and Development (AIGHD) in collaboration with Doctors with Africa CUAMM. The content of this manuscript is solely the responsibility of the authors and does not necessarily represent the official views of any of the institutions mentioned above. We thank all our institutional collaborators, the study participants, the staff at the project clinical sites and laboratories, as well as the project support staff for their invaluable support to this program in general and the current manuscript in particular.

Authors contribution NEO, GBG, SH, DN, and TRW contributed to the conceptualization and design of the study. NEO conducted the field study and data collection. ONE was responsible for data analysis and interpretation with guidance from DN. NEO, GBG, SH, JdK, TRW were all involved in the interpretation of the results. TRW was responsible for the overall scientific management of the study. NEO wrote the initial draft of the manuscript. All authors contributed to drafts of the manuscript, read, and approved the final version.

Funding The Shinyanga T&T project is supported by Gilead Sciences Inc. NEO was supported by the Erasmus Mundus Joint Doctorate Trans Global Health Programme (EMJD-TGH) and the Amsterdam Institute for Global Health and Development (AIGHD). The funders had no role in the design, plan for data collection, analysis, interpretation, and writing of this article.

Availability of data and materials The dataset used and analyzed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethical approval Ethics approval for this research study was obtained from NIMR i.e. NIMR/HQ/R.8c/Vol. I/674. Written consent was obtained from individuals who agreed to participate in the study using appropriate forms that had been approved for the same as part of the ethics application.

Consent for publication Not Applicable.

Employment GBG is currently employed by Sanofi Pasteur. Sanofi Pasteur did not provide funding for this study.

Financial and non-financial interests All other authors – VC, CM, KC, PK, GM, JdK, SH, AP, TRdW, and DN certify that they have no affiliations with or involvement in any organization or entity with any financial interest or non-financial interest in the subject matter or materials presented in this manuscript.

Preprint sharing A preprint of this manuscript has been posted on the Research square website – URL: https://www.researchsquare.com/article/rs-91027/v1, https://doi.org/10.21203/rs.3.rs-91027/v1 licensed under a Creative Commons BY 4.0 License.

Open Access This article is licensed under a Creative Commons Attribution 4.0 International License, which permits use, sharing, adaptation, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons licence, and indicate if changes were made. The images or other third party material in this article are included in the article's Creative Commons licence, unless indicated otherwise in a credit line to the material. If material is not included in the article's Creative Commons licence and your intended use is not permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder. To view a copy of this licence, visit http://creativecommons.org/licenses/by/4.0/.

References

1. Louwagie GM, Bachmann MO, Meyer K, Booysen F le R, Fairall LR, Heunis C. Highly active antiretroviral treatment and health related quality of life in South African adults with human immunodeficiency virus infection: A cross-sectional analytical study. BMC Public Health. 2007; 7:244.
2. Thomas, R., Burger, R., Harper, A., Kanema, S., Mwenge, L., Vanqa, N., et al. (2017). Differences in health-related quality of life between HIV-positive and HIV-negative people in Zambia and South Africa: a cross-sectional baseline survey of the HPTN 071 (PopART) trial. *Lancet Glob Heal., 5*(11), e1133–e1141.
3. Nakagawa, F., May, M., & Phillips, A. (2013). Life expectancy living with HIV. *Current Opinion in Infectious Diseases, 26*(1), 17–25.
4. Pozniak, A. (2014). *Quality of life in chronic HIV infection* (Vol. 1, pp. e6–7). The Lancet HIV. https://doi.org/10.1016/S2352-3018(14)70003-7.
5. Yang, H. Y., Beymer, M. R., & Chuan, S. S. (2019). Chronic disease onset among people living with HIV and AIDS in a large private insurance claims dataset. *Scientific Reports*, *9*(1), 18514. https://doi.org/10.1038/s41598-019-54969-3.
6. Schouten, J., Wit, F. W., Stolte, I. G., Kootstra, N. A., Van Der Valk, M., Geerlings, S. E., et al. (2014). Cross-sectional comparison of the prevalence of age-associated comorbidities and their risk factors between HIV-infected and uninfected individuals: The AGE h IV cohort study. *Clinical Infectious Diseases*, *59*(12), 1787–1797.
7. Friedman, E. E., & Duffus, W. A. (2016). Chronic health conditions in Medicare beneficiaries 65 years and older with HIV infection HHS Public Access. *AIDS, 30*(16), 2529–2536.
8. Mayer, K. H., Loo, S., Crawford, P. M., Crane, H. M., Leo, M., Denouden, P., et al. (2018). Excess clinical comorbidity among HIV-infected patients accessing primary care in US community health centers. *Public Health Reports, 133*(1), 109–118.
9. Miners, A., Phillips, A., Kreif, N., Rodger, A., Speakman, A., Fisher, M., et al. (2014). Health-related quality-of-life of people with HIV in the era of combination antiretroviral treatment: A cross-sectional comparison with the general population. *Lancet HIV., 1*(1), e32-40.
10. UNAIDS. (2014). 90–90–90 An ambitious treatment target to help end the AIDS epidemic. UNAIDS/JC2684.
11. Lazarus, J. V., Safreed-Harmon, K., Barton, S. E., Costagliola, D., Dedes, N., del Amo, V. J., et al. (2016). Beyond viral suppression of HIV - the new quality of life frontier. *BMC Medicine., 14*, 94.
12. Karimi, M., & Brazier, J. (2016). Health, health-related quality of life, and quality of life: What is the difference? *PharmacoEconomics, 34*(7), 645–649.
13. Romero, M., Vivas-Consuelo, D., & Alvis-Guzman, N. (2013). Is Health Related Quality of Life (HRQoL) a valid indicator for health systems evaluation? *Springerplus, 2*(1), 664.
14. Jelsma, J., MacLean, E., Hughes, J., Tinise, X., & Darder, M. (2005). An investigation into the health-related quality of life of individuals living with HIV who are receiving HAART. *AIDS Care, 17*(5), 579–588.
15. Robberstad, B., & Olsen, J. (2010). The health related quality of life of people living with HIV/AIDS in sub-Saharan Africa - a literature review and focus group study. *Cost Eff Resour Alloc., 8*(1), 5.
16. Akinboro, A. O., Akinyemi, S. O., Olaitan, P. B., Raji, A. A., Popoola, A. A., Awoyemi, O. R., et al. (2014). Quality of life of Nigerians living with human immunodeficiency virus. *The Pan African Medical Journal*, *18*, 234.
17. Bello, S. I., & Bello, I. K. (2013). Quality of life of HIV/AIDS patients in a secondary health care facility. In *Baylor university medical center proceedings* (Vol. 26, pp. 116–119). Ilorin, Nigeria: Taylor & Francis.
18. Bakiono, F., Ouédraogo, L., Sanou, M., Samadoulougou, S., Guiguemdé, P. W. L., Kirakoya-Samadoulougou, F., et al. (2014). Quality of life in people living with HIV: A cross-sectional study in Ouagadougou. *Burkina Faso. Springerplus., 3*(1), 1–11.
19. Oliveira, F. B. M., Moura, M. E. B., De Araújo, T. M. E., & Andrade, E. M. L. R. (2015). Quality of life and associated factors in people living with HIV/AIDS. *ACTA Paul Enferm., 28*(6), 510–516.
20. Yaya, I., Djalogue, L., Patassi, A. A., Landoh, D. E., Assindo, A., Nambiema, A., et al. (2019). Health-related quality of life among people living with HIV/AIDS in Togo: Individuals and contextual effects. *BMC Research Notes*, *12*(1), 140.
21. Imam, M., Karim, M., Ferdous, C., & Akhter, S. (1970). Health related quality of life among the people living with HIV. *Bangladesh Medical Research Council Bulletin, 37*(1), 1–6.
22. Osei-Yeboah, J., Owiredu, W. K. B. A., Norgbe, G. K., Lokpo, S. Y., Obirikorang, C., Allotey, E. A., et al. (2017). Quality of life of people living with HIV/AIDS in the Ho municipality, Ghana: A cross-sectional study. *AIDS Res Treat., 2017*, 6806951.
23. Erdbeer, G., Sabranski, M., Sonntag, I., Stoehr, A., Horst, H.-A., Plettenberg, A., et al. (2014). Everything fine so far? Physical and mental health in HIV-infected patients with virological success

and long-term exposure to antiretroviral therapy. *Journal of the International AIDS Society, 17*, 19673.
24. Magafu, M. G. M. D., Moji, K., Igumbor, E. U., Hashizume, M., Mizota, T., Komazawa, O., et al. (2009). Usefulness of highly active antiretroviral therapy on health-related quality of life of adult recipients in Tanzania. *AIDS Patient Care and STDs, 23*(7), 563–570.
25. Zeluf-Andersson, G., Eriksson, L. E., Schönnesson, L. N., Höijer, J., Månehall, P., & Ekström, A. M. (2019). Beyond viral suppression: The quality of life of people living with HIV in Sweden. *AIDS Care - Psychol Socio-Medical Asp AIDS/HIV., 31*(4), 403–412.
26. Donald, K. A. (2017). *Health-related quality of life of people with HIV in Zambia and South Africa*. https://doi.org/10.1016/S2214-109X(17)30384-4.
27. Parcesepe, A. M., Nash, D., Tymejczyk, O., Reidy, W., Kulkarni, S. G., & Elul, B. (2019). Gender, HIV-related stigma, and health-related quality of life among adults enrolling in HIV care in Tanzania. *AIDS and Behavior, 24*, 142–150.
28. Bulali, R. E., Kibusi, S. M., & Mpondo, B. C. T. (2018). Factors associated with HIV status disclosure and its effect on treatment adherence and quality of life among children 6–17 years on antiretroviral therapy in southern highlands zone, Tanzania: Unmatched case control study. *International Journal Of Pediatrics, 2018*, 1–10.
29. IAS. (2016). *Differentiated care for Hiv: A decision framework for antiretroviral therapy delivery* (pp. 1–56). Differ Care.org (International AIDS Soc).
30. Decroo, T., Rasschaert, F., Telfer, B., Remartinez, D., Laga, M., & Ford, N. (2013). Community-based antiretroviral therapy programs can overcome barriers to retention of patients and decongest health services in sub- saharan africa: A systematic review. *International Health, 5*(3), 169–179.
31. Vogt, F., Kalenga, L., Lukela, J., Salumu, F., Diallo, I., Nico, E., et al. (2017). Dentralizing ART supply for stable HIV patients to community based distribution centers: Program outcomes from an urban context in Kinshasa, DRC. *JAIDS J Acquir Immune Defic Syndr., 74*(3), 326–331.
32. Prust, M. L., Banda, C. K., Nyirenda, R., Chimbwandira, F., Kalua, T., Jahn, A., et al. (2017). Multi-month prescriptions, fast-track refills, and community ART groups: Results from a process evaluation in Malawi on using differentiated models of care to achieve national HIV treatment goals. *Journal of the International AIDS Society, 20*, 41–50.
33. Pasipamire, L., Nesbitt, R. C., Ndlovu, S., Sibanda, G., Mamba, S., Lukhele, N., et al. (2018). Retention on ART and predictors of disengagement from care in several alternative community-centred ART refill models in rural Swaziland. *Journal of the International AIDS Society, 21*(9), e25183.
34. UNAIDS. (2019). United Republic of Tanzania | UNAIDS [Internet]. Country Fact Sheet. 2018. Available from: http://www.unaids.org/en/regionscountries/countries/unitedrepublicoftanzania.
35. Tsondai, P. R., Wilkinson, L. S., Grimsrud, A., Mdlalo, P. T., Ullauri, A., & Boulle, A. (2017). High rates of retention and viral suppression in the scale-up of antiretroviral therapy adherence clubs in Cape Town. *South Africa. J Int AIDS Soc., 20*, 21649.
36. Okoboi, S., Ding, E., Persuad, S., Wangisi, J., Birungi, J., Shurgold, S., et al. (2015). Community-based ART distribution system can effectively facilitate long-term program retention and low-rates of death and virologic failure in rural Uganda. *AIDS Research and Therapy, 12*(12), 37.
37. Jaffar, S., Amuron, B., Foster, S., Birungi, J., Levin, J., Namara, G., et al. (2009). Rates of virological failure in patients treated in a home-based versus a facility-based HIV-care model in Jinja, southeast Uganda: a cluster-randomised equivalence trial. *Lancet, 374*(9707), 2080–2089.
38. De Nardo, P., Okere, N. E., De Klerk, J., Gentilotti, E., De Wit, T. F. R., Bortolani, A., et al. (2020). Protocol and operational procedures for the implementation of a differentiated HIV service delivery model in north-western tanzania : A multicentre implementation research. *Int J Heal Syst Implement Res., 4*(2), 80–91.
39. Ministry of Health Community Development Gender Elderly and Children. (2017). National AIDS control programme Tanzania. National Guidelines for Management of HIV and AIDS 6th edition.
40. Nyongesa, M. K., Sigilai, A., Hassan, A. S., Thoya, J., Odhiambo, R., Van de Vijver, F. J. R., et al. (2017). A mixed methods approach to adapting and evaluating the functional assessment of HIV infection (FAHI), Swahili version, for use with low literacy populations. *PLoS ONE, 12*(4), e0175021.
41. Cella, D. (2007). *Functional Assessment of HIV Infection. Facit., 2007*, 1–4.
42. FACIT.org. (2021). FAHI measure & scoring [Internet]. Available from: https://www.facit.org/measures/FAHI.
43. The EpiData Association. EpiData Software [Internet]. About. (2013). Available from: https://www.epidata.dk/.
44. World Health Organization. (2017).Guidelines for managing advanced HIV disease and rapid initiation of antiretroviral therapy. License: CC BY-NC-SA 3.0 IGO. pp. 1–56.
45. International AIDS Society. (2016). Differentiated care for HIV: A decision framework for antiretroviral therapy delivery for children, adolescents, and pregnant and breastfeeding women.
46. McGuire, M., Pedrono, G., Mukhuna, B., Huckabee, M., Heinzelmann, A., Szumilin, E. et al. (2011). *Optimizing patient monitoring after the first year of ART: Three years of implementing 6-monthly clinical appointments in rural Malawi*. Abstract for IAS.
47. Nakiwogga-Muwanga, A., Katabira, E., Sempa, J., Kambugu, A., Nakibuuka-Lubwama, E., Lamorde, M., et al. (2013). A Pharmacy-Only Refill Program at a Large HIV Clinic in Uganda: Experience and Satisfaction of Patients. *Journal of the International Association of Providers of AIDS Care*. https://doi.org/10.1177/2325957413488179
48. Bock, P., Gunst, C., Maschilla, L., Holtman, R., Grobbelaar, N., Wademan, D., et al. (2019). Retention in care and factors critical for effectively implementing antiretroviral adherence clubs in a rural district in South Africa. *Journal of the International AIDS Society, 22*(10), e25396.
49. MSF, SAMU. (2013). *Reaching closer to home progress implementing community-based and other adherence strategies supporting people on HIV treatment*. Doctors Without Borders.
50. Fatiregun, A., Mofolorunsho, K., & Osagbemi, K. (2009). Quality of life of people living with Hiv/Aids in Kogi state. *Nigeria. Benin J Postgrad Med., 11*(1), 21–27.
51. Giri, S., Neupane, M., Pant, S., Timalsina, U., Koirala, S., Timalsina, S., et al. (2013). Quality of life among people living with acquired immune deficiency syndrome receiving antiretroviral therapy: A study from Nepal. *HIV/AIDS - Research Palliat Care, 5*, 277–282.
52. Folasire, O. F., Irabor, A. E., & Folasire, A. M. (2012). Quality of life of people living with HIV and AIDS attending the antiretroviral clinic, university college hospital, Nigeria. *African Journal Prim Heal Care Fam Med., 4*(1), 8.
53. Shan, D., Ge, Z., Ming, S., Wang, L., Sante, M., He, W., et al. (2011). Quality of life and related factors among HIV-positive spouses from serodiscordant couples under antiretroviral therapy in Henan Province, China. *PLoS ONE, 6*(6), e21839.
54. Liping, M., Peng, X., Haijiang, L., Lahong, J., & Fan, L. (2015). Quality of life of people living with HIV/ AIDS: A

Cross-sectional study in zhejiang province, China. *PLoS ONE, 10*(8), e0135705.
55. Abrefa-Gyan, T., Cornelius, L. J., & Okundaye, J. (2016). Socio-demographic factors, social support, quality of life, and HIV/AIDS in Ghana. *Journal of Evidence-Informed Soc Work., 13*(2), 206–216.
56. Tesfay, A., Gebremariam, A., Gerbaba, M., & Abrha, H. (2015). Gender differences in health related quality of life among people living with HIV on highly active antiretroviral therapy in mekelle town, northern ethiopia. *Biomedical Research International*. https://doi.org/10.1155/2015/516369
57. Mwanyangala, M. A., Mayombana, C., Urassa, H., Charles, J., Mahutanga, C., Abdullah, S., et al. (2010). Health status and quality of life among older adults in rural Tanzania. *Global Health Action, 27*, 3.
58. Stangl, A. L., Bunnell, R., Wamai, N., Masaba, H., & Mermin, J. (2012). Measuring quality of life in rural Uganda: Reliability and validity of summary scores from the Medical Outcomes Study HIV Health Survey (MOS-HIV). *Quality of Life Research, 21*(9), 1655–1663.
59. Imam, M. H., Karim, M. R., Ferdous, C., & Akhter, S. (2011). Health-related quality of life among the people living with HIV. *Bangladesh Medical Research Council Bulletin*, *37*(1), 1–6.
60. Zeluf-Andersson, G., Eriksson, L. E., Schönnesson, L. N., Höijer, J., Månehall, P., & Ekström, A. M. (2018). *AIDS Care Psychological and Socio-medical Aspects of AIDS/HIV Beyond viral suppression: the quality of life of people living with HIV in Sweden Beyond viral suppression: the quality of life of people living with HIV in Sweden. Aids Care, 20*, 35–42.
61. Mutabazi-Mwesigire, D., Katamba, A., Martin, F., Seeley, J., & Wu, A. W. (2015). Factors that affect quality of life among people living with HIV attending an urban clinic in Uganda: A cohort study. *PLoS ONE, 10*(6), 1–21.
62. Mafirakureva, N., Dzingirai, B., Postma, M. J., van Hulst, M., & Khoza, S. (2016). Health-related quality of life in HIV/AIDS patients on antiretroviral therapy at a tertiary care facility in Zimbabwe. *AIDS Care - Psychol Socio-Medical Asp AIDS/HIV., 28*(7), 904–912.
63. Oguntibeju, O. O. (2012). Quality of life of people living with HIV and AIDS and antiretroviral therapy. *HIV/AIDS - Research and Palliative Care., 4*, 117–124.

Publisher's Note Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

The burden of drug resistant tuberculosis in a predominantly nomadic population in Uganda: a mixed methods study

PAPER

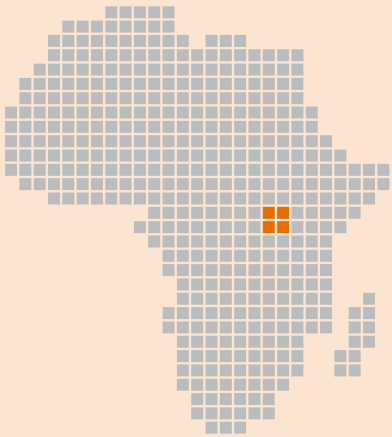
Authors
Nakafeero Simbwa B., Katamba A., Katana E. B., Laker E. A. O., Nabatanzi S., Sendaula E., Opio D., Ictho J., Lochoro P., Karamagi C. A., Kalyango J. N. & Worodria W.

Published in
BMC Infectious Diseases,
September 2021

Link
https://doi.org/10.1186/s12879-021-06675-7

Topic
Infectious and tropical diseases

Focus country
Uganda



Simbwa *et al. BMC Infect Dis (2021) 21:950*
https://doi.org/10.1186/s12879-021-06675-7

BMC Infectious Diseases

RESEARCH Open Access

The burden of drug resistant tuberculosis in a predominantly nomadic population in Uganda: a mixed methods study

Brenda Nakafeero Simbwa[1*], Achilles Katamba[3], Elizabeth B. Katana[1], Eva A. O. Laker[2], Sandra Nabatanzi[1], Emmanuel Sendaula[1], Denis Opio[1], Jerry Ictho[6], Peter Lochoro[6], Charles A. Karamagi[1,5], Joan N. Kalyango[1] and William Worodria[3,4]

Abstract

Background: Emergence of drug resistant tuberculosis (DR-TB) has aggravated the tuberculosis (TB) public health burden worldwide and especially in low income settings. We present findings from a predominantly nomadic population in Karamoja, Uganda with a high-TB burden (3500 new cases annually) and sought to determine the prevalence, patterns, factors associated with DR-TB.

Methods: We used mixed methods of data collection. We enrolled 6890 participants who were treated for tuberculosis in a programmatic setting between January 2015 and April 2018. A cross sectional study and a matched case control study with conditional logistic regression and robust standard errors respectively were used to the determine prevalence and factors associated with DR-TB. The qualitative methods included focus group discussions, in-depth interviews and key informant interviews.

Results: The overall prevalence of DR-TB was 41/6890 (0.6%) with 4/64,197 (0.1%) among the new and 37/2693 (1.4%) among the previously treated TB patients respectively. The drug resistance patterns observed in the region were mainly rifampicin mono resistant (68.3%) and Multi Drug-Resistant Tuberculosis (31.7%). Factors independently associated with DR-TB were previous TB treatment, adjusted odds ratio (aOR) 13.070 (95%CI 1.552–110.135) and drug stock-outs aOR 0.027 (95%CI 0.002–0.364). The nomadic lifestyle, substance use, congested homesteads and poor health worker attitudes were a great challenge to effective treatment of TB.

Conclusion: Despite having the highest national TB incidence, Karamoja still has a low DR-TB prevalence. Previous TB treatment and drug stock outs were associated with DR-TB. Regular supply of anti TB medications and health education may help to stem the burden of TB disease in this nomadic population.

Keywords: Drug resistant Tuberculosis, Nomadic, Uganda, Karamoja, Gene-Xpert, Low prevalence, Alcohol, Drug stock out, Stigma

Background

Worldwide Tuberculosis (TB) is one of the leading infectious diseases with the highest case fatality rate [1]. In Sub Saharan Africa, drug resistance is becoming a great challenge in the fight against TB [2]. Multidrug-resistant tuberculosis (MDR-TB) a global public health problem, is caused by TB bacteria that is resistant to at least isoniazid and rifampicin [3]. DR-TB is transmitted through air from person to person but may sometimes

*Correspondence: nakafeerob@gmail.com
[1] Clinical Epidemiology Unit, Makerere University College of Health Sciences, Kampala, Uganda
Full list of author information is available at the end of the article

© The Author(s) 2021. **Open Access** This article is licensed under a Creative Commons Attribution 4.0 International License, which permits use, sharing, adaptation, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons licence, and indicate if changes were made. The images or other third party material in this article are included in the article's Creative Commons licence, unless indicated otherwise in a credit line to the material. If material is not included in the article's Creative Commons licence and your intended use is not permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder. To view a copy of this licence, visit http://creativecommons.org/licenses/by/4.0/. The Creative Commons Public Domain Dedication waiver (http://creativecommons.org/publicdomain/zero/1.0/) applies to the data made available in this article, unless otherwise stated in a credit line to the data.

develop when the bacteria becomes resistant to the drugs used to treat TB as a result of poor adherence to or wrong prescription of TB treatment [2]. In many countries, treatment of MDR-TB is more than seven times the treatment of susceptible TB and this may deter effectiveness of TB control programs [4, 5]. This is because MDR-TB involves expensive second-line regimens given the prolonged treatment [6]. However this poses serious financial challenges for families and health systems as a whole, especially in sub-Saharan Africa with economically constrained settings [7]. The World Health Organization (WHO) anti-TB drug resistance surveillance data shows that there's an increasing number of new and previously treated TB cases in the world that have rifampicin or multidrug-resistant tuberculosis [8]. The latest treatment outcome data shows over half of the Multidrug-resistant/Rifampicin Resistant tuberculosis (MDR/RR-TB) patients who start treatment are successful, mortality rate is at 18%, and those that fail on treatment are 8%. [9] However, treatment success in extensively drug-resistant TB patients is only a third [9]. Extensively drug-resistant TB (XDR-TB) is a rare type of MDR-TB that is resistant to isoniazid and rifampin, plus any fluoroquinolone and at least amikacin, kanamycin, or capreomycin [10]. In 2017, WHO reported about 558,000 new cases of MDR/RR-TB and a Case fatality rate of 40% globally and 8.5% of these cases had extensively drug-resistant TB (XDR-TB). In the same period TB was responsible for 1.3 million HIV-negative and 374,000 HIV-positive deaths globally [11]. This indicates TB is fatal and prevention efforts should be emphasized.

Karamoja, in north-eastern Uganda, is considered by many a "hard to reach" sub-region [12]. It is characterised by cattle rustling, insecurity from armed nomadic tribes, a semi-arid climate and a few economic activities [12] of which the local community has not been involved extensively. For years, infrastructure including roads, healthcare facilities and adequate water had been specially lacking, making the sub-region the least socially and economically developed in Uganda [13]. Karamoja is the region with the highest incidence of TB in Uganda [14] with 3500 new cases identified and treated every year including increasing cases of MDR [15]. Unfortunately, this is due to people who stop their treatment early. An estimated 40% of the TB patients fail to complete their course of treatment and abandon health care facilities [14, 15]. The cost of treating a patient for drug-susceptible TB is estimated to be 258 US dollars in Uganda, however treating an MDR patient can cost more than 1200 US dollars [16] which is beyond the reach of the average Ugandan [17]. Some of the specific risk factors for TB in nomadic populations include poor living conditions (small and crowded group of huts within one fence, the Manyattas), Poor adherence due to the long distances travelled while raring cattle, TB knowledge gaps [18], higher perceived stigma [19], working conditions associated with high risk of TB transmission like working in the mines with crowded spaces and poor ventilation [20]; and other factors such as diseases that damage immunity, malnutrition, smoking, and alcohol abuse [15, 21]. Although a national survey on drug resistance prevalence, patterns and associated has been done [22], among nomadic populations in Uganda, the patterns and associated factors of DR TB have not been documented. There still exist substantial knowledge gaps on anti-TB-drug resistance that ought to be addressed. It's therefore important that the burden and risk factors of DR-TB in nomadic populations are determined in order to inform policy makers of status of this community and the existing gaps in programming for their DR TB prevention needs. This study aimed to determine the prevalence, patterns and factors associated with and factors influencing DR-TB in a predominantly nomadic population in Uganda.

Materials and methods

Study design

A baseline cross-sectional study was carried out in Matany hospital to determine the prevalence of drug resistant tuberculosis in Karamoja region. A case control study and qualitative study were then carried out to determine the factors associated with drug resistant tuberculosis in Karamoja region among TB patients in the period of January 2015 to January 2018.

Study setting

Karamoja region has seven districts with 37 subcounties. The study was conducted at St. Kizito Hospital Matany in Napak district. Matany Hospital is the only DR-TB treatment initiation site in Karamoja region. The Hospital has been Gene-Xpert (gold standard) for diagnosing TB as well as rifampicin resistance since 2015. This has made Matany Hospital a diagnostic and centre for MDR-TB. The hospital also treats all DR-TB patients from the region including adults and children. Patients diagnosed with rifampicin resistant TB on the Xpert® MTB/RIF assay are subjected to additional investigations including sputum culture, drug susceptibility testing, chest X-rays, HIV tests, thyroid function tests and blood chemistry tests. Patients are then started on the national standardized MDR-TB treatment regimen while awaiting sputum culture and drug susceptibility testing results. The drug susceptibility test results inform on the pattern of resistance either resistance to rifampicin +/− isoniazid (MDR) or resistant to fluoroquinolone (XDR).

Data collection and management

Cross sectional study

Data to determine the prevalence and patterns of DR-TB was extracted from the District Health Information System (DHIS2) online tool. Data of all TB patients between January 2015 and April 2018 was extracted and analysed by the PI.

Case control study

A matched case–control study among DR-TB patients was conducted retrospectively. Cases were matched with controls by Location (Place of residence) at Sub-county level. We matched to control for Sex, Age and area of residents.

We defined a case as a TB patient with sputum culture positive for *Mycobacterium tuberculosis*, resistant to at least isoniazid and rifampicin and a control as a sputum smear-positive drug-susceptible TB patient.

All cases at Matany hospital initiation site were enrolled in the study since the numbers of cases were few (41). Four controls were randomly enrolled per case identified from the sampling frame containing eligible controls. Simple random sampling procedures using computer generated random numbers were used to select controls who presented around same time of 2 months as the case identified. In the event that random number was repeated or control died or migrated, the immediate next person in the TB register was considered.

For each participant we collected the following information; social demographic characteristics, HIV status, nutrition status at diagnosis, history of TB treatment, disease classification and drug stock outs in facilities where patient was getting treatment using the health facility TB registers and anti TB drug stock cards used from January 2015 to April 2019.

The research assistants extracted data from the patient files and TB registers using a pre designed questionnaire. This was used to collect the quantitative data. Prior to the beginning of data collection, the questionnaire was pretested in a sample of 30 records in OPD and all inconsistencies noted in the line of data collection were corrected. Research assistants were trained on the methods of data collection to extract the data from the databases.

Triangulation of the information from the different sources was undertaken to ensure consistency.

Qualitative study

We conducted a qualitative study with the aim of assessing the perspectives, opinions, social and cultural factors influencing and associated with drug resistant tuberculosis among Tuberculosis patients in Karamoja region. The qualitative interview guides were specifically developed for each specific interview but was reviewed and approved by relevant research ethics committees, and pre-tested in the Wakiso district to assess its suitability.

Ten Key informant interviews were carried with Health workers in the seven districts to assess heath related factors influencing drug resistant tuberculosis. The participants included Medical officers in charge of the TB wards, District Tuberculosis and Leprosy Supervisors, Health Inspectors, Nurses, Clinical Officers, data managers and District Health Officers. These were carried out by the PI in English. They were all recorded and notes were taken during the interviews. These were 10–15 min long.

In-depth interviews

Ten in-depth interviews were carried out with patients with DR-TB to determine social–cultural factors influencing and associated to drug resistance. These were carried out in both English and the local language. An in-depth interview tool guide was used to guide the discussion and the discussion points in the guide were those that could help to describe the socio-cultural factors influencing Drug resistance among patients with TB. The interviewers were required to be thoroughly familiar with the in-depth interview tool as it allowed the moderator to be more engaged during the discussion and to rephrase questions that were unclear to participants, or to spontaneously think of follow-up questions and probes. The interview took 20–30 min.

Focus group discussions

3 Focus Group Discussions (FGD) were carried out to collect data on social–cultural factors influencing and associated to drug resistance. We used Purposive sampling to include participants in a FGD and a homogeneous groups that brings together people of similar backgrounds and experiences was considered. Two skilled moderators conducted the FGDs; one person acted as the moderator of the discussion and the other recording using a voice recorder. An FGD guide was used to guide the discussion and the discussion points in the guide were those that could help to describe the socio-cultural factors influencing Drug resistance among TB patients. The FGD moderators were required to be thoroughly familiar with the FGD guide as it allowed the moderator to be more engaged during the discussion and to rephrase questions that were unclear to participants, or to spontaneously think of follow-up questions and probes [23]. The discussions was audio taped, and notes taken during each session lasting between 45 and 60 min. A total of 10 participants were allowed for each FGD session and the FGDs conducted until there was data saturation therefore preliminary was data reviewed and analysis was done in conjunction with data collection.

Study variables

Dependent variable

The Primary outcome in this study was Drug resistance to anti-TB drugs. It was measured as a categorical variable.

Independent variables

Patient socio-demographic factors Age, sex, marital status of the cases and control. These were measured as categorical variables. Residence of the cases and controls; was measured as a continuous variable.

Clinical factors Type of patient, HIV status, Nutrition status, Disease classification of the subjects and these were measured as categorical variables.

Drug related factors Drug stock out; this was measured as a categorical variable to determine whether a health facility had any TB drug stock outs in the period between January 2015 and January 2018.

Substance use Alcohol consumption, Herbal medicines and smoking status of the subjects were measured as categorical variables.

The factors associated with Drug resistant Tuberculosis are showed in Fig. 2 as well as the secondary outcomes.

Data management

Interviews were recorded, transcribed and analysed using open code. Quantitative data was double entered, cleaned, and edited in a statistical software EpiData version 3.1 and thereafter exported to STATA version 13.0. Adjustment was made for the effect of clustering in the data and all statistical analysis performed using STATA version 13.0. Discrepancies were checked against the raw data.

All methods were performed in accordance with the relevant guidelines and regulations under the declaration of Helsinki.

Data analysis

We performed descriptive statistical analysis including frequency counts and percentages for all the participants' characteristics. To identify the factors associated with drug resistant Tuberculosis, we performed conditional logistic regression analysis with a significance level of 0.05. The McNemar's test (chi-square test for matched-pair data) was used to compare if the cases are significantly different from the controls. We conducted both unadjusted and adjusted conditional logistic regression with the adjusted model only including factors that are significant in the unadjusted model. The goodness of fit for the adjusted model was tested through the link-test goodness of fit. For qualitative data, we undertook thematic-content analysis for the qualitative data using Open code version 4.2.1 to generate themes from the interviews and followed by interpretation of the data generated.

Study participants flow chart

A total of 6890 people were reported to have received treatment for Tuberculosis in the period between January 2015 and April 2018. Of these 41 patients were found to have drug resistant tuberculosis. All the 41 patients and 164 controls were included in our study as showed in Fig. 1

The analysis was completed on 41 cases and 164 controls.

Results

The prevalence of DR-TB among patients with TB in Karamoja region in the period between January 2015 and April 2018 was 0.6%. Results of DR-TB are summarised in Table 1.

Among the TB patients s with drug resistance in region, majority 28 (68.3%) had rifampicin mono-resistance while 13 (31.7%) had MDR-TB in Karamoja as summarised in Table 2.

The median age of participants was 37.5 years (interquartile range (IQR) 25 ranging from 6 to 80 years with more females (53.7%) having TB. The greatest proportion of TB patients (39%) was from Nakapiripirit district and was among married participants. A large percentage of the participants had a previous history of TB and was malnourished. Substance use was high among the participants and a small proportion (2.4%) had HIV. Most of the participants received services from a health centre that had at least one TB drug stock-out as shown in Table 3.

Marital Status (OR 3.16), disease classification (OR 17.09), category of TB patient (OR 7.199) and substance use (OR 1.798) and were found significantly associated with DR-TB. Among the health services factors, only drug stock out (OR 0.023) was found significant as shown in Table 4.

In the CLR model, the aOR of two risk factors were found statistically significantly associated with DR-TB namely, Type of patient and Drug stock out. The aOR of history of previous TB treatment was 5.51 (95%CI 1.74–17.44) compared to those with no history of TB treatment. Thus the risk of DR-TB increased 5.5 times among the respondents who had taken TB treatment in the past

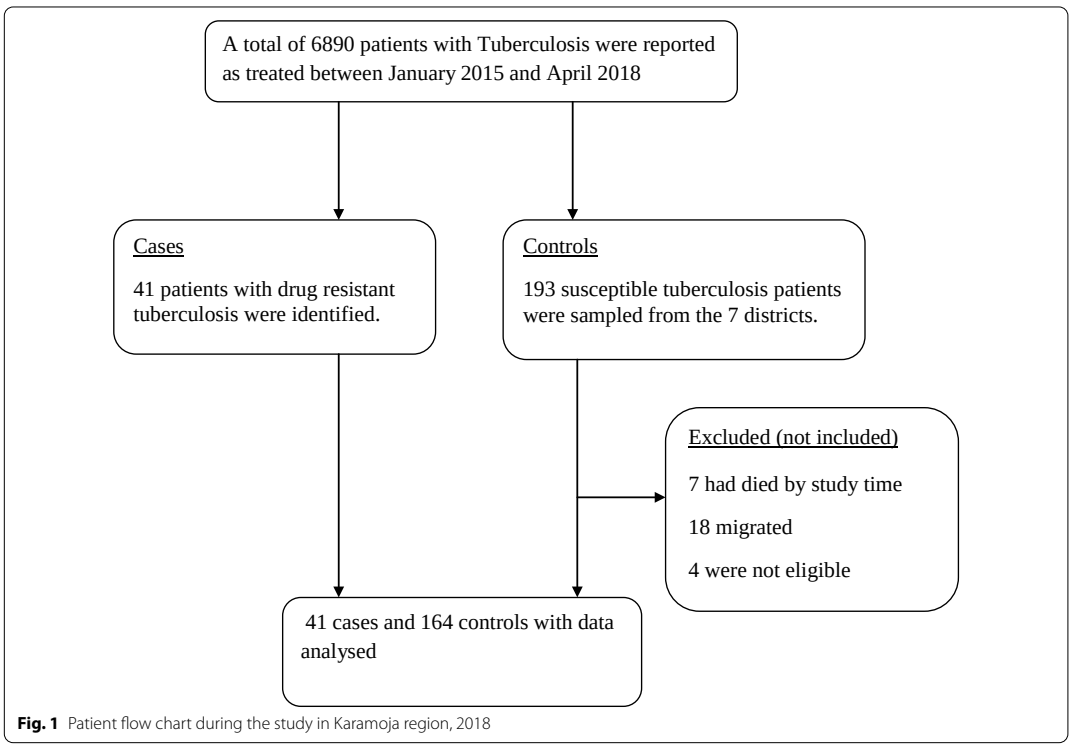


Fig. 1 Patient flow chart during the study in Karamoja region, 2018

than the respondents whose did not. Among the TB patients, the risk was 70% lower among people who were getting treatment from facilities with no TB drug stock out compared to people who were getting treatment from facilities with TB drug stock outs.Substance use was found to confound Drug stock as shown in Table 5.

Qualitative findings

The key themes that emerged from the qualitative analysis

The key issues that emerged in relation to Drug Resistant Tuberculosis in Karamoja District are as outlined below.

Drug resistance still a big problem

Drug resistance is a big issue among the nomadic in Karamoja and the numbers reported are much less than the actual numbers. This is because of the long distances travelled to access health services, poor retention, patients with TB who do not report to health facilities at all and their nomadic life style.

"...most of the patients walk a long distance to the health centres to get medication. They stay in very remote areas with very bad roads especially in rainy seasons even rivers follow and block them." Key informant from Nakapiripirit district.

"....Karamojongs are pastoralists and yet the weather here is not very favourable so they usually travel in groups and make kraals where there's food for the cattle sometimes it is even in Kenya, we have failed to find such people" Key informant from Napak district.

Congested homesteads

Poor housing conditions in Karamoja have increased the exposure of disease to other people.

The Karamojongs stay in enclosed homesteads with many people sharing poorly ventilated huts.

"...At my home we sleep 15 girls in my hut and in the Manyatta we have very many families. All of us young girls have to sleep in one hut. Only those who are going to get married are given their own huts"

Table 1 Prevalence of drug resistant tuberculosis among patients with tuberculosis in Karamoja region

Variable	Frequency (n)	Percentage (%)
Overall		
n = 6890	41	0.60
According to patient type		
New (n = 4197)	4	0.1
Previous TB treatment (n = 2693)	37	1.4
Age		
≤ 9 years (n = 756)	1	0.1
10–19 years (n = 1268)	5	0.4
20–59 years (n = 4134)	29	0.7
≥ 60 years (732)	6	0.8
Sex		
Male (n = 4479)	19	0.4
Females (n = 2411)	22	0.9
District of residence		
Abim (n = 584)	2	0.03
Amudat (n = 150)	1	0.07
Kaabong (n = 823)	4	0.05
Kotido (n = 721)	6	0.08
Moroto (n = 1523)	2	0.01
Nakapiripirit (n = 1161)	16	0.14
Napak (n = 1928)	10	0.05

A participant during FGD with DR-TB patients in Napak district.

Table 2 Patterns of drug resistance among patients with tuberculosis in Karamoja region

Characteristics	RR n (%)	MDR n (%)
Overall		
Frequency (n)	28 (68.3)	13 (31.7)
Age		
≤ 19 years	5 (17.9)	1(7.7)
20–59 years	21 (75.0)	8 (61.5)
≥ 60 years	2 (7.1)	4 (0.3)
Sex		
Males	13 (46.4)	6 (46.2)
Females	15 (53.6)	7 (53.8)
Districts		
Abim	0 (0.0)	2 (15.4)
Amudat	1 (3.6)	0 (0.0)
Kaabong	2 (7.1)	2 (15.4)
Kotido	4 (14.3)	2 (15.4)
Moroto	1 (3.6)	1 (7.7)
Nakapiripirit	13 (46.4)	3 (23.1)
Napak	7 (25)	3 (23.1)

Table 3 Characteristics of demographic, social economic, and health services-related factors for 41 cases and 164 controls in Karamoja region

Characteristics	Frequency (n) Cases (N = 41)	Percentage (%) Controls (N = 164)	P value
Marital status			
Married n (%)	26 (63.4)	126 (76.8)	0.034
Not married n (%)	15 (36.6)	38 (23.2)	
Personal health-related factors			
Category of patient			
New n (%)	4 (9.8)	156 (95.1)	< 0.001
Previous TB treatment n (%)	37 (90.2)	8 (4.9)	
HIV status			
Negative n (%)	39 (95.1)	156 (95.1)	1.000
Positive n (%)	2 (4.9)	8 (4.9)	
Malnutrition			
Yes n (%)	24 (58.5)	82 (50.0)	0.363
No n (%)	17 (41.5)	82 (50.0)	
Disease classification			
PTB n (%)	40 (97.6)	120 (73.2)	0.011
EPTB n (%)	1 (2.4)	44 (26.8)	
Substance use			
Yes n (%)	40 (97.6)	95 (57.9)	0.001
No n (%)	1 (2.4)	69 (42.1)	
Health services factors			
Drug stock out			< 0.001
Yes n (%)	36 (87.8)	36 (22.0)	
No n (%)	5 (12.2)	128 (78.0)	

Retention in care for susceptible TB patients

Retention in care for susceptible TB patients is very poor. The rate of lost to follow up and treatment failure is very high in the region. During the dry season the nomads migrate to look for greener pastures for their animals. Most patients with TB also move without completing the treatment and rarely visit health facilities where they have migrated to.

"...some of the problems we are facing with TB treatment here is lost to follow up most of our people don't have mobile phones so it is very hard to contact them when they don't come for appointments" Key informant from Kotido district.

"...The Pastoralists go to the kraals for months and return only if they are very sick or the dry season is done. Even then we do not know the exact time and period they go and yet they don't inform us." Key informant from Moroto district.

Table 4 Bivariate analysis between independent factors and drug resistant tuberculosis

Variable	DR-TB		OR	95% CI	P
Socio-demographic factors	**Cases n (%)**	**Controls n (%)**			
Marital status					
Married	26 (63.4)	126 (76.8)	1		
Not married	15 (36.6)	38 (23.2)	3.16	1.09–9.14	**0.034**
Clinical factors					
Category of patient					
New	4 (9.8)	156 (95.1)	1		
Previous TB treatment	37(90.2)	8 (4.9)	7.20	3.47–14.91	**< 0.001**
HIV status					
Negative	39 (95.1)	156 (95.1)	1		
Positive	2 (4.9)	8 (4.9)	1	0.26–6.22	1
Malnutrition					
Yes	24 (58.5)	82 (50.0)	1		
No	17 (41.5)	82 (50.0)	1.44	0.66–3.16	0.363
Substance use					
No	1 (2.4)	31 (18.9)	1		
Yes	28 (68.3)	126 (76.8)	38.23	4.34–336.36	**0.001**
Health services factors					
Drug stock out					
No	5 (12.2)	128 (78.0)	1		
Yes	36 (87.8)	36 (22.0)	43.97	10.43–185.37	**< 0.001**

Bold is for variables with statisttically significant P values

Table 5 Multivariate analysis of independent factors and Drug resistant Tuberculosis in Karamoja

Variable	OR	95% CI	P	AOR	95%CI	P
Marital status						
Married	1			1		
Not married	3.16	1.09–9.14	**0.034**	1.84	0.30–11.25	0.510
Category of patient						
New	1			1		
Previous TB treatment	7.20	3.47–14.91	**< 0.001**	5.54	1.74–17.44	**0.004**
Drug stock out						
No	1	1		1		
Yes	43.97	10.43.185.37	**< 0.001**	20.1	3.62–112.57	**0.001**
Confounders substance use						
No	1			1		
Yes	38.23	4.34–336.36	**0.001**	3.35	0.44–25.7	0.0.0.246

Bold is for variables with statisttically significant P values

Direct observed treatment (DOTs) program is not well implemented

All the patients with TB are eventually enrolled on community based DOTs program and yet they have no treatment supporters and the rate of lost to follow up is high.

"...here we use the community based DOT because we cannot afford Facility based but even the treatment supporters are not doing their jobs. Some of them can't remind the person to take his drugs when they are away in the kraals also wives can't force their husbands to adhere to drugs if they

refuse to." A participant during FGD with Health workers in Karamoja.

The DOTs program is also challenged by stigma as awareness is increasing people instead want to stay away from the patients so adherence is not closely monitored

"...the other problem faced by TB patients is isolation and stigma. One chairman told the whole village that a patient had Ebola so they chased him from the village because they didn't want to be infected too." A participant during FGD with Health workers in Karamoja.

Too much substance use

Many of the adults take alcohol in their free time and community hours in the evenings while the pastoralists smoke a lot to keep warm. Also many believe you have you use traditional herbs to get well.

"...it is very hard to stop drinking especially when on medication. But when I go home a drink a little and take the medicine in the morning." A participant during FGD with DR-TB patients in Napak district.

Poor adherence to TB medication

There is very poor adherence especially when patients leave hospital to return home and when they go to the kraals. The long regimens and associated side effects make it very hard to finish the medication.

"...in the kraals we sometimes sleep under one cow to protect them. We carry very little clothing. Sometimes the medicine gets lost and you can't find it." A participant during FGD with DR-TB patients in Napak district.
"The tablets are very many and for a long time. The problem is that you have to keep going to hospital to pick every month yet sometimes we have travelled far from our homes. Also the medication makes me weak and you can't work yet everyone depends on me" A participant during FGD with DR-TB patients in Napak district.

Attitudes in the health workers

Some health workers avoid interacting with TB patients for fear of being infected. There is a gap in managing patients with TB.

"Health workers here are not empowered to manage TB patients, they fear to treat them so they isolate the patients especially the recurrent ones." Key informant from Moroto district.

Lack of equipment and drug stock out

Most of the health facilities have had more than one episode of drug stock out in a year. The protective gears and Gene-Xpert cartridges can sometimes run out of stock for a long period of time.

"...sometimes the nearby hospital doesn't have the medicine that it is finished so we have to wait until they bring more. If you feel so sick you take some of our traditional herbs and they work" A participant during FGD with DR-TB patients in Napak district.
"...One of the problems we have is that NMS is not consistent with drug supplies so when we run out of anti TB drugs we borrow from nearby Health facilities however sometimes they also don't have some drugs so we send patients to other facilities, but some of course don't go and am sure these are the people who get resistance" Key informant from Nakapiripirit district.
"...We have equipment but they are not been serviced in a long time even after we have written emails and sent complaints. Sometimes the gene Xpert machine has no cassettes and it takes very long to get them. This decreases case detection". A participant during FGD with Health workers in Karamoja.

Discussion

The study found a low prevalence of DR-TB among new and previously treated TB patients respectively in Karamoja region. WHO classifies settings with a DR-TB prevalence of less than 3% among new patients as having a low DR-TB burden [11]. These findings were consistent with previous findings of an anti-TB drug resistance survey in Uganda [22]. The low burden observed may be attributed to the low access to health care and movements in the region due to the nomadic life styles.

Nakapiripirit district had the highest number of DR-TB patients (0.14% of its TB patients reported in this period) followed by Napak and Kaabong districts.

These findings are however surprising because Karamoja is a region with the highest TB incidence in Uganda and only 40% of TB patients complete their treatment, majority abandon health care facilities due to their nomadic lifestyle [15]. The region only has two rapid molecular diagnostic test centres and no centres that can perform mycobacteriology cultures this could be a reason for under detection of DR-TB cases. From our study over 90% of the DR-TB patients were previously treated susceptible TB (These include participants with Treatment relapse, Lost to follow up and Treatment failure) therefore prevalence of DR-TB maybe higher than observed.

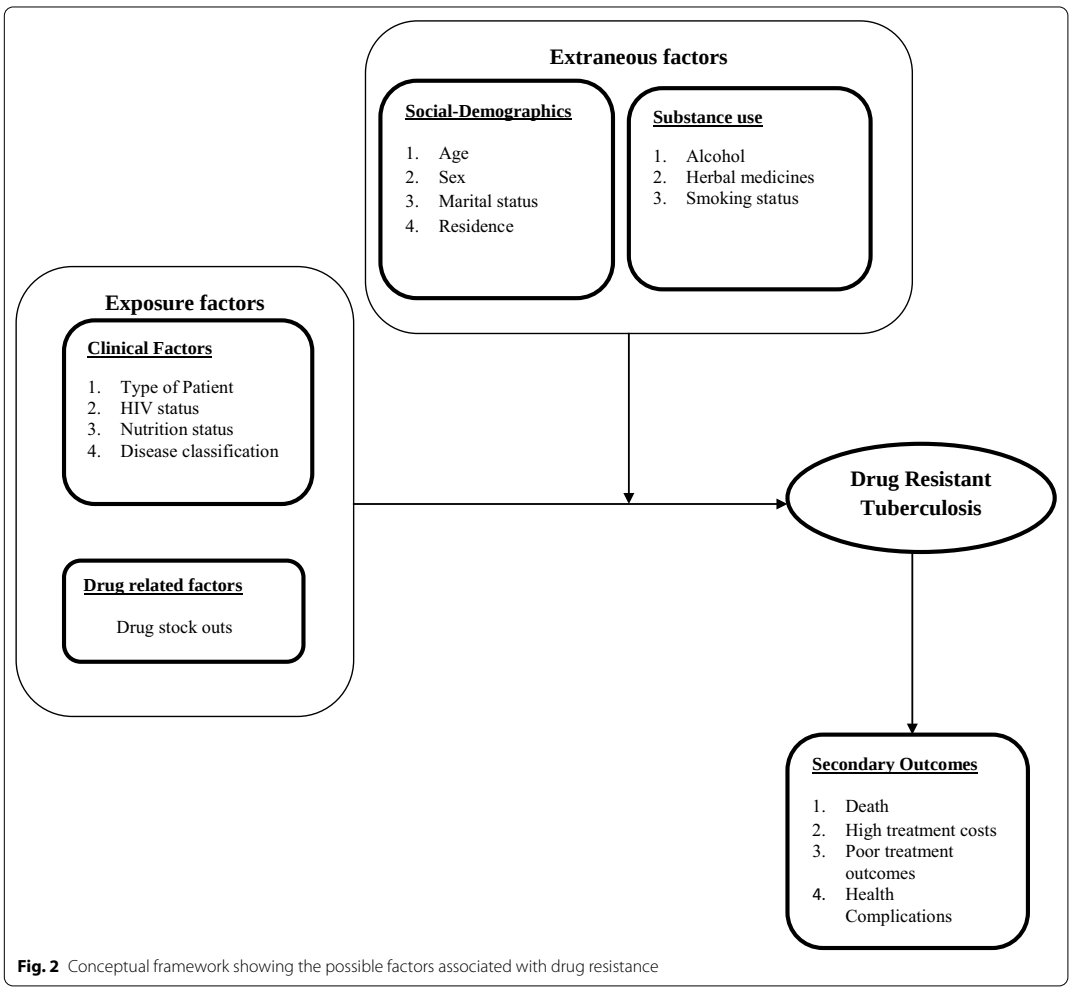


Fig. 2 Conceptual framework showing the possible factors associated with drug resistance

DR-TB patients that were identified as MDR-TB were 31.7% and an additional 68.3% patients were found to have resistance to rifampicin placing these patients just one step away from developing MDR-TB these results are in line with the Global TB report 2017 that showed that there are more RR patients than MDR-TB patients [11].

Previous history of TB treatment was significantly associated with DR-TB. Patients who had previous history of treatment for TB were 5.51 times at higher risk of developing MDR-TB than patients who did not have a history of previous treatment for TB this is also consistent with findings from studies in Ethiopia [22, 24, 25] who reported that most of the people that were diagnosed with DR-TB had a history of having received treatment for TB.

Similar to previous studies, HIV status had no significant association with DR-TB [22, 25]. However this is contrary to the study in Ethiopia which found that patients who had HIV infection had three times higher risk than those who had no HIV infection to develop DR-TB [24]. They noted that this association had a marginal statistical significance showing that HIV infection is not a strong predictor of DR-TB infection in TB patients. Karamoja is one of the regions in the country with the lowest HIV prevalence of 3.4% [26].

In this study substance use was found to be significantly associated with DR-TB. Substance use increased the risk of developing DR-TB by 30%. However, majority of the DR-TB patients (70%, n = 29) were found to consume alcohol. Alcohol consumption is also one of the risk factors for the development of DR-TB. It might be associated with its substantial role in failure rate among new TB cases. Hence, it increases the rate of DR-TB cases. In other studies also alcohol consumption was frequently reported as one of the risk factors for DR-TB in Ethiopia [25].

The nutrition status of TB patients was not significantly associated with DR-TB this may result from the fact that most of the participants were malnourished by the time they were diagnosed. In addition Karamoja region is still battling with food security leaving most families with poor nutrition statuses. These resulted in no difference between the cases and controls.

Health services factors

Having one or more TB Drug stock outs in health facilities treating susceptible TB was significantly associated with risk of developing DR-TB and this has been noted as one of the factors contributing to poor outcomes and risk for development of DR-TB especially in Health facilities in rural areas in Uganda [27, 28].

Socio-cultural factors

Evidence from the qualitative method in this study showed that DR-TB is a stigmatized disease in Karamoja. However, the incidence is only increasing due to nomadic movements, poor adherence, poor living conditions where families live in poorly ventilated congested houses in a very close community (Manyattas) with very little economic activity, poor infrastructure, excessive alcohol consumption, several drug stock outs in the health facilities and poor attitudes of health workers.

Limitations

The study only characterized patients diagnosed through the National Tuberculosis and Leprosy Program supervised health facilities and does not account for drug resistance patterns among patients that did not have access to the health facilities. We do not data about the size and characteristics of these patients.

The study used patients' self-reports on some variables like substance use which could have caused information bias towards the null.

There could also have been selection bias in this study, as those who had died and those that had migrated and could not be accessed were eliminated. It is possible that these are the patients who had developed Drug resistant TB. However, the impact of this may not have been big because other participants were identified and included in the study.

Health facilities with missing data on anti TB drug stock outs were left out of the study for objective two. It is possible that these facilities had more information on anti-TB drug stock outs that could significantly change our results.

Due to the small numbers of patients with Drug resistant TB the factors discussed as associated with high TB burden may be narrow to explain the MDR-TB patterns.

Conclusion and recommendations

The national TB program should improve provision of TB drug supplies and expedite the process of decentralization of TB treatment initiation services to lower health facilities. The poor retention due to nomadic lifestyle is high and needs further investigation on when and where the pastoralists migrate to.

Appendix

Conceptual framework (see Fig. 2).

Abbreviations

AIDS: Acquired Immune Deficiency Syndrome; CBTBC: Community-based tuberculosis (TB) Care; CEU: Clinical Epidemiology Unit; CI: Confidence interval; DOT: Directly Observed Therapy; DR-TB: Drug resistant tuberculosis; DST: Drug susceptibility test; DTLS: District Tuberculosis and Leprosy Supervisor; FGD: Focus Group Discussion; HIV: Human Immuno-Deficiency Virus; IQR: Interquartile range; MDRTB: Multidrug resistant tuberculosis; MOH: Ministry of Health; MSF: Medecins Sans Frontieres International; NTLP: National Tuberculosis and Leprosy Programme; SOMREC: School of Medicine Research Ethics Committee; TB: Tuberculosis; UNCST: Uganda National Council of Science and Technology; WHO: World Health Organization.

Acknowledgements

We thank the management and staff of Clinical epidemiology unit, Makerere University who supervised the research, the management and staff CUAMM doctors with Africa for sponsoring the research and the management and staff of Matany Hospital, Napak district where most of the research activities took place.

Authors' contributions

BN conceived of the work, designed the work, acquired and drafted the work. EA.O. L, SN, ES, OD interpreted the data. WW and JI also interpreted the data and critical review of manuscript. JK, CK, AK and PL revised the manuscript critically for important intellectual content. All authors agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. All authors read and approved the final manuscript.

Funding

This research and data collection activities were funded by CUAMM, doctors with Africa, Uganda office.

Availability of data and materials

All data generated or analysed during this study are included in this published article. The secondary data used in the study was accessed from the National TB registers in the facility, The anti TB drug stock cards in the Health facilities

and from the District Health Information System 2 (DHIS2) with permission from Ministry of health. DHIS2 is a web-based information system used by all health facilities country wide as a health management information system (HMIS).

Declarations

Ethics approval and consent to participate

All methods used in this research were carried out in accordance with relevant guidelines and regulations. Approval to carry out this research was sought from School of Medicine research and Ethics committee (SOMREC) REC REF 2018–052. Permission to collect data was sought from Clinical Epidemiology Unit and each of the seven district authorities in Karamoja. Signed informed consent and assent was sought from the study participants including Patients with TB, Health workers, District leaders in both the quantitative and qualitative components. A waiver to assess secondary was got from SOMREC. To ensure patient protection and confidentiality, any possible patient identifiers were eliminated by use of serial numbers. A transport refund was given to all the participants in the qualitative study.

Consent for publication

Not applicable.

Competing interests

The authors declare that they do not have any competing interest.

Author details

[1]Clinical Epidemiology Unit, Makerere University College of Health Sciences, Kampala, Uganda. [2]Infectious Disease Institute, Kampala, Uganda. [3]Department of Medicine, Makerere University College of Health Sciences, Kampala, Uganda. [4]Division of Pulmonology, Department of Medicine, Mulago National Referral Hospital, Kampala, Uganda. [5]Department of Pediatrics, Makerere University, Kampala, Uganda. [6]Doctors with Africa, CUAMM, Kampala, Uganda.

Received: 16 April 2021 Accepted: 25 August 2021
Published online: 14 September 2021

References

1. TBfacts. TB statistics—incidence, prevalence, high burden. 2018. Accessed 14 March 2019.
2. Berhan A, Berhan Y, Yizengaw D. A meta-analysis of drug resistant tuberculosis in Sub-Saharan Africa: how strongly associated with previous treatment and HIV co-infection? Ethiop J Health Sci. 2013;23(3):271–82.
3. Seung KJ, Omatayo DB, Keshavjee S, Furin JJ, Farmer PE, Satti H. Early outcomes of MDR-TB treatment in a high HIV-prevalence setting in southern Africa. PLoS ONE. 2009;4(9):e7186.
4. Ahuja SD, Ashkin D, Avendano M, Banerjee R, Bauer M, Bayona JN, et al. Multidrug resistant pulmonary tuberculosis treatment regimens and patient outcomes: an individual patient data meta-analysis of 9,153 patients. PLoS Med. 2012;9(8):e1001300.
5. Rajbhandary SS, Marks SM, Bock NN. Costs of patients hospitalized for multidrug-resistant tuberculosis. Int J Tuberc Lung Dis. 2004;8(8):1012–6.
6. Leung ECC, Yew WW, Leung CC, Leung WM, Tam CM. Shorter treatment duration for selected patients with multidrug-resistant tuberculosis. Eur Respir J. 2011;38(1):227–30.
7. Mitnick CD, Appleton SC, Shin SS. Epidemiology and treatment of multidrug resistant tuberculosis. Semin Respir Crit Care Med. 2008;29(5):499–524.
8. END_TB. MDR-RR_TB_factsheet_2017. WHO; 2017. Accessed 7 May 2019.
9. WHO. Multidrug-resistant tuberculosis (MDR-TB) 2018 Update; 2018.
10. CDC. TB elimination: extensively drug-resistant tuberculosis (XDR TB). 2013.
11. Organization WH. Global tuberculosis report 2017. Geneva: World Health Organisation; 2017. p. 2017.
12. University Research Co., LLC. Increasing access to healthcare services in the Karamoja sub-region, Uganda. Chevy Chase: University Research Co., LLC; 2014.
13. Safer World. Karamoja Conflict and Security Assessment. Uganda: Safer World; 2010.
14. MoH. U. Uganda NTLP Revised National Strategic Plan 2015/16—2019/20. Uganda: Uganda National Tuberculosis and Leprosy Control Program; 2017.
15. Lochoro DP. What has TB meant for your life one question for ten responses. 2016. Available from: http://www.mediciconlafrica.org/en/our-voice/news/what-has-tb-meant-for-your-life-one-question-for-ten-responses/. Accessed 11 Nov 2017.
16. Laurence YV, Griffiths UK, Vassall A. Costs to health services and the patient of treating tuberculosis: a systematic literature review. Pharmacoeconomics. 2015;33(9):939–55.
17. Uganda Bureau of Statistics. 2017 Uganda Statistical Abstract. Uganda; 2017.
18. Melaku S, Sharma HR, Alemie GA. Pastoralist Community's perception of tuberculosis: a quantitative study from Shinille area of Ethiopia. Tuberc Res Treat. 2013;2013:475605.
19. Sima BT, Belachew T, Abebe F. Knowledge, attitude and perceived stigma towards tuberculosis among pastoralists; Do they differ from sedentary communities? A comparative cross-sectional study. PLoS ONE. 2017;12(7):e0181032.
20. Millet J-P, Moreno A, Fina L, del Baño L, Orcau A, de Olalla PG, et al. Factors that influence current tuberculosis epidemiology. Eur Spine J. 2013;22(Suppl 4):539–48.
21. John S, Gidado M, Dahiru T, Fanning A, Codlin AJ, Creswell J. Tuberculosis among nomads in Adamawa, Nigeria: outcomes from two years of active case finding. Int J Tuberc Lung Dis. 2015;19(4):463–8.
22. Lukoye D, Adatu F, Musisi K, Kasule GW, Were W, Odeke R, et al. Anti-tuberculosis drug resistance among new and previously treated sputum smear-positive tuberculosis patients in Uganda: results of the first national survey. PLoS ONE. 2013;8(8):e70763.
23. Natasha M, Cynthia W, Kathleen M, Macqueen, Greg G, Emily N. Qualitative research methods: a data coolector's field guide. Research Triangle Park, NC: Family Health International; 2005.
24. Workicho A, Kassahun W, Alemseged F. Risk factors for multidrug-resistant tuberculosis among tuberculosis patients: a case–control study. Infect Drug Resist. 2017;10:91–6.
25. Mulu W, Mekonnen D, Yimer M, Admassu A, Abera B. Risk factors for multidrug resistant tuberculosis patients in Amhara National Regional State. Afr Health Sci. 2015;15(2):368–77.
26. Hirsch-Moverman Y, Colson PW, Bethel J. Can a peer-based intervention impact adherence to the treatment of latent tuberculous infection? Int J Tuberc Lung Dis. 2013;17(9):1178.
27. Ministry of Health. National guidelines for the programmatic management of Drug Resistant Tuberculosis. 23 October 2017. 2nd ed. Uganda 2017 28th January 2017. 251 p.
28. Okethwangu D, Birungi D, Biribawa C, Kwesiga B, Turyahabwe S, Ario AR, et al. Multidrug-resistant tuberculosis outbreak associated with poor treatment adherence and delayed treatment: Arua District, Uganda, 2013–2017. BMC Infect Dis. 2019;19(1):387.

Publisher's Note

Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

Impact of socio-economic factors on Tuberculosis treatment outcomes in northeastern Uganda: a mixed methods study

PAPER

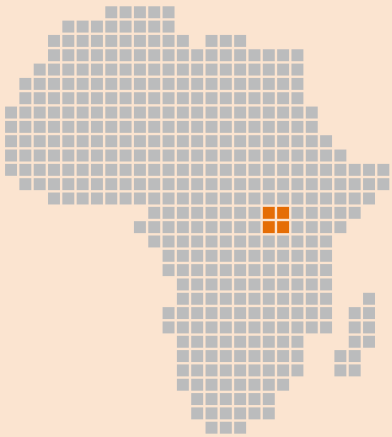
Authors
Nidoi J., Muttamba W., Walusimbi S., Imoko J.F., Lochoro P., Ictho J., Mugenyi L., Sekibira R., Turyahabwe S., Byaruhanga R., Putoto G., Villa S., Raviglione M.C., Kirenga B.

Published in
BMC Public Health,
November 2021

Link
https://doi.org/10.1186/s12889-021-12056-1

Topic
Infectious and tropical diseases

Focus country
Uganda



Nidoi *et al. BMC Public Health* (2021) 21:2167
https://doi.org/10.1186/s12889-021-12056-1

BMC Public Health

RESEARCH Open Access

Impact of socio-economic factors on Tuberculosis treatment outcomes in north-eastern Uganda: a mixed methods study

Jasper Nidoi[1*], Winters Muttamba[1], Simon Walusimbi[1], Joseph F. Imoko[1], Peter Lochoro[2], Jerry Ictho[2], Levicatus Mugenyi[1], Rogers Sekibira[1], Stavia Turyahabwe[3], Raymond Byaruhanga[3], Giovanni Putoto[4], Simone Villa[5], Mario C. Raviglione[5] and Bruce Kirenga[1]

Abstract

Background: Tuberculosis (TB) is a major public health problem and at 48%, Karamoja in North-Eastern Uganda has the lowest treatment success rate nationally. Addressing the social determinants of TB is crucial to ending TB. This study sought to understand the extent and ways in which socio-economic factors affect TB treatment outcomes in Karamoja.

Methods: We conducted a convergent parallel mixed methods study in 10 TB Diagnostic and Treatment Units. The study enrolled former TB patients diagnosed with drug-susceptible TB between April 2018 and March 2019. Unit TB and laboratory registers were reviewed to identify pre-treatment losses to follow-up. Four focus group discussions with former TB patients and 18 key informant interviews with healthcare workers were conducted. Principle component analysis was used to generate wealth quintiles that were compared to treatment outcomes using the proportion test. The association between sociodemographic characteristics and TB treatment outcomes was evaluated using the chi-square test and multiple logistic regression.

Results: A total of 313 participants were randomly selected from 1184 former TB patients recorded in the unit TB registers. Of these, 264 were contacted in the community and consented to join the study: 57% were male and 156 (59.1%) participants had unsuccessful treatment outcomes. The wealthiest quintile had a 58% reduction in the risk of having an unsuccessful treatment outcome (adj OR = 0.42, 95% CI 0.18–0.99, $p = 0.047$). People who were employed in the informal sector (adj OR = 4.71, 95% CI 1.18–18.89, $p = 0.029$) and children under the age of 15 years who were not in school or employed (adj OR = 2.71, 95% CI 1.11–6.62, p = 0.029) had significantly higher odds of unsuccessful treatment outcome. Analysis of the pre-treatment loss to follow-up showed that 17.2% of patients with pulmonary bacteriologically confirmed TB did not initiate treatment with a higher proportion among females (21.7%) than males (13.5%). Inadequate food, belonging to migratory communities, stigma, lack of social protection, drug stock-outs and transport challenges affected TB treatment outcomes.

Conclusions: This study confirmed that low socio-economic status is associated with poor TB treatment outcomes emphasizing the need for multi- and cross-sectoral approaches and socio-economic enablers to optimise TB care.

Keywords: Tuberculosis treatment outcomes, Socio-economic factors, Determinants of health

* Correspondence: jjnidoi@gmail.com
[1]Makerere University Lung Institute (MLI), Kampala, Uganda
Full list of author information is available at the end of the article

© The Author(s). 2021 **Open Access** This article is licensed under a Creative Commons Attribution 4.0 International License, which permits use, sharing, adaptation, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons licence, and indicate if changes were made. The images or other third party material in this article are included in the article's Creative Commons licence, unless indicated otherwise in a credit line to the material. If material is not included in the article's Creative Commons licence and your intended use is not permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder. To view a copy of this licence, visit http://creativecommons.org/licenses/by/4.0/. The Creative Commons Public Domain Dedication waiver (http://creativecommons.org/publicdomain/zero/1.0/) applies to the data made available in this article, unless otherwise stated in a credit line to the data.

Background

Globally, tuberculosis (TB) comes second only to COVID – 19 as a leading cause of mortality from a single infectious organism, accounting for 1.4 million deaths annually [1, 2]. The epidemiological impact of available therapeutic and preventive strategies on pertinent TB indicators has been slow, resulting in the growing recognition of the role of social determinants of health at an individual and societal level on strategies to end TB as a public health problem [3–6].

The End TB Strategy and the United Nations Sustainable Development Goals (SDGs) recognize the interdependence between social determinants and health [4, 7–9]. The conditions in which people are born, grow, live, work and age act on a population, resulting in health disparities which are particularly important in TB where striking inequalities are well recognised [10]. Globally, over 90% of TB patients are in low- and middle-income countries and the cases remain mainly clustered among economically and socially disadvantaged groups [6, 11, 12]. Social status and daily living conditions modify several risk factors over time and influence access to resources leading to differential exposure, differential vulnerability to disease-causing and/or modifying agents and differential consequences of ill health [13, 14].

An association between social determinants of health and treatment outcomes has been established. Patients of low socio-economic status (SES) are less likely to seek medical help, get appropriate investigations for TB, have good TB treatment outcomes and they incur catastrophic costs [15, 16]. Predictors of poor treatment outcomes associated with socio-economic deprivation include low income, low education, high alcohol intake, long travel times, rural residence and under-nutrition [17–22]. A review of three socio-economic determinants found that not only were low income and alcohol abuse significantly associated with treatment failure but also increased the risk of developing multi-drug resistant TB; however, low education levels were only associated with treatment failure [23]. HIV is known to increase the vulnerability to TB and it has been associated with poor TB treatment outcomes [24, 25] particularly among patients not on anti-retroviral therapy [25–28]. The healthcare system is another important social determinant of health and a study in South Africa demonstrated that poorer regions had higher rates of drug stock-outs and in turn, drug stock-outs significantly reduced TB treatment cure and success rates [29]. In Mozambique, a lack of laboratory confirmation of TB probably due to misdiagnosis or paucibacillary TB among immune-suppressed people living with HIV was significantly associated with higher mortality [28].

Addressing the social determinants of health is pivotal in ending TB. A modelling study on the impact of ending extreme poverty and expanding social protection coverage under SGD 1 found that their combined direct effects would result in an 84·3% reduction in TB incidence [30]. Indeed, conditional cash transfers [31] and economic enablers [32] given during TB treatment have been found to improve treatment outcomes, possibly through a reduction in loss to follow-up (LTFU) rates [32, 33]. In real-world settings, poor implementation of economic enabler programmes may attenuate the desired effects on TB treatment outcomes. A trial done in South Africa showed non-significant improvements in treatment outcomes from economic enablers because of low fidelity to the intervention with over a third of eligible patients not receiving the intervention [34].

Uganda is listed among the 30 high TB/HIV burden countries with a national TB prevalence of 253/100,000, HIV prevalence among those aged 15–64 of 6.2% and a 41% HIV coinfection rate among notified TB patients [35, 36]. Karamoja, a region located in the North-East, has the highest crude TB prevalence (2394/100,000 population), highest case notification rate (230/100,000 population) and lowest treatment success rate (48%) [36]. This region also has the highest proportion of persons that are poor [37, 38]. In the populations, diverse social-cultural practices aided by high levels (74.2%) of poverty and low (33%) literacy also contribute negatively to health service utilisation and outcomes.

TB patients initiated on treatment who fail to achieve desired outcomes are at risk of death, developing drug-resistant TB, and perpetuating TB transmission in their community. This study sought to document the magnitude and ways in which socio-economic factors affect TB treatment outcomes and the proportion of pre-treatment LTFU among TB patients. The study employed the social causation hypothesis which alludes to low social status as a precursor for ill health [39, 40]. We hypothesized that economically and socially disadvantaged groups lack financial, nutritional and social support and will ultimately encounter challenges in completing TB treatment resulting in poor outcomes. The framework for proximate risk factors and upstream determinants of TB [6] was used to identify and analyse social determinants of health and their association to TB outcomes.

Methods

Study design

We conducted a convergent parallel mixed methods [41] study in which former TB patients diagnosed with drug-susceptible TB and entered in the unit TB registers between April 2018 and March 2019 were enrolled into a retrospective cohort. Focus group discussions (FGDs) with former TB patients and key informant interviews (KII) with healthcare personnel involved in TB care were

conducted to capture patient experiences and health system factors that could affect TB treatment outcomes. This study aimed to assess the relationship between social determinants of health and TB treatment outcomes in the Karamoja region. Mixed methods were selected to extend the breadth of inquiry on the impact of socio-economic factors on TB treatment outcomes: quantitative methods were used to establish the magnitude of the association between socio-economic factors and TB treatment outcomes while FGDs and KIIs were used to identify perceptions on how conditions of daily life and healthcare system factors acted as barriers or motivators during TB treatment. Data was collected simultaneously between 10th February and 24th March 2020.

Study setting

The study was conducted in Karamoja, a rural economically deprived region in North-Eastern Uganda [37, 38]. Data were collected in 10 TB Diagnostic & Treatment Units (DTUs) in the five southern districts of Moroto, Napak, Amudat, Nabilatuk and Nakapiripirit. Electronic data from the District Health Information System [42], which includes records of notified TB cases, was analysed to identify DTUs for the study. The system is hosted by the Ministry of Health, Uganda for reporting routine Health Management Information System data. For feasibility purposes, the 10 DTUs selected had the highest case notification volume between April 2018 and March 2019 and managed 74.8% of all the TB patients notified in the region. The DTUs are under the National TB and Leprosy Program (NTLP) and are supported by Doctors with Africa CUAMM.

Study population

Quantitative

Former TB patients diagnosed with drug-susceptible TB (pulmonary bacteriologically confirmed TB (PBC TB), pulmonary clinically diagnosed TB and extra-pulmonary TB) and registered between April 2018 and March 2019 were identified from a review of the unit TB registers. Former TB patients were included if they resided in the study districts, had drug-susceptible TB and provided informed consent. Patients who were diagnosed with rifampicin-resistant and multi-drug resistant TB or had died were excluded from the study. A sample size of 313 participants was calculated using a formula comparing two proportions, assuming a 15-point difference in the treatment success rate for members of the lowest SES quintile from the average rate in Karamoja. This was adjusted by a factor of 1.5 for clustering in DTUs and by 27% for LTFU.

Two line lists for successful and unsuccessful treatment outcomes were generated based on the outcomes assigned to former TB patients using the NTLP guidelines. For this study, successful TB treatment outcomes included cured and treatment completed; unsuccessful outcomes included treatment failed, not evaluated and LTFU. Random computer-generated numbers were used to select 313 participants for the study in a ratio of 1:2 for successful versus unsuccessful TB treatment outcomes. The sample size was distributed across the 10 DTUs proportionally based on the number of patients notified during the study period.

A line list of patients with PBC TB was developed from a review of the laboratory register and this was compared against the unit TB register to identify patients who had not initiated treatment between April 2018 and March 2019 i.e., the pre-treatment LTFU. The registers in Loputuk HC III, Iriiri HC III and Matany Hospital were reviewed. Sputum samples that were referred from other facilities were not included in the analysis.

Qualitative

Purposive sampling was used to obtain diversity within each FGD in terms of baseline characteristics and treatment outcomes of former TB patients and with KII in terms of healthcare worker (HCW) cadres. Four FGDs were conducted in two DTUs that experienced high loss to follow-up rates; two in Moroto Regional Referral Hospital and two in Tokora Health Centre IV. To capture health system challenges, 18 KII with HCWs involved in TB diagnosis and treatment were carried out until thematic saturation was reached. These included interviews with community health workers [3], staff at the DTUs [6] and their district health team members [6], regional staff [1] and national supervisors [2].

Data collection

Quantitative

Data were collected on android tablet computers onto which the KoBoCollect app was installed and uploaded onto a corresponding KoBoToolbox electronic database. SES was collected using a questionnaire based on the demographic and health survey wealth index [38]. Wealth was used to measure SES instead of annual income because it captures information on asset ownership which depicts long-term status and can take savings from previous incomes into account. Furthermore, since the majority of Karamoja's inhabitants are agro-pastoral nomads, income-earning would be subject to seasonal variability. SES data were collected alongside data on socio-demographic characteristics and TB treatment. A separate KoBoToolbox database was developed to collect data on pre-treatment loss to follow-up.

Qualitative

Scheduling was done for KIIs at a time and place that was convenient for the participants. FGDs were conducted at the DTU in a secure, relaxed environment and participants recruited from these facilities were given a date on which the discussion would be held. All interviews were recorded and written informed consent was obtained. A local dialect, Ng'akarimojong, was used for the FGDs and English for the KIIs. FGDs were conducted by a social scientist and the KIIs were conducted by a social scientist and a trained field coordinator. The semi-structured interview guide in Additional file 1 was used to steer the discussions during the interviews. The FGD facilitator encouraged the participation of all group members and the expression of divergent experiences and opinions.

Data analysis

Quantitative

Baseline characteristics of study participants were summarised using proportions for categorical variables and median for continuous variables. Principle component analysis was used to analyse data collected on the wealth index including ownership of assets like a motorcycle, computer, television, radio, house, domestic animals, and the type of building materials for the houses they lived in. The wealth index excluded respondents' occupation and employment status. Wealth quintiles were generated with the upper quintile representing high SES and the lower quintile representing low SES. Treatment outcomes were compared between quintiles using the proportion test. The primary outcome in the study was an unsuccessful treatment outcome and the primary predictor was the SES measured by the wealth index. Participants were also stratified by sociodemographic characteristics and we evaluated their association with TB treatment outcomes using the chi-square test. Variables with a *p*-value less than 0.2 were included in a multivariable analysis using a multiple logistic regression model. Model building was then conducted first, by checking for multicollinearity problems using variance inflation factor (VIF) whereby variables with VIF > 10 were considered to cause multicollinearity. In case of multicollinearity, centring was considered for continuous variables or dropped if categorical and of less biological or statistical significance. Then, a backward elimination process was used to further build the model whereby variables with the biggest *p*-values were dropped one at a time and a likelihood ratio test was used to compare nested models. This process was continued until no further variables could be deleted without a statistically significant loss of fit. Data on pre-treatment loss to follow-up were summarised using proportions. All analyses were done in STATA v14.

Dichotomised TB treatment outcome values were used to generate a concentration curve that showed the cumulative proportion of unsuccessful TB treatment outcomes by the cumulative proportions of individuals in the study population ranked by wealth from poorest to richest. The concentration index was calculated using the formula:

$$G_1 = 1 - \sum_{k=1}^{n} (X_k - X_{k-1})(Y_k + Y_{k-1})$$

Where G is the coefficient, X is the cumulative proportion of the population variable, Y is the cumulative proportion of the outcome variable and K is the number of individuals. This analysis was done using Microsoft Excel.

Pre-treatment LTFU and their socio-demographic characteristics were summarised using proportions.

Qualitative

The FGDs and KIIs were transcribed verbatim. The transcripts from the FGDs were translated to English. The transcripts were analysed using content analysis to identify meaning units that were condensed into codes and categorised into sub-themes and themes. To enhance reliability, the transcripts were analysed separately by two investigators and the themes generated were compared and discussed. Saturation for the KII was analysed by organising the interviews in batches of six and analysing the number of batches needed to generate 80–90% of all codes [43].

Data integration

Narrative data integration was done by comparing and contrasting quantitative and qualitative data to evaluate coherence in the study findings [41]. Themes from the qualitative data were compared to corresponding quantitative variables for agreement.

Ethics

Ethical approval for the study was sought from Mulago Hospital Research and Ethics Committee (MHREC No. 1765) and the Uganda National Council of Science and Technology (HS 2712). Written informed consent was obtained from all participants aged 18 years and above. Parents or legal guardians provided informed consent for minors and assent was obtained from minors aged 8–17 years.

Results

Quantitative phase

Study participants

We identified 1184 former TB patients recorded in the unit TB registers and from these, we randomly selected

313 to participate in the study. We oversampled six participants with successful treatment outcomes and requisite notification was given to the ethics committee. Data were collected from 264 (84.3%) participants as shown in Fig. 1.

The sociodemographic characteristics of the participants and their distribution across the wealth index quintiles are presented in Table 1. The study had more males (57.2%) than females (42.8%), and the median age of the participants was 30 years (IQR 13–44). Relative to each variable, the wealthiest quintile had higher proportions of participants who were male (23.2%), aged 25–34 years (32.7%), had three or more meals a day (43.2%) with secondary (81.8%) or tertiary education (100%). They also had the highest proportion of household heads with secondary (70.6%) or tertiary education (100%).

TB treatment outcomes by wealth

The treatment outcomes of participants by wealth are presented in Table 2. A total of 156 participants (59.1%) had unsuccessful treatment outcomes. The wealthiest quintile had significantly lower odds of having an unsuccessful treatment outcome (OR = 0.41, 95% CI: 0.19–0.90, $p = 0.026$).

Figure 2 shows that 40.4% (21/52) of the participants in the highest wealth quintile had unsuccessful treatment outcomes with higher proportions of unsuccessful treatment outcomes observed in the lower four wealth quintiles: 62.3% (33/53) in Q1 and 64.2% (34/53) in Q2-Q4. The concentration curve shows that the distribution of unsuccessful treatment outcomes in individuals ranked by wealth from poorest to richest was pro-poor. A negative concentration index of −0.061 was computed.

Due to homogeneity in the lower four quintiles, a secondary analysis was performed on the distribution of participants by sociodemographic characteristics and SES with the lower four wealth quintiles (poor) compared to the highest quintile (rich). The odds of being in the highest wealth quintile were higher for participants aged 25–34 years (OR = 5.35, 95% CI 1.95–14.66, $p = 0.001$) and 55–64 years (OR = 4.23, 95% CI 1.12–15.96, $p = 0.033$). Secondary education of the respondent and household head was also strongly associated with being in the wealthiest quintile with odds ratios of 28.12 (95% CI 5.77–136.99, $p < 0.001$) and 14.9 (95% CI 4.88–45.41, $p < 0.001$) respectively. All participants who had tertiary education belonged to the highest wealth quintile. Participants who had three meals or more or reported satisfaction after a meal had higher odds of being in the highest quintile at 4.95 (95% CI 2.03–12.06, $p < 0.001$) and 2.33 (95%CI 1.19–4.56, $p = 0.013$). Marital status and alcohol consumption was not significantly associated with belonging to the highest wealth quintile while mixed results were obtained on the nature of employment. Full results are in Additional file 2.

TB treatment outcomes by socio-demographic characteristics

The impact of socio-demographic characteristics on TB treatment outcomes is presented in Table 3. The odds of

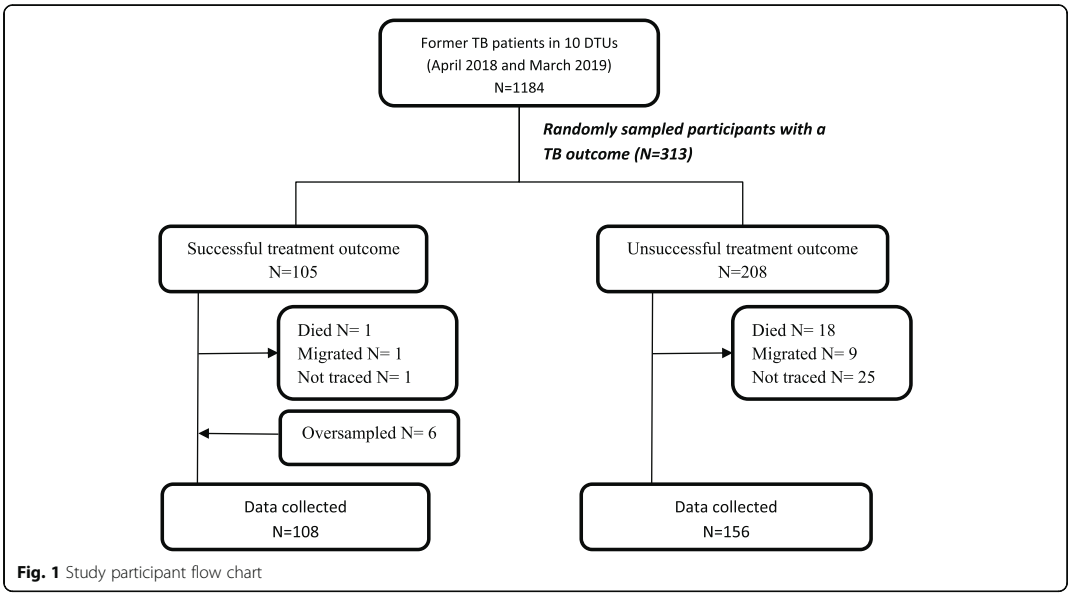


Fig. 1 Study participant flow chart

Table 1 Distribution of study population sociodemographic characteristics in wealth index quintiles

Variable		Total N	Q1 N (%)	Q2 N (%)	Q3 N (%)	Q4 N (%)	Q5 N (%)
		264	53	53	53	53	52
Sex	Male	151	26 (17.2)	31 (20.5)	27 (17.9)	32 (21.2)	35 (23.2)
	Female	113	27 (23.9)	22 (19.5)	26 (23.0)	21 (18.6)	17 (15.0)
Age	< 15	72	12 (16.7)	27 (37.5)	16 (22.2)	11 (15.3)	6 (8.3)
	15–24	30	9 (30.0)	5 (16.7)	2 (6.7)	9 (30.0)	5 (16.7)
	25–34	55	7 (12.7)	12 (21.8)	11 (20.0)	7 (12.7)	18 (32.7)
	35–44	42	11 (26.2)	3 (7.1)	8 (19.1)	12 (28.6)	8 (19.1)
	45–54	23	3 (13.0)	1 (4.4)	5 (21.7)	9 (39.1)	5 (21.7)
	55–64	18	6 (33.3)	1 (5.6)	4 (22.2)	2 (11.1)	5 (27.8)
	> = 65	24	5 (20.8)	4 (16.7)	7 (29.2)	3 (12.5)	5 (20.8)
HH	Parent	82	16 (19.5)	30 (36.6)	14 (17.1)	13 (15.9)	9 (11.0)
	Spouse	53	15 (28.3)	10 (18.9)	13 (24.5)	8 (15.1)	7 (13.2)
	Respondent	119	22 (18.5)	13 (10.9)	21 (17.7)	32 (26.9)	31 (26.1)
	Other	10	0 (0.0)	0 (0.0)	5 (50.0)	0 (0.0)	5 (50.0)
Respondent's education level	None	203	42 (20.7)	46 (22.7)	44 (21.7)	43 (21.2)	28 (13.8)
	Primary	46	11 (23.9)	5 (10.9)	9 (19.6)	10 (21.7)	11 (23.9)
	Secondary	11	0 (0.0)	2 (18.2)	0 (0.0)	0 (0.0)	9 (81.8)
	Tertiary	4	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	4 (100)
HH's education level	No education	209	44 (21.1)	50 (23.9)	43 (20.6)	43 (20.6)	29 (13.9)
	Primary	33	8 (24.2)	2 (6.1)	9 (27.3)	8 (24.2)	6 (18.2)
	Secondary	17	1 (5.9)	1 (5.9)	1 (5.9)	2 (11.8)	12 (70.6)
	Tertiary	5	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	5 (100)
Respondent's occupation	None	73	13 (17.8)	26 (35.6)	21 (28.8)	8 (11.0)	5 (6.9)
	Subsistence farmer	146	32 (21.9)	22 (15.1)	27 (18.5)	35 (24.0)	30 (20.6)
	Formal	7	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	7 (100)
	Informal	19	1 (5.3)	2 (10.5)	4 (21.1)	4 (21.1)	8 (42.1)
	Student	19	7 (36.8)	3 (15.8)	1 (5.3)	6 (31.6)	2 (10.5)
Employed	Yes	50	1 (2.0)	4 (8.0)	10 (20.0)	15 (30.0)	20 (40.0)
	No	158	40 (25.3)	25 (15.8)	33 (20.9)	31 (19.6)	29 (18.4)
	Not applicable[¥]	56	12 (21.4)	24 (42.9)	10 (17.9)	7 (12.5)	3 (5.4)
HH's occupation	None	20	7 (35.0)	2 (10.0)	5 (25.0)	5 (25.0)	1 (5.0)
	Subsistence farmer	206	46 (22.3)	47 (22.8)	40 (19.4)	42 (20.4)	31 (15.1)
	Formal	13	0 (0.0)	1 (7.7)	0 (0.0)	2 (15.4)	10 (76.9)
	Informal	25	0 (0.0)	3 (12.0)	8 (32.0)	4 (16.0)	10 (40.0)
HH employed	Yes	67	2 (3.0)	7 (10.5)	13 (19.4)	21 (31.3)	24 (35.8)
	No	195	51 (26.2)	46 (23.6)	39 (20.0)	31 (15.9)	28 (14.4)
	Not applicable[¥]	2	0 (0.0)	0 (0.0)	1 (50.0)	1 (50.0)	0 (0.0)
Marital status[ϕ]	Single	33	5 (15.2)	8 (24.2)	5 (15.2)	5 (15.2)	10 (30.3)
	Married	131	30 (22.9)	19 (14.5)	26 (19.9)	30 (22.9)	26 (19.9)
	Divorced/separated	15	4 (26.7)	1 (6.7)	1 (6.7)	4 (26.7	5 (33.3)
	Widowed	21	4 (26.7)	2 (9.5)	6 (28.6)	4 (19.1)	5 (33.3)
Meals per day	One	90	20 (22.2)	21 (23.3)	18 (20.0)	19 (21.1)	12 (13.3)
	Two	137	30 (21.9)	30 (21.9)	32 (23.4)	21 (15.3)	24 (17.5)
	Three or more	37	3 (8.1)	2 (5.4)	3 (8.1)	13 (35.1)	16 (43.2)

Table 1 Distribution of study population sociodemographic characteristics in wealth index quintiles *(Continued)*

Variable		Total N	Q1 N (%)	Q2 N (%)	Q3 N (%)	Q4 N (%)	Q5 N (%)
		264	53	53	53	53	52
Meal satisfaction	Yes	152	12 (7.9)	31 (20.4)	32 (21.2)	39 (25.7)	38 (25.0)
	No	112	41 (36.6)	22 (19.6)	21 (18.8)	14 (12.5)	14 (12.5)
Alcohol consumption	Yes	130	26 (20.0)	22 (16.9)	27 (20.8)	27 (20.8)	28 (21.5)
	No	134	27 (20.2)	31 (23.1)	26 (19.4)	26 (19.4)	24 (17.9)

ɣ Not applicable was defined as participants under the age of 15 who were not in school or employed
ϕ Marital status was not evaluated for participants under 15 who were not married, divorced/separated or widowed
HH Household head

having an unsuccessful treatment outcome were significantly lower for formally employed household heads (OR = 0.19, 95% CI: 0.04–0.87, $p = 0.032$). The participants' treatment outcome was not significantly associated with gender, age, nature of household head, respondent's occupation, respondent's or household head's level of education, marital status, meal frequency, meal satisfaction and alcohol consumption. Regarding HIV, 4.5% of the TB patients were co-infected with HIV. A positive HIV status was not significantly associated with unsuccessful treatment outcomes (OR = 0.97, 95% CI 0.30–3.13, $p = 0.956$).

For the multivariable analysis, the final statistical model included the following variables: wealth index quintiles, occupation and employment status. Results from the final model are presented as adjusted estimates and the goodness of fit test showed borderline fit ($p = 0.063$). The final fit was free from multicollinearity with mean VIF values of 1.7 for wealth index and occupation, and 1.9 for employment. Table 4 shows the results from the better fit. The adjusted odds of unsuccessful TB treatment outcome in the highest wealth quintile were significantly lower compared to the poorest quintile (OR = 0.42, 95% CI 0.18–0.9, p = 0.047). Odds of unsuccessful treatment outcome were higher among participants employed in the informal sector (OR = 4.71, 95% CI 1.18–18.89, p = 0.029) and children under the age of 15 years who were not in school or employed (OR = 2.71, 95% CI 1.11–6.62, p = 0.029).

Healthcare system factors and TB treatment outcomes

Additional file 3 shows the analysis of healthcare system factors by TB treatment outcomes. Under half (48.7%) of all patients reported that they lived within 5kms from the healthcare unit, an almost equal proportion (51.3%) rated the distance to the health facility as long. Generally, the participants were satisfied with healthcare services received at 96.8% for participants with unsuccessful treatment and 96.3% for participants with successful treatment. These factors were not significantly associated with TB treatment outcomes.

Pre-treatment LTFU

A line list of 256 patients with PBC TB was developed from the laboratory registers and this was compared against the unit TB registers. By sex, there were more male PBC TB patients (141/256, 55.1%) than females. The proportion of pre-treatment LTFU was 17.2% and this proportion was higher in females than males at 21.7% (25/115) versus 13.5% (19/141). By facility, Matany Hospital had the highest pre-treatment LTFU rate at 22.8% followed by Iriiri HC III at 9.1%. No pre-treatment LTFUs were identified at Loputuk HC III.

Qualitative phase

Treatment barriers and motivators

Analysis of the KIIs generated 46 codes and 89.1% (41/46) of the codes were generated in the first batch of six interviews. Saturation was reached in the second batch of interviews. Two major thematic areas of barriers and motivators experienced during TB treatment were developed from the analysis of the FGDs and KIIs with the results summarised in Table 5 below.

Table 2 Impact of wealth index quintiles on TB treatment outcomes

Wealth index quintiles	Unsuccessful treatment N (%)	Successful treatment N (%)	Unadjusted O. R (95% CI)	*p*-value	Adjusted OR (95% CI)	*p*-value
Q1 (Poorest reference)	33 (21.2)	20 (18.5)	1		1	
Q2	34 (21.8)	19 (17.6)	1.08 (0.49–2.39)	0.840	0.96 (0.42–2.19)	0.920
Q3	34 (21.8)	19 (17.6)	1.08 (0.49–2.39)	0.840	1.12 (0.49–2.54)	0.794
Q4	34 (21.8)	19 (17.6)	1.08 (0.49–2.39)	0.840	1.06 (0.46–2.41)	0.894
Q5 (richest)	21 (13.5)	31 (28.7)	0.41 (0.19–0.90)	**0.026**	0.42 (0.18–0.99	**0.047**

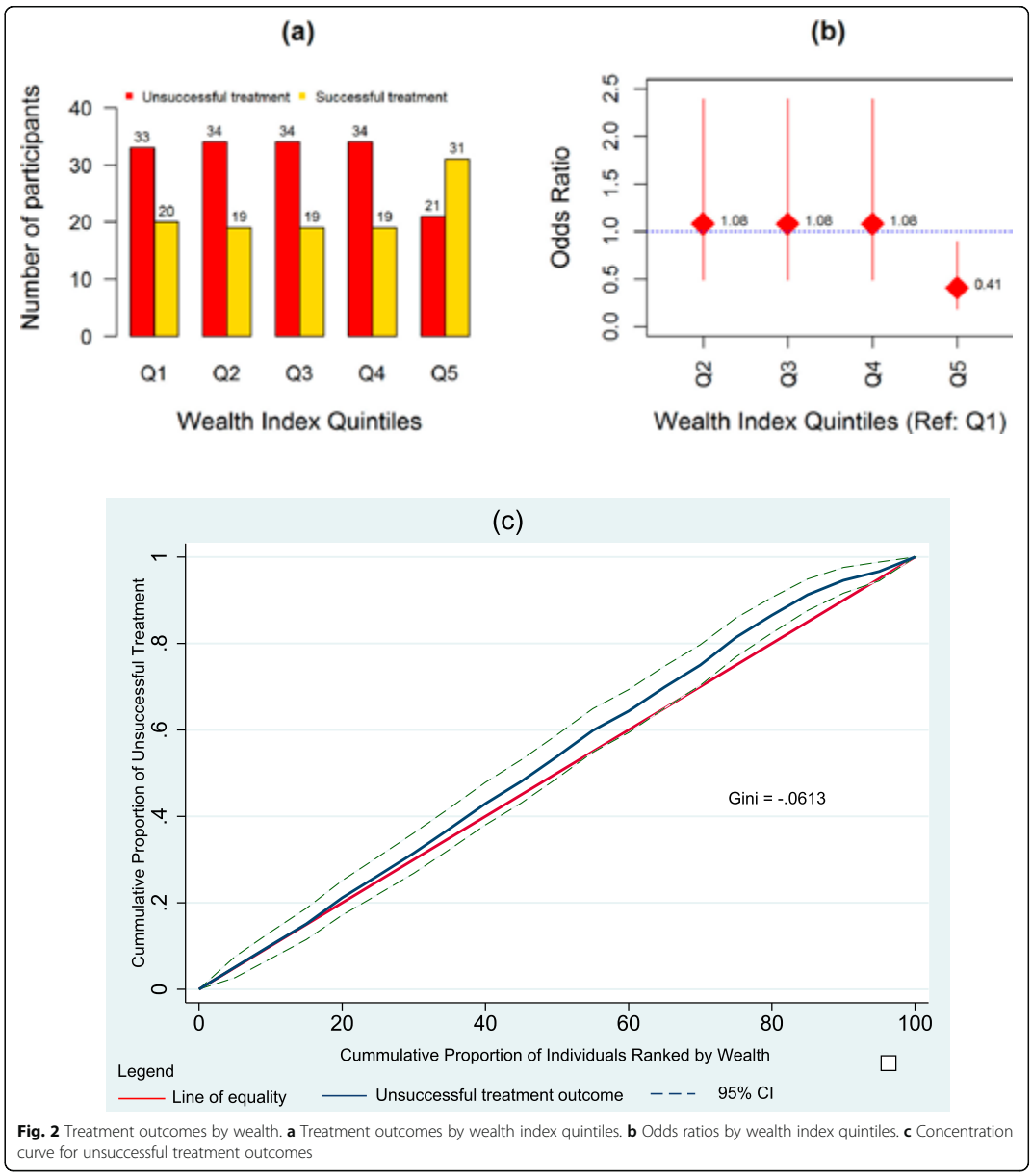


Fig. 2 Treatment outcomes by wealth. **a** Treatment outcomes by wealth index quintiles. **b** Odds ratios by wealth index quintiles. **c** Concentration curve for unsuccessful treatment outcomes

TB treatment barriers

TB patients reported that they did not have adequate finances to meet their basic needs including food and transport during TB treatment. Participants reported that they looked for menial jobs, sold assets such as farm animals or relied on family and friends for financial support during treatment.

> *There is no way you can get money to board a motorcycle, so you come on foot to get your drugs and when you return, you go and look for a job to get something to cook.* [Female FGD participant]

As a result of financial constraints, participants lacked adequate food to meet their nutritional needs. Both

Table 3 Distribution by sociodemographic characteristics and TB treatment outcomes

Variable		Unsuccessful treatment N (%)	Successful treatment N (%)	O.R (95% CI)	p-value
Sex	Male	86 (55.1)	65 (60.2)	1	
	Female	70 (44.9)	43 (39.8)	1.23 (0.75–2.02)	0.414
Age	< 15	46 (29.5)	26 (24.1)	1	
	15–24	21 (13.5)	9 (8.3)	1.32 (0.53–3.30)	0.554
	25–34	27 (17.3)	28 (25.9)	0.55 (0.27–1.11)	0.096
	35–44	24 (15.4)	18 (16.7)	0.75 (0.35–1.64)	0.476
	45–54	13 (8.3)	10 (9.3)	0.73 (0.28–1.91)	0.527
	55–64	7 (4.5)	11 (10.2)	0.36 (0.12–1.04)	0.059
	> = 65	18 (11.5)	6 (5.6)	1.70 (0.60–4.81)	0.320
HH	Parent	51 (32.7)	31 (28.7)	1	
	Spouse	32 (20.5)	21 (19.4)	0.93 (0.46–1.88)	0.832
	Respondent	67 (43.0)	52 (48.2)	0.78 (0.44–1.39)	0.405
	Other	6 (3.9)	4 (3.7)	0.91 (0.24–3.49)	0.893
Respondent's education level	No education	122 (78.2)	81 (75.0)	1	
	Primary	28 (18.0)	18 (16.8)	1.03 (0.53–1.99)	0.923
	Secondary	4 (2.6)	7 (6.5)	0.38 (0.11–1.34)	0.132
	Tertiary	2 (1.3)	2 (1.9)	0.66 (0.09–4.81)	0.685
HH's education level	No education	129 (82.7)	80 (74.1)	1	
	Primary	18 (11.5)	15 (14.0)	0.74 (0.36–1.56)	0.434
	Secondary	7 (4.5)	10 (9.3)	0.43 (0.16–1.19)	0.104
	Tertiary	2 (1.3)	3 (2.8)	0.41 (0.07–2.53)	0.339
Respondent's occupation	None	43 (27.6)	30 (27.8)	1	
	Subsistence farmer	86 (55.1)	60 (55.6)	1.00 (0.56–1.77)	> 9.999
	Formal	1 (0.6)	6 (5.6)	0.12 (0.01–1.02)	0.052
	Informal	14 (9.0)	5 (4.6)	1.95 (0.64–6.00)	0.242
	Student	12 (7.7)	7 (6.5)	1.20 (0.42–3.39)	0.736
Respondent's employment	No	89 (57)	69 (63.9)	1	
	Yes	28 (18.0)	22 (20.4)	0.99 (0.52–1.97)	0.967
	Not applicable[¥]	39 (25.0)	17 (15.7)	1.78 (0.93–3.41)	0.083
HH's occupation	None	14 (9.0)	6 (5.6)	1	
	Subsistence farmer	122 (78.2)	84 (77.8)	0.62 (0.23–1.69)	0.351
	Formal	4 (2.6)	9 (8.3)	0.19 (0.04–0.87)	**0.032**
	Informal	16 (10.3)	9 (8.3)	0.76 (0.22–2.68)	0.672
HH employment	No	119 (76.3)	76 (70.4)	1	
	Yes	36 (23.1)	31 (28.7)	0.74 (0.42–1.30)	0.295
	Not applicable[¥]	1 (0.6)	1 (0.9)	0.64 (0.04–10.36)	0.752
Marital status	Single	20 (12.8)	13 (12.0)	1	
	Married	72 (46.2)	59 (54.6)	0.79 (0.36–1.73)	0.560
	Divorced/ separated	11 (7.1)	4 (3.7)	1.79 (0.47–6.83)	0.396
	Widowed	13 (8.3)	8 (7.4)	1.06 (0.34–3.25)	0.924
Meals per day	One	51 (32.7)	39 (36.1)	1	
	Two	88 (56.4)	49 (45.4)	1.37 (0.80–2.37)	0.253
	Three	17 (10.9)	20 (18.5)	0.65 (0.30–1.40)	0.272
Meal satisfaction	No	71 (45.5)	41 (38.0)	1	

Table 3 Distribution by sociodemographic characteristics and TB treatment outcomes *(Continued)*

Variable		Unsuccessful treatment N (%)	Successful treatment N (%)	O.R (95% CI)	p-value
	Yes	85 (54.5)	67 (62.0)	0.73 (0.44–1.21)	0.223
Alcohol consumption	No	84 (53.9)	50 (46.3)	1	
	Yes	72 (46.2)	58 (53.7)	0.74 (0.45–1.21)	0.228
HIV status	Negative	149 (95.5)	103 (95.4)	1	
	Positive	7 (4.5)	5 (4.6)	0.97 (0.30–3.13)	0.956

ɣ Not applicable was defined as participants under the age of 15 who were not in school or employed
ϕ Marital status was not evaluated for participants under 15 who were not married, divorced/separated or widowed
HH Household head

former TB patients and HCWs used different expressions to demonstrate the perception that adequate nutrition is needed during TB treatment. Participants reported that they preferred to take their medications after a meal, usually milk or porridge, with some reporting that they did not take their medication if they failed to get food. Notably, patients reported that they had no sources of financial aid while sick and appealed for support, particularly from the government in terms of food

> *What we have to say is that you as government please rescue us in terms of some food because every day what we eat is the tree leaf that is why this disease has refused to go because of hunger.* [Male FGD participant]

The demand to make a living while on treatment contributed to poor treatment outcomes. TB patients in the region were noted to be highly mobile and nomadic, often migrating from their usual place of residence. This was attributed to economic activities like agriculture and mining. HCWs acknowledged that LTFU is a major problem in the Karamoja region due to the mobile communities that made follow-up tedious. The porous borders, particularly with Kenya, made it easy for patients to get LTFU during treatment. Some patients also moved deliberately *'as a way of dodging drugs.'* Only one formally employed participant reported sick leave for the duration of TB treatment.

> *We have also found that there is a lot of mobility among the patients (…) the moment you are to continue on treatment, they have disappeared. This is a nomadic area; they will have disappeared to another place and finding them may be difficult.* [Male HCW]

Limited modes of transport within the region and long distances were highlighted as challenges for both the HCWs and TB patients in delivering and accessing

Table 4 Unadjusted and adjusted odds ratios for factors associated with unsuccessful treatment outcomes

Variable	Unadjusted OR (95% CI)	*p*-value	Adjusted OR (95% CI)	*p*-value
Wealth index quintiles				
Q1 (Poorest reference)	1		1	
Q2	1.08 (0.49–2.39)	0.840	0.96 (0.42–2.19)	0.920
Q3	1.08 (0.49–2.39)	0.840	1.12 (0.49–2.54)	0.794
Q4	1.08 (0.49–2.39)	0.840	1.06 (0.46–2.41)	0.894
Q5 (richest)	0.41 (0.19–0.90)	**0.026**	0.42 (0.18–0.99	**0.047**
Respondent's occupation				
None	1		1	
Subsistence farmer	1.00 (0.56–1.77)	> 9.999	1.92 (0.90–4.10)	0.091
Formal	0.12 (0.01–1.02)	0.052	0.45 (0.04–5.11)	0.523
Informal	1.95 (0.64–6.00)	0.242	4.71 (1.18–18.89)	**0.029**
Student	1.20 (0.42–3.39)	0.736	1.05 (0.34–3.22)	0.936
Respondent's employment				
No	1		1	
Yes	0.99 (0.52–1.97)	0.967	1.01 (0.45–2.28)	0.986
Not applicableɣ	1.78 (0.93–3.41)	0.083	2.71 (1.11–6.62)	**0.029**

ɣ Not applicable was defined as participants under the age of 15 who were not in school or employed

Table 5 Barriers and motivators during TB treatment

Dimension	Barrier	Motivator
Intrapersonal	Shortage of money	Perceived benefits of taking medication
	Lack of food to eat before taking medication	
Interpersonal	Stigma and the fear of being stigmatized	Social support from family and friends such as food, money, bedside care
		Treatment support from HCWs like counselling, follow-up calls
Environmental	Migration in search of food, pasture and water for animals, mining and porous borders	Health system and community support by NGOs
	Difficulties in transportation due to limited modes of transport, long travel distances and weather	Adapting service delivery mechanisms to meet needs through teamwork and internal reorganization
	Drug and equipment stock-outs	Strengthening lower-level facilities through support supervision, mentorship, capacity building and training
	Lack of access to financial support while sick to meet basic needs	Community engagement through community sensitization, radio talk shows and directly at the health facilities

healthcare services respectively. HCWs reported that difficulties in accessing transport was not only detrimental to service delivery but also demotivated them. Transport difficulties affected services such as providing support supervision, updating registers, fieldwork activities, transporting TB samples to designated units and transporting TB results.

> *(…) it a very long distance even if you went in a car you will reach late. When I came back here, it was a Sunday and there were no nurses so I just relaxed until the TB came back (…)* [Female FGD participant]

> *(…) they need to offer transport for us. We are ready to work at any time, whenever we are called to do any work.* [Female HCW]

TB patients reported experiencing stigma and abandonment from family members. Stigma and the fear of being stigmatised influenced patient's behaviour before, during and after the TB treatment. One participant decided to relocate during treatment because of stigma while another was driven to seek treatment far away from her home as quoted below:

> *All the people who were mine feared me; even my own mother feared me, all the family members fear me so when I saw that everyone was fearing me, I went up to Tokora on foot carrying my baby on the back.* [Female FGD participant]

Former TB patients described experiences in which they missed drugs because they were not available from the facility. HCWs also noted that although there has been an improvement in the supply of laboratory equipment and drugs used in managing TB, occasionally they experienced stock-outs which resulted in LTFU particularly among paediatric patients. Equipment challenges included GeneXpert cartridges stock-out, breakdown of microscopes and X-ray machines and power shortages despite local solar power systems leading to difficulties in correctly diagnosing and following up TB patients.

> *Then the other challenging part is the stock-out of drugs. (…) Last December we had medicines for adults, but the problem, we did not have paediatric formulations for TB treatment: the whole December, we did not have anything.* [Male HCW]

TB treatment motivators

Social and economic support was mentioned as a motivator for treatment adherence. Patients noted that they received both tangible and non-tangible support such as money, food and bedside care. Female relatives such as wives and grandmothers often offered care and support to TB patients. HCWs also provided treatment support for patients like offering counselling and reminder phone calls about upcoming refill appointments, which were beneficial for treatment adherence and completion.

> *I did not have money. If my wife went to sell charcoal, she would bring for me. When she hasn't gone then I also don't have.* [Male FGD participant]

> *Yeah, for me the other factor that made it possible to come for my appointments was reminders, at least I had reminders most of the times.* [Male FGD participant]

Former TB patients noted that after initiating treatment, their symptoms started to subside and for some, this motivated them to continue treatment. On the other hand, the improvement experienced while on treatment

made some patients stop taking treatment as they believed they were cured.

> *The good thing about that drug is that when you take it you stop coughing.* [Male FGD participant]

The HCWs noted that both the government and non-governmental organisations (NGOs) are working in the region to support TB programs. This collaboration has been credited for improving the quality, efficiency and reach of TB services particularly through community dialogues. Community engagement through which health education is delivered either through community sensitization meetings, radio talk shows or at health facility entry points is credited for improvements in TB treatment. These efforts were intensified after identifying Karamoja as a TB 'hot spot' and realizing that some TB patients often fail to complete. HCWs also credited adaptions to services delivery at the health facility to improvements in TB care. One noted that the number of LTFU cases was higher in 2018 than in 2019 and credited this drop to teamwork and adopting a task-shifting approach in which TB drug refills were carried out by any staff member on the TB unit.

> *One of it is high collaboration with partners. Partners have been helping us too much (…) we have always moved with them to mentor our staff, we also do contact tracing with them, we have also distributed food that was given by OPM [Office of the Prime Minister] government to our district to make sure that our clients, TB AND HIV clients, benefit from it.* [Male HCW]

Support supervision, mentorship, capacity building and training were credited for strengthening lower-level facilities and a reduction in treatment default rate. Support supervision through a top-down demand for accountability was seen as a beneficial process by both the supervisors and the HCWs at the facilities. It also served as a tool to address challenges in motivation and attitudes to providing TB care.

Data integration

Quantitative and qualitative data were compared and converged. The quantitative data showed that poor quintiles had higher proportions of unsuccessful treatment outcomes and this corroborated interview findings in which patients highlighted the difficulty in getting food and transport brought on by financial hardship during TB treatment. Although the number of meals per day and meal satisfaction was not independently associated with treatment outcomes, HCWs and patients' perceptions were that food was important during TB treatment, affecting treatment adherence. Despite the lack of a direct association, quantitative data showed that high meal frequency and meal satisfaction was associated with the wealthiest quintile. Formal employment of the household head was protective for unsuccessful treatment outcomes (univariate analysis) and informal employment was positively associated with unsuccessful treatment outcomes (multivariable analysis). Participants reported that they continued to work during treatment and the only participant that got sick leave was formally employed.

Both quantitative and qualitative data showed high levels of satisfaction with the healthcare services with treatment support such as counselling and follow-up calls identified as beneficial during treatment. However, health services delivery was affected by drug and equipment stock-outs, long travel distances and few modes of transport.

Discussion

Regarding TB, Karamoja is a high burden region in a high burden country. While efforts have been made by the health system to detect all TB cases in the region, there is still a very low proportion of patients with successful treatment outcomes in TB care. This study, done in this poor rural region in Uganda [37, 38], found a significant association between SES and TB treatment outcomes. Having a high wealth quintile, in our experience, reduces the risk of an unsuccessful treatment outcome by 58%. A vast majority of the modifiable risk factors for TB are linked to poverty and low SES. Poor TB outcomes in this region were attributed in part to the poor socio-economic status, rampant poverty and high levels of illiteracy.

The wealthiest quintile had significantly lower odds of having an unsuccessful treatment outcome and these findings are in line with previous studies [15]. It is clear that the effect of wealth on TB treatment outcomes significantly manifests only in the wealthiest quintile. Arguably, the majority of Karamoja's inhabitants are homogenously poor [37, 38], and this may explain the similar TB treatment outcomes observed in the lower quintiles, initially paralleling the line of equality.

Socio-demographic characteristics related to poverty have their independent effects on treatment outcomes such as the type of employment. The odds of having poor treatment outcomes were higher for individuals employed in the informal sector; conversely, formal employment of household heads independently reduced the odds of having poor treatment outcomes. Being a child below 15 and not attending school was similarly detrimental to successful treatment for TB. Our results align with findings reported in other settings. For instance, a South African study evaluating TB mortality found that

it varied across occupation groups with the highest rates observed among people in an elementary occupation such as agricultural workers, cleaners and refuse workers [44]. Although other sociodemographic factors were not found to be associated with treatment outcome in this study, other studies have found the level of education to be significantly associated with it [17]. The wealth quintile effect on treatment outcomes may indirectly work through the level of education as individuals in this study belonging to the highest wealth quintile were more likely to have had secondary or tertiary education.

Study participants had a preference for or believed that TB drugs should be taken after meals and subsequently, many reported not taking them if they failed to get food. In a place like Karamoja that often experiences food scarcity, one can understand why many patients are discontinuing treatments. This phenomenon is not something new as previous studies already showed lack of food, stigma, lack of social and economic support during treatment and long distances to health facilities affected patients' treatment adherence [45–47]. Financial challenges during TB treatment do impact patients' ability to cater for food and transport costs during treatment. These challenges are exacerbated by the high mobility of the population, especially across the Uganda-Kenya border for economic reasons, which makes treatment follow-up difficult.

Patients in this study relied on family or friends as a social support system to meet their financial expenditures and loss of income and did not report access to any organised social protection schemes. Amid low levels of social protection and limited savings, the poorest patients are more likely to resort to coping mechanisms such as the sale of assets or borrowing to defray costs plunging them further into poverty [48]. Poverty and TB are intrinsically intertwined as poverty fosters TB and, in turn, TB can lead to loss of income and the costs of managing TB can become catastrophic [49–54]. A survey done in Uganda showed that over half of TB patients experienced catastrophic costs [48] and these have been linked to poor outcomes [55].

Globally, we are not on track to meet the milestones of the End TB strategy for 2025. The current TB case fatality ratio of 14% should fall to about 7% and the annual 1.7% reduction in TB incidence rate is only a factor of the requisite 10% drop rate [1]. Integrated, patient-centered care and prevention are crucial to ending TB as a public health problem and models have shown that interventions to end extreme poverty and expand social protection coverage alone can result in a significant decline in TB incidence and protect people with TB from untoward financial hardships including catastrophic costs [30]. People living in socio-economically deprived areas face higher TB mortality [56, 57] and population-level interventions like increased government spending on social protection initiatives have been shown to reduce TB incidence and mortality [58–60]. Social protection programmes such as conditional cash transfer payments linked to TB treatment targets or microfinance schemes have been shown to reduce vulnerability, alleviate poverty, and improve food security and treatment outcomes [14, 49, 61–63]. Social protection schemes that address the broader determinants of health and protect against tuberculosis-associated financial consequences are needed to improve the treatment outcomes in the Karamoja region.

In Karamoja, HIV prevalence is lower than the national average [64] and as such, HIV is not a major determinant of TB and outcomes: only 4.5% of the study participants were HIV positive. In contrast to other studies [17, 20] that had a higher HIV co-infection rate, HIV did not increase the risk of having an unsuccessful TB treatment outcome in this study.

This study has some limitations. First of all, there is a selection bias due to the 1:2 randomization design between successful and unsuccessful outcomes. If poor TB treatment outcomes are generally linked to low wealth quintiles, there may have been an increased chance of selection of those belonging to the real-life poorer wealth quintiles. As a result, a high proportion of the sample especially of people in Q1–4 may have clustered in the lower 'real-life' wealth quintiles. This might explain why significantly lower odds of having an unsuccessful treatment outcome were got in only the wealthiest quintile. Secondly, being a retrospective study on patients who had completed treatment, the findings may be subject to recall bias. However, the use of a wealth index to measure SES as opposed to income was of benefit to the study. In contrast to an individual's income that is limited to a narrow time frame and subject to seasonal variability particularly in the informal sector, wealth is a long-term indicator of SES as it depicts assets accumulated over time, incorporating the impacts of education, employment, income and savings [65, 66]. Another limitation is that patients who died during TB treatment were not included in the study, an additional 19 participants died before the inception of this study. TB mortality is a pertinent indicator in most TB programs and one of the most researched treatment outcomes but we were not able to analyse it in this study. We postulate that patients who died may have had lower SES [57, 67] and this would have increased the significance of our findings. Lastly, patients experiences and perspectives on TB treatment barriers and motivators were explored using FGDs only. Whereas lived experiences are better explored with one-on-one interviews, FGDs were chosen to identify cross-cutting themes and

general problems and this may have led to a loss of information on unique, personal experiences.

Conclusion

This study shows that higher socio-economic status, measured by wealth and related attributes of formal employment, is associated with better TB treatment outcomes. High losses to follow-up before treatment initiation and during the continuation phase are likely affected by lack of food, stigma, belonging to nomadic communities, and lack of transport and finances to meet basic needs. Initiatives that target poverty and other social determinants of health have the potential to accelerate progress to the End TB targets firstly by protecting against TB-associated catastrophic costs and in the long run, reducing TB incidence and mortality. Improving treatment outcomes in Karamoja will require addressing these socio-economic determinants alongside improvements in general programmatic performance. Institution of treatment enablers for all TB patients including provision of food, transport and innovative microfinancing mechanisms is necessary for a poverty-stricken region like Karamoja and should be a priority for health authorities.

Abbreviations

DTUs: TB Diagnostic &Treatment Units; FGDs: Focus group discussions; HCW: Healthcare worker; KII: Key informant interviews; LTFU: Loss to follow-up; NGOs: Non-governmental organisations; NTLP: National Tuberculosis and Leprosy Control Program; PBC TB: Pulmonary bacteriologically confirmed TB; SDGs: United Nations Sustainable Development Goals; SES: Socio-economic status; TB: Tuberculosis

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s12889-021-12056-1.

Additional file 1. Interview Guides. Interview guides used for key informant interviews of health care workers and focus group discussions among former TB patients.

Additional file 2. Distribution by sociodemographic characteristics and wealth. Table of results.

Additional file 3. Healthcare system factors and TB treatment outcomes. Table of results.

Acknowledgements

Not applicable.

Authors' information (optional)

Not applicable

Authors' contributions

BK, MCR, SW, JFI, PL, JI, WM, GP, SV, ST, RB and NJ conceptualized the study and contributed to its design. LM and RS performed the statistical analysis and prepared Tables 1-4, additional files 2 and 3, Fig. 2a and b. BK, WM and NJ analysed the qualitative data and NJ prepared Table 5, Figs. 1 and 2c. BK, WM, SW, JFI and NJ interpreted and integrated the data and prepared the first draft of the manuscript that was revised by PL, JI, MCR, GP, SV, ST and RB. All authors reviewed the manuscript and approved the final manuscript.

Funding

Funding for the SETO TB project was made possible by Doctors with Africa, CUAMM. Authors PL, JI, GP, SV and MCR are affiliated with CUAMM. They were involved in the design of the study and collection, analysis, and interpretation of data and in writing the manuscript.

Availability of data and materials

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate

All methods were performed in accordance with the relevant guidelines and regulations. Ethics approval for this study was obtained from Mulago Hospital Research and Ethics Committee with reference number MHREC 1765 and the Uganda National Council for Science and Technology (UNCST). Information regarding the study was provided and all participants willing to join the study gave written informed consent. All participants aged 18 years and above provided informed consent. A parent or legal guardian of a minor provided informed consent for participants under 18 years and assent was obtained from minors aged 8–17 years.

Consent for publication

Not applicable.

Competing interests

The authors declare that they have no competing interests.

Author details

[1]Makerere University Lung Institute (MLI), Kampala, Uganda. [2]Doctors with Africa CUAMM, Kampala, Uganda. [3]National Tuberculosis and Leprosy Control Program (NTLP), Kampala, Uganda. [4]Doctors with Africa CUAMM, Padova, Italy. [5]Centre for Multidisciplinary Research in Health Science, University of Milan, Milan, Italy.

Received: 11 May 2021 Accepted: 15 October 2021
Published online: 26 November 2021

References

1. World Health Organization. Global Tuberculosis Report. Geneva. 2020:2020.
2. Kyu HH, Maddison ER, Henry NJ, Mumford JE, Barber R, Shields C, et al. The global burden of tuberculosis: results from the global burden of disease study 2015. Lancet Infect Dis. 2018 Mar 1;18(3):261–84. https://doi.org/10.1016/S1473-3099(17)30703-X.
3. Wingfield T, Tovar MA, Huff D, Boccia D, Saunders MJ, Datta S, et al. Beyond pills and tests: addressing the social determinants of tuberculosis. Clin Med (Northfield Il). 2016;16(Suppl 6):s79.
4. World Health Organization. The End TB Strategy. World Health Organization. Geneva: World Health Organization; 2015.
5. Pedrazzoli D, Boccia D, Dodd PJ, Lönnroth K, Dowdy DW, Siroka A, et al. Modelling the social and structural determinants of tuberculosis: opportunities and challenges. Int J Tuberc Lung Dis. 2017;21(9):957–64. https://doi.org/10.5588/ijtld.16.0906.
6. Lönnroth K, Jaramillo E, Williams BG, Dye C, Raviglione M. Drivers of tuberculosis epidemics: the role of risk factors and social determinants. Soc Sci Med. 2009;68(12):2240–6. https://doi.org/10.1016/j.socscimed.2009.03.041.
7. About the Sustainable Development Goals – United Nations Sustainable Development Goals [Internet]. Available from: https://www.un.org/sustainabledevelopment/sustainable-development-goals/
8. Lönnroth K, Raviglione M. The WHO's new end TB strategy in the post-2015 era of the sustainable development goals. Trans R Soc Trop Med Hyg. 2016;110(3):148–50. https://doi.org/10.1093/trstmh/trv108.
9. Fitchett JR, Macpherson P, Corbett EL. Implementing the end TB strategy and the intersection with the sustainable development goals, 2016-2030 challenges to ending TB. Trans R Soc Trop Med Hyg. 2016 Mar 1;110(3):145–7. https://doi.org/10.1093/trstmh/trw010.
10. Valles SA. A pluralistic and socially responsible philosophy of epidemiology field should actively engage with social determinants of health and health disparities. Synthese. 2019 Mar;5:1–23.

11. Trauer JM, Dodd PJ, Gomes MGM, Gomez GB, Houben RMGJ, McBryde ES, et al. The importance of heterogeneity to the epidemiology of tuberculosis. Clin Infect Dis. 2019;69(1):159–66. https://doi.org/10.1093/cid/ciy938.
12. World Health Organization. WHO | Global tuberculosis report. World Health Organization. World Health Organization. 2019;2019.
13. Solar O, Irwin A. A conceptual framework for action on the social determinants of health. Social Determinants of Health Discussion Paper 2 (Policy and Practice). Geneva. 2010.
14. Hargreaves JR, Boccia D, Evans CA, Adato M, Petticrew M, Porter JDH. The social determinants of tuberculosis: from evidence to action. Am J Public Health. 2011;101(4):654–62. https://doi.org/10.2105/AJPH.2010.199505.
15. Alene KA, Viney K, Gray DJ, McBryde ES, Wagnew M, Clements ACA. Mapping tuberculosis treatment outcomes in Ethiopia. BMC Infect Dis. 2019 Dec 28;19(1):474. https://doi.org/10.1186/s12879-019-4099-8.
16. Zhang T, Tang S, Jun G, Whitehead M. Persistent problems of access to appropriate, affordable TB services in rural China: experiences of different socio-economic groups. BMC Public Health. 2007;7(1):19. https://doi.org/10.1186/1471-2458-7-19.
17. Di Gennaro F, Pizzol D, Cebola B, Stubbs B, Monno L, Saracino A, et al. Social determinants of therapy failure and multi drug resistance among people with tuberculosis: A review. Vol. 103, Tuberculosis. Churchill Livingstone; 2017. p. 44–51, DOI: https://doi.org/10.1016/j.tube.2017.01.002.
18. Aibana O, Slavuckij A, Bachmaha M, Krasiuk V, Rybak N, Flanigan TP, et al. Patient predictors of poor drug sensitive tuberculosis treatment outcomes in Kyiv Oblast, Ukraine. F1000Research. 2019 Nov;22(6):1873.
19. Rashak HA, Sánchez-Pérez HJ, Abdelbary BE, Bencomo-Alerm A, Enriquez-Ríos N, Gómez-Velasco A, et al. Diabetes, undernutrition, migration and indigenous communities: Tuberculosis in Chiapas. Mexico Epidemiol Infect. 2019;147.
20. Secretary of Jan Swasthya Sahyog, Laux TS, Patil S. Predictors of tuberculosis treatment outcomes among a retrospective cohort in rural, Central India. J Clin Tuberc Other Mycobact Dis. 2018 Aug 1;12:41–7.
21. Adamu AL, Aliyu MH, Galadanci NA, Musa BM, Lawan UM, Bashir U, et al. The impact of rural residence and HIV infection on poor tuberculosis treatment outcomes in a large urban hospital: a retrospective cohort analysis. Int J Equity Health. 2018 Jan;8(1):17(1). https://doi.org/10.1186/s12939-017-0714-8.
22. Gelmanova IY, Keshavjee S, Golubchikova VT, Berezina VI, Strelis AK, Yanova GV, et al. Barriers to successful tuberculosis treatment in Tomsk, Russian Federation: non-adherence, default and the acquisition of multidrug resistance. Bull World Health Organ. 2007 Sep;85(9):703–11. https://doi.org/10.2471/BLT.06.038331.
23. Di Gennaro F, Pizzol D, Cebola B, Stubbs B, Monno L, Saracino A, et al. Social determinants of therapy failure and multi drug resistance among people with tuberculosis: A review. Vol. 103, Tuberculosis. Churchill Livingstone; 2017. p. 44–51, DOI: https://doi.org/10.1016/j.tube.2017.01.002.
24. Eshetie S, Gizachew M, Alebel A, van Soolingen D. Tuberculosis treatment outcomes in Ethiopia from 2003 to 2016, and impact of HIV co-infection and prior drug exposure: A systematic review and meta-analysis. Subbian S, editor. PLoS One. 2018 Mar 19;13(3):e0194675.
25. Tweya H, Feldacker C, Phiri S, Ben-Smith A, Fenner L, Jahn A, et al. Comparison of Treatment Outcomes of New Smear-Positive Pulmonary Tuberculosis Patients by HIV and Antiretroviral Status in a TB/HIV Clinic, Malawi. Ho W, editor. PLoS One. 2013 Feb 15;8(2):e56248.
26. Nglazi MD, Bekker LG, Wood R, Kaplan R. The impact of HIV status and antiretroviral treatment on TB treatment outcomes of new tuberculosis patients attending co-located TB and ART services in South Africa: a retrospective cohort study. BMC Infect Dis. 2015 Nov 19;15(1):536. https://doi.org/10.1186/s12879-015-1275-3.
27. Ahmad Khan F, Minion J, Al-Motairi A, Benedetti A, Harries AD, Menzies D. An updated systematic review and meta-analysis on the treatment of active tuberculosis in patients with hiv infection. Vol. 55, Clinical Infectious Diseases. Clin Infect Dis; 2012. p. 1154–1163, An Updated Systematic Review and Meta-analysis on the Treatment of Active Tuberculosis in Patients With HIV Infection, 8, DOI: https://doi.org/10.1093/cid/cis630.
28. García-Basteiro AL, Respeito D, Augusto OJ, López-Varela E, Sacoor C, Sequera VG, et al. Poor tuberculosis treatment outcomes in southern Mozambique (2011-2012). BMC Infect Dis. 2016 May;20:16(1).
29. Koomen LEM, Burger R, Van Doorslaer EKA. Effects and determinants of tuberculosis drug stockouts in South Africa. BMC Health Serv Res. 2019 Apr 3;19(1):213. https://doi.org/10.1186/s12913-019-3972-x.
30. Carter DJ, Glaziou P, Lönnroth K, Siroka A, Floyd K, Weil D, et al. The impact of social protection and poverty elimination on global tuberculosis incidence: a statistical modelling analysis of sustainable development goal 1. Lancet Glob Heal. 2018;6(5):e514–22. https://doi.org/10.1016/S2214-109X(18)30195-5.
31. Durovni B, Saraceni V, Puppin MS, Tassinari W, Cruz OG, Cavalcante S, et al. The impact of the Brazilian family health strategy and the conditional cash transfer on tuberculosis treatment outcomes in Rio de Janeiro: an individual-level analysis of secondary data. J Public Health (Oxf). 2018;40(3):e359–66. https://doi.org/10.1093/pubmed/fdx132.
32. Ukwaja KN, Alobu I, Gidado M, Onazi O, Oshi DC. Economic support intervention improves tuberculosis treatment outcomes in rural Nigeria. Int J Tuberc Lung Dis. 2017 May 1;21(5):564–70. https://doi.org/10.5588/ijtld.16.0741.
33. de Andrade KVF, Nery JS, de Souza RA, Pereira SM. Effects of social protection on tuberculosis treatment outcomes in low or middle-income and in high-burden countries: systematic review and meta-analysis. In: Effects of social protection on tuberculosis treatment outcomes in low or middle-income and in high-burden countries: systematic review and meta-analysis, vol. 34. Fundacao Oswaldo Cruz: Cadernos de Saude Publica; 2018.
34. Lutge E, Lewin S, Volmink J, Friedman I, Lombard C. Economic support to improve tuberculosis treatment outcomes in South Africa: a pragmatic cluster-randomized controlled trial. Trials. 2013 May 28;14(1):1–13. https://doi.org/10.1186/1745-6215-14-154.
35. Uganda Ministry of Health. The Uganda National Tuberculosis Prevalence Survey. Survey Report. 2014-2015:2015.
36. National Tuberculosis and Leprosy Division. National Tuberculosis And Leprosy Division: July 2017 – June 2018 Report. Uganda Ministry of Health 2018.
37. Uganda Bureau of Statistics (UBOS). Uganda National Household Survey 2016/2017. Kampala, Uganda; 2018.
38. Uganda Bureau of Statistics (UBOS), ICF. Uganda Demographic and Health Survey 2016. Kampala, Uganda and Rockville, Maryland, USA: UBOS and ICF; 2018.
39. Kröger H, Pakpahan E, Hoffmann R. What causes health inequality? A systematic review on the relative importance of social causation and health selection. Eur J Pub Health. 2015;25(6):951–60. https://doi.org/10.1093/eurpub/ckv111.
40. Shavers VL. Measurement of socioeconomic status in health disparities research. J Natl Med Assoc. 2007 Sep;99(9):1013–23.
41. Edmonds WA, Kennedy TD. An Applied Guide to Research Designs: Quantitative, Qualitative, and Mixed Methods. Second Edi. An Applied Guide to Research Designs: Quantitative, Qualitative, and Mixed Methods. 2017. 181–188 p.
42. Ministry of Health Uganda. Uganda eHMIS [Internet]. [cited 2020 Jan 24]. Available from: https://hmis.health.go.ug/dhis-web-commons/security/login.action
43. Guest G, Bunce A, Johnson L. How many interviews are enough? Field methods. 2006 Feb 21;18(1):59–82. https://doi.org/10.1177/1525822X05279903.
44. Kootbodien T, Wilson K, Tlotleng N, Ntlebi V, Made F, Rees D, et al. Tuberculosis mortality by occupation in South Africa, 2011–2015. Int J Environ Res Public Health. 2018 Dec 1;15(12):2011–5. https://doi.org/10.3390/ijerph15122756.
45. Gebreweld FH, Kifle MM, Gebremicheal FE, Simel LL, Gezae MM, Ghebreyesus SS, et al. Factors influencing adherence to tuberculosis treatment in Asmara. Eritrea: A qualitative study J Heal Popul Nutr. 2018 Jan;5(1):37(1). https://doi.org/10.1186/s41043-017-0132-y.
46. Marahatta SB, Yadav RK, Giri D, Lama S, Rijal KR, Mishra SR, et al. Barriers in the access, diagnosis and treatment completion for tuberculosis patients in central and western Nepal: A qualitative study among patients, community members and health care workers. PLoS One. 2020;15(1).
47. Da Silva RD, De Luna FDT, De Araújo AJ, Camêlo ELS, Bertolozzi MR, Hino P, et al. Patients' perception regarding the influence of individual and social vulnerabilities on the adherence to tuberculosis treatment: a qualitative study. BMC Public Health. 2017 Sep;19(1):17(1). https://doi.org/10.1186/s12889-017-4752-3.
48. Muttamba W, Tumwebaze R, Mugenyi L, Batte C, Sekibira R, Nkolo A, et al. Households experiencing catastrophic costs due to tuberculosis in Uganda: magnitude and cost drivers. BMC Public Health. 2020;20(1):1–10. https://doi.org/10.1186/s12889-020-09524-5.

49. Grede N, Claros JM, Pee S de, Bloem M. Is There a Need to Mitigate the Social and Financial Consequences of Tuberculosis at the Individual and Household Level? AIDS Behav 2014 185. 2014 Apr 8; 18(5):542–553.
50. Walcott RL, Ingels JB, Corso PS, Zalwango S, Whalen CC, Sekandi JN. There's no such thing as a free TB diagnosis: catastrophic TB costs in urban Uganda. Glob Public Health. 2020;15(6):877–88. https://doi.org/10.1080/17441692.2020.1724313.
51. Duarte R, Lönnroth K, Carvalho C, Lima F, Carvalho ACC, Muñoz-Torrico M, et al. Tuberculosis, social determinants and co-morbidities (including HIV). Pulmonology. 2018;24(2):115–9. https://doi.org/10.1016/j.rppnen.2017.11.003.
52. Jackson S, Sleigh AC, Wang G-J, Liu X-L. Poverty and the economic effects of TB in rural China.
53. Ukwaja KN, Modebe O, Igwenyi C, Alobu I. The economic burden of tuberculosis care for patients and households in Africa: A systematic review. Vol. 16, Int J Tuberculosis and Lung Disease. 2012. p. 733–739.
54. Kamolratanakul P, Sawert H, Kongsin S, Lertmaharit S, Sriwongsa J, Na-Songkhla S, et al. Economic impact of tuberculosis at the household level. Int J Tuberc Lung Dis. 1999;3(7):596–602.
55. Wingfield T, Boccia D, Tovar M, Gavino A, Zevallos K, Montoya R, et al. Defining Catastrophic Costs and Comparing Their Importance for Adverse Tuberculosis Outcome with Multi-Drug Resistance: A Prospective Cohort Study, Peru. PLoS Med. 2014;11(7).
56. dos Santos DT, Seles Alves L, Moraes Arcoverde MA, Arroyo LH, Zamboni Berra T, Ramos ACV, et al. Social risk and its association with tuberculosis mortality in a context of high inequality in South Brazil: a geo-epidemiology analysis. J Infect Public Health. 2020 Aug 1;13(8):1148–55. https://doi.org/10.1016/j.jiph.2020.03.010.
57. Arcoverde MAM, Berra TZ, Alves LS, Dos Santos DT, Belchior ADS, Ramos ACV, et al. How do social-economic differences in urban areas affect tuberculosis mortality in a city in the tri-border region of Brazil. Paraguay and Argentina BMC Public Health. 2018 Jun 26;18(1):795. https://doi.org/10.1186/s12889-018-5623-2.
58. Reeves A, Basu S, McKee M, Stuckler D, Sandgren A, Semenza J. Social protection and tuberculosis control in 21 European countries, 1995-2012: a cross-national statistical modelling analysis. Lancet Infect Dis. 2014 Nov 1;14(11):1105–12. https://doi.org/10.1016/S1473-3099(14)70927-2.
59. Siroka A, Ponce NA, Lönnroth K. Association between spending on social protection and tuberculosis burden: a global analysis. Lancet Infect Dis. 2016 Apr 1;16(4):473–9. https://doi.org/10.1016/S1473-3099(15)00401-6.
60. Carter DJ, Glaziou P, Lönnroth K, Siroka A, Floyd K, Weil D, et al. The impact of social protection and poverty elimination on global tuberculosis incidence: a statistical modelling analysis of sustainable development goal 1. Lancet Glob Heal. 2018 May 1;6(5):e514–22. https://doi.org/10.1016/S2214-109X(18)30195-5.
61. Sripad A, Castedo J, Danford N, Zaha R, Freile C. Effects of Ecuador's national monetary incentive program on adherence to treatment for drug-resistant tuberculosis. Int J Tuberc Lung Dis. 2014 Jan 1;18(1):44–8. https://doi.org/10.5588/ijtld.13.0253.
62. Boccia D, Hargreaves J, Lönnroth K, Jaramillo E, Weiss J, Uplekar M, Porter JDH, Evans CA Cash transfer and microfinance interventions for tuberculosis control: Review of the impact evidence and policy implications. Vol. 15, International Journal of Tuberculosis and Lung Disease. Europe PMC Funders; 2011. p. S37, Cash transfer and microfinance interventions for tuberculosis control: review of the impact evidence and policy implications, 6, S49, DOI: https://doi.org/10.5588/ijtld.10.0438.
63. Klein K, Bernachea MP, Irribarren S, Gibbons L, Chirico C, Rubinstein F. Evaluation of a social protection policy on tuberculosis treatment outcomes: A prospective cohort study. In: Evaluation of a social protection policy on tuberculosis treatment outcomes: a prospective cohort study, vol. 16. PLoS Medicine: Public Library of Science; 2019.
64. Ministry of Health Uganda. Uganda Population-Based HIV Impact Assessment (UPHIA) 2016-2017. 2019.
65. Braveman PA, Cubbin C, Egerter S, Chideya S, Marchi KS, Metzler M, et al. Socioeconomic status in health research: one size does not fit all. J Am Med Assoc. 2005 Dec 14;294(22):2879–88. https://doi.org/10.1001/jama.294.22.2879.
66. Pollack CE, Chideya S, Cubbin C, Williams B, Dekker M, Braveman P. Should Health Studies Measure Wealth?. A Systematic Review. Vol. 33, American Journal of Preventive Medicine. Elsevier; 2007. p. 250–264, 3, DOI: https://doi.org/10.1016/j.amepre.2007.04.033.
67. Kabudula CW, Houle B, Collinson MA, Kahn K, Gómez-Olivé FX, Tollman S, et al. Socioeconomic differences in mortality in the antiretroviral therapy era in Agincourt, rural South Africa, 2001–13: a population surveillance analysis. Lancet Glob Heal. 2017 Sep 1;5(9):e924–35. https://doi.org/10.1016/S2214-109X(17)30297-8.

Publisher's Note

Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

Ready to submit your research? Choose BMC and benefit from:

- fast, convenient online submission
- thorough peer review by experienced researchers in your field
- rapid publication on acceptance
- support for research data, including large and complex data types
- gold Open Access which fosters wider collaboration and increased citations
- maximum visibility for your research: over 100M website views per year

At BMC, research is always in progress.

Learn more biomedcentral.com/submissions

BMC

‘It is not fashionable to suffer nowadays’: Community motivations to repeatedly participate in outreach HIV testing indicate UHC potential in Tanzania

PAPER

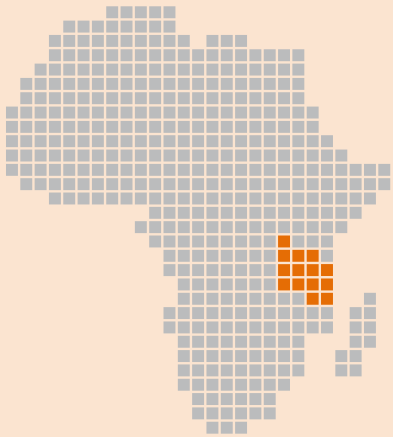
Authors
de Klerk J., Bortolani A., Meta J., Erio T., Rinke de Wit T., Moyer E.

Published in
Plos One,
December 2021

Link
https://doi.org/10.1371/journal.pone.0261408

Topic
Infectious and tropical diseases

Focus country
Tanzania



PLOS ONE

RESEARCH ARTICLE

'It is not fashionable to suffer nowadays': Community motivations to repeatedly participate in outreach HIV testing indicate UHC potential in Tanzania

Josien de Klerk[1☯], Arianna Bortolani[2‡], Judith Meta[1‡], Tusajigwe Erio[1], Tobias Rinke de Wit[1‡], Eileen Moyer[1☯*]

1 Amsterdam Institute for Global Health and Development, Amsterdam, the Netherlands, **2** Doctors with Africa–CUAMM, Padova, Italy

☯ These authors contributed equally to this work.
‡ These authors also contributed equally to this work.
* e.m.moyer@uva.nl

Check for updates

OPEN ACCESS

Citation: de Klerk J, Bortolani A, Meta J, Erio T, Rinke de Wit T, Moyer E (2021) 'It is not fashionable to suffer nowadays': Community motivations to repeatedly participate in outreach HIV testing indicate UHC potential in Tanzania. PLoS ONE 16(12): e0261408. https://doi.org/10.1371/journal.pone.0261408

Editor: Bidhubhusan Mahapatra, Population Council, INDIA

Received: March 8, 2021

Accepted: December 1, 2021

Published: December 22, 2021

Peer Review History: PLOS recognizes the benefits of transparency in the peer review process; therefore, we enable the publication of all of the content of peer review and author responses alongside final, published articles. The editorial history of this article is available here: https://doi.org/10.1371/journal.pone.0261408

Copyright: © 2021 de Klerk et al. This is an open access article distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.

Data Availability Statement: Data cannot be shared publicly because of confidentiality issues and agreements made with research participants.

Abstract

Objective

This study examined people's motivations for (repeatedly) utilizing HIV testing services during community-based testing events in urban and rural Shinyanga, Tanzania and potential implications for Universal Health Coverage (UHC).

Methods

As part of a broader multidisciplinary study on the implementation of a HIV Test and Treat model in Shinyanga Region, Tanzania, this ethnographic study focused on community-based testing campaigns organised by the implementing partner. Between April 2018 and December 2019, we conducted structured observations (24), short questionnaires (42) and in-depth interviews with HIV-positive (23) and HIV-negative clients (8). Observations focused on motivations for (re-)testing, and the counselling and testing process. Thematic analysis based on inductive and deductive coding was completed using NVivo software.

Results

Regular HIV testing was encouraged by counsellors. Most participants in testing campaigns were HIV-negative; 51.1% had tested more than once over their lifetimes. Testing campaigns provided an accessible way to learn one's HIV status. Motivations for repeat testing included: monitoring personal health to achieve (temporary) reassurance, having low levels of trust toward sexual partners, feeling at risk, seeking proof of (ill)-health, and acting responsibly. Repeat testers also associated testing with a desire to start treatment early to preserve a healthy-looking body, should they prove HIV positive.

Data are available from the Amsterdam Institute for Global Health and Development Institutional Data Access (contact via secretariat@aighd) for researchers who meet the criteria for access to confidential data.

Funding: The Shinyanga and Simiyu Test&Treat program in Tanzania is supported by Gilead Sciences (USA) and the Diocese of Shinyanga through the Good Samaritan Foundation (Vatican). The implementation of the project is by Doctors with Africa CUAMM and the Diocese of Shinyanga within the framework of the Tanzanian Ministry of Health, Community Development, Gender, Elderly and Children (MoHCDGEC) through the National AIDS Control Program (NACP). The scientific evaluation of the project is under guidance of Principal Investigator Prof Anton Pozniak and is performed by the Amsterdam Institute for Global Health and Development (AIGHD) in collaboration with CUAMM. This research falls under the overall research project 'Feasibility of universal access to HIV test and treat in Shinyanga and Simiyu Regions, Tanzania, ethically cleared by NIMR under NIMR/HQ/R.8a/Vol.IX/2711'. The content of this manuscript is solely the responsibility of the authors and does not necessarily represent the official views of any of the institutions mentioned above. We thank all our institutional collaborators, the study participants, the staff at the project clinical sites and laboratories, as well as the project support staff for their invaluable support to this program in general and the current manuscript in particular.

Competing interests: The Shinyanga and Simiyu Test & Treat program in Tanzania is funded by Gilead Sciences (USA), contract date June 1st 2016. The Amsterdam Institute for Global Health and Development (AIGHD) is a co-recipient of this award. All authors were employed under AIGHD's auspices. This does not alter our adherence to PLOS ONE policies on sharing data and materials. The funders did not play an active role in study design, data collection, analysis, decision to publish or preparation of the manuscript. All authors declare not to have competing interests.

Conclusions

Community-based testing campaigns serve three valuable functions related to HIV prevention and treatment: 1) enable community members to check their HIV status regularly as part of a personalized prevention strategy that reinforces responsible behaviour; 2) identify recently sero-converted clients who would not otherwise be targeted; and 3) engage community with general prevention and care messaging and services. This model could be expanded to include routine management of other (chronic) diseases and provide an entry for scaling up UHC.

Introduction

In 2016, Treat All, referring to the immediate initiation of all people living with HIV on antiretroviral treatment, was implemented as the standard of HIV care in Tanzania [1] in alignment with the 2011 UNAIDS 90-90-90 targets, which aim to identify 90% of all HIV-infected people, link and retain 90% of HIV-positive people to antiretroviral treatment (ART), and achieve viral suppression among 90% of those on treatment [2]. The strategy in Tanzania is called Treat All, referring to the immediate initiation of all people living with HIV on antiretroviral treatment. In this context, a pilot UTT intervention combined with decentralized HIV care was designed and simultaneously rolled-out in the Tanzanian Shinyanga and Simiyu regions. This project is hosted by the Catholic Diocese of Shinyanga, supported by an international donor, implemented by an Italian organisation and evaluated by a Dutch Global Health research institute. The intervention informs the Tanzanian government about the most effective UTT practices. This paper describes people's motivations for (repeatedly) utilizing HIV testing services during community-based outreach events in urban and rural Shinyanga.

Between May 2017 and April 2018, 91,968 [3] HIV tests were administered, through community-based testing campaigns and during special testing events in rural and urban locations in Simiyu and Shinyanga Regions, including Shinyanga town, a regional centre and hub for truck routes. Campaigns specifically targeted groups that were usually underserved by health facility-based testing, such as youth and men [4, 5].

Because of repeat testing practices, no data were available on how the total number of tests performed corresponded to the total number of clients. Initial results showed that the outreach reached more men (56%) than women and 31.9% of respondents were under 20 years [3]. In April 2019 the percentage HIV positive cases newly identified in the campaigns was 1.8%, lower than the reported 2016 HIV prevalence for these regions (5.9% for Shinyanga and 3.9% for Simiyu) [6]. Tanzanian testing coverage by August 2019 was estimated to be 78% [7]. With this already high coverage rate's the significantly lower percentage of newly identified HIV patients was not surprising. Declining 'yields', percentages of HIV positive patients identified through community out-reach campaigns, have motivated African governments [8] and international donors [9] (to embrace targeted HIV testing approaches directed at those considered most-at-risk. Tanzania is in a transition in this respect with a recent move to expand index testing and targeted provider-initiated testing in health facilities [10]. Qualitative data collected from the preliminary phase of our research, conducted between May 2017 and April 2018, uncovered some unexpected findings. At least half (51,1%) of the population was repeat HIV testers (Giulia Martelli, personal communication) and of those who did test HIV positive, 13% had already been enrolled in HIV services and received ART [3]. These data raised several

questions about the phenomenon of repeat testing. With so many people testing HIV negative, so many having already tested at least once previously, and a sizeable percentage already enrolled in AIDS treatment programmes, what motivated different people to utilize community-based testing campaigns and what could this imply for future programming and community outreach?

In this paper we present the findings of a qualitative ethnographic study to understand motivations for utilizing HIV testing services, including repeat testing, during community-based testing events in urban and rural Shinyanga, Tanzania.

Methods

Ethical clearance

Research for the project was conducted with the approval of the Tanzanian National Institute for Medical Research. The research falls under the overall research project 'Feasibility of universal access to HIV test and treat in Shinyanga and Simiyu Regions, Tanzania,' ethically cleared by NIMR under NIMR/HQ/R.8a/Vol.IX/2711.

Study setting and project background

Shinyanga Region, Tanzania, is mainly rural and home to diamond and gold mines, which attract migrant workers. The region has two urban centres: the regional capital of Shinyanga Town and the larger mining town of Kahama. Both are hubs for businesses and transport. The population of Shinyanga Region was 1,534,808 in 2012, with a male:female ration of 96:100, that of Simiyu Region was 1.584,157, with a male:female ratio of 92:100 [11]. Most residents belong to the Sukuma ethnic group and live in scattered homesteads; both women and men travel for work to other regions, including for seasonal farming. Government dispensaries, health clinics, and private faith-based health centres offer HIV testing, as does the Shinyanga regional hospital and a host of private laboratories. HIV outreach testing also takes place during important events on public holidays. Shinyanga has 8 hospitals, 23 health centres, 215 dispensaries and Simiyu 8 hospitals, 18 health centres and 192 dispensaries (Shinyanga and Simiyu Regional AIDS Control Coordinators, personal communication).

The Shinyanga and Simiyu Test and Treat (T&T) project, within which this ethnographic study was conducted, is implemented by CUAMM-Doctors with Africa in collaboration with the Catholic Diocese of Shinyanga which runs the four 'hubs'–Care and Treatment Centres (CTC)– selected to identify HIV-positive people through provider-initiated testing and counselling as well as mobile outreach to communities in remote areas. The original aim was to test 300,000 people in Shinyanga and Simiyu regions to identify an estimated 20,000 HIV patients and link them to care. Distances from the campaign sites to these hubs varied between 0.5 and 5 hours cycling. We used cycling hours as this was the most common form of transportation to the clinic and was used by clinic counsellors as well. Mobile outreach follows the 'kitongoji strategy', offering services at the ward level to make testing accessible. To date, the T&T project has targeted the wards of 172 villages. One hub is located in an urban location and outreach activities take place at busy crossroads, bus-stands, marketplaces and densely populated neighbourhoods. In rural areas, seasonal and daily agriculture rhythms dictate people's availability for testing; in town, work and school hours affect who can participate in testing campaigns, hence testing events were held during the day and in the evenings and on public holidays.

The feasibility and effectiveness of the intervention is being studied by a multidisciplinary team, based at the Amsterdam Institute for Global Health and Development. This paper draws on data collected between May 2018 and April 2019 within a broader ethnographic study on people's experiences with Treat All and differentiated care. Our applied study entailed an

inductive, bottom-up approach, with attention to themes that emerged from rounds of data-collection and built-in opportunities in the protocol to adjust our data collection tools. Methodologically, participant observation and informal conversations informed the development of the in-depth interview tools.

Study findings were used to inform the implementation on a continuous basis. Interim results were discussed with the implementing organisation, CUAMM, in the quarterly testing team meetings. Regional sharing took place through the Quarterly Regional HIV/AIDS Partners meeting at the Shinyanga and Simyu Regional Medical Office. The primary beneficiaries of the programme were the implementing organisation, including the counsellors running the testing programme, secondary beneficiaries included the district and regional health authorities, and government officials.

Data collection

Two Tanzanian Master's level cultural sociologists (one male, one female) were trained in ethnographic methods before conducting observations of the community-outreach campaigns in two catchment areas, an urban and a rural site. One researcher was a native Sukuma speaker. The sociologists were trained in structured observation, note-taking, probing, transcription and data-analysis, and they worked with a detailed observation guideline. Research focused on community mobilization techniques, social dynamics in the waiting area, and practices in counselling sessions. When people expressed their motivation for testing during counselling sessions, researchers recorded it. To recruit people undergoing testing, rapid interviews were held with people in the waiting area. Each person was asked to provide basic demographic information, contact details, and consent to be (re-)interviewed one month after the test. Following analysis of the rapid interviews, a diverse sample was purposively selected based on gender, age, geographical location, testing history, and HIV status. These people were then approached by telephone to schedule an in-depth interview (IDI), to which 8 HIV-negative and 2 HIV positive people responded positively. To increase the sample of HIV-positive participants, people who tested positive were specifically approached through the implementing partner. Here a convenience approach was used since no relationship with researcher had been established.

Interview guides for IDI were translated from English into Kiswahili. IDIs lasted 60 to 90 minutes. Before the start of the interview each respondent was taken through a written informed consent procedure and given the opportunity to withdraw from the study. Interviews were conducted in Kiswahili. Although this is the national language, some people living in the area spoke only rudimentary Kiswahili and these were interviewed in Kisukuma by a Sukuma-speaking researcher. Informed consent of illiterate participants was obtained by an extended verbal explanation of the study and elicited verbal consent. The respondents chose the setting for the interview, in locations ranging from private homes to public cafés to workplaces. Interviewees were asked to recount their testing experience, their motivation for testing, the testing process and trajectory, and their views on the new Treat All strategy. Example questions included: 'Can you tell me about the day you tested, what convinced you to go to get tested? How did the counsellor do the test? (probe for the testing practice). What do you know about Treat All? (probe for health benefits and prevention benefits). All tools were translated into Kiswahili and pretested with volunteers to check for flow and comprehensibility. Because recruitment was excessively difficult, we limited pre-testing to a few participants per tool (both men and women).

Additionally, four focus group discussions were conducted with influential leaders from the community in the areas surrounding the urban and the rural health centre. These were chosen

with assistance from local chairmen. Discussions focused on the value of community-based testing campaigns, issues around mobilizing community members to test for HIV, and perceptions of the Treat All strategy.

Data analysis

Analysis took a two-step approach. Rapid interviews were initially analysed for testing characteristics of community-based testing campaign attendees. In addition to basic demographics, codes included 'number of previous tests and location of tests', 'reason to come for testing at the campaign'. Based on these interim findings, IDI guides were developed. All IDI were audio-recorded, and transcribed in Kiswahili by a trained data-transcriber and checked against the tape by the social scientists. They were all translated into English for the benefit of the wider study, but the social scientists analysed the Kiswahili version. IDI were analysed together with the observations and content of the rapid interviews. Content analysis was conducted using NVivo 12 Pro (QSR international, Doncaster, VC, Australia), since we were interested in the unexpected themes emerging from the data. The goal of our analysis was to understanding the meaning of themes, i.e., repeat testing, for different community groups, health professionals and the implementing organisation. A set of codes was developed by the first author (JK) and the Tanzanian social scientists (JM, TE) through an interactive process: Preliminary codes were based on the initial research objectives, subsequent codes were developed through a line by line reading of interviews were read line by line and a discussion of the meaning by the group, and a code was created. Main coding categories followed the trajectory of most clients: "Testing Experiences", including sub-codes such as testing trajectory, motivation for testing, re-testing, testing refusing, testing location, alternative treatment history, reaction HIV+ result. 'Counselling' included sub-codes such as client concerns, 'script'/language, counseling HIV+, counselling HIV-, reaction to HIV+ result, counselling practice, sero-discordancy.

The two Tanzanian social scientists reflected on their own positionality in weekly meetings with the lead social scientist. These included conversations about gender, language, age and how these informed rapport as well as conversations on the ethics of getting involved. In the analysis, several biases were acknowledged, including the sampling strategy for HIV-positive testers. Rather than selecting equal numbers of males and females, youth or older people, we sampled on categories of testing outcome: linked to care, not linked to care. Recruitment proved more difficult and time consuming than expected, especially amongst those not linked to care. The consequences of this is visible in the final sample of clients living with HIV, which in the rural area comprises more men than women. We addressed this bias by carefully analysing gender dynamics in testing decisions and decisions to link or not link to care after an HIV-positive test. Another bias constituted age. IDIs with HIV-negative clients of testing campaigns consisted of many older men and relatively few young women. We address this bias in age by looking at the historical time in which generations grew up and situating their answers in these time periods.

Results

Study participant characteristics

The total number of interviewees was 72, including people who were approached for a rapid interview (41, 2 HIV-positive) at testing campaigns and the people interviewed through an IDI (31, 23 HIV-positive). The interview data were complemented with 24 observations of outreach campaigns. Table 1 presents an overview of the testing characteristics of the participants of the rapid interviews.

Table 1. Testing characteristics participants rapid interviews (n = 41).

	Ngokolo (Urban)			Bugisi (Rural)		
	Male	Female	Total	Male	Female	Total
First time to test	2	1	4	1	2	3
Re-tested 1–3 times	4	7	11	0	5	5
Re-tested 4–9 times	4	3	7	5	3	8
Re-tested 10+ times	2	1	3	0	0	0
Unknown	1	0	1	0	0	0
Total	13	12	25	6	10	16

https://doi.org/10.1371/journal.pone.0261408.t001

Amongst the HIV-negative clients of the CBTC (41), 8 were first-time testers, most of whom were under 22 or over 50 years of age, with no difference in gender. The majority (33) of clients were 'repeat testers' who tested regularly, following the Tanzanian Ministry of Health guideline to test every three months when at risk and every six months to one year when not at risk. Re-testing is therefore considered normal practice under Treat All. Amongst the 33 'repeat testers', most had previously tested between 1 and 4 times. There were some exceptions: 3 repeat testers from the urban area had tested more than 10 times. Numbers were too small to indicate clear gender differences. Not presented in the table are some other characteristics of the participants of the rapid interviews. Most (30) of the CBTC clients we interviewed were married. Seventeen of the 41 participants tested for the first time through a community-based testing campaign, 21 had tested in a Health Facility for the first time, and 3 participants did not provide an answer. Amongst repeat testers, 14 had tested repeatedly at community-based testing campaigns; none could distinguish between CUAMM campaigns or campaigns organised by other organisations. Of the 8 HIV-negative clients who participated in a follow-up IDI, 5 were men, 4 of whom were over 50 years. Of the 3 women, 2 were in their mid-twenties.

Twenty-three IDI were conducted with 23 people who had tested HIV-positive in the outreach campaign. Of these 23, 10 (5 women, 5 men) were immediately linked to care following the Treat All strategy; 7 (6 women and 1 man) tested positive in the CBCT, but were not yet linked to care, or had linked to care but had dropped out. We additionally interviewed 6 people (5 women, 1 man), who re-tested in the outreach campaigns while already enrolled in an HIV treatment programme elsewhere (CUAMM testing registers showed that 13% of clients of CBTC were in fact already taking antiretroviral treatment). Table 2 presents the testing histories of the IDI participants who tested positive in the CBTC.

Amongst the 23 HIV-positive participants who tested positive in the CBTC, 10 were first-time testers, four had repeatedly tested before eventually testing positive; three already knew their status from a prior test but used the campaign to retest. Six positive clients were already enrolled in a treatment programme elsewhere. Of the 10 people who tested positive without having a prior awareness of their status through an earlier test, 5 were not yet linked to care or had initiated care but dropped out and were considering re-testing.

Table 2. Testing histories of IDI participants who tested positive in the CBTC (n = 23).

	Male	Female	Total
First-time testers in CBTC and being found HIV-positive	4	6	10
Repeat testers before being found HIV-positive	1	3	4
Repeat testers already aware of HIV-status but not linked to care	1	2	3
Repeat testers already on antiretroviral treatment	1	5	6

https://doi.org/10.1371/journal.pone.0261408.t002

Outreach testing convenience

Testing campaigns were generally experienced by study participants as an easy way to access HIV testing, creating the convenience of closer-to-home testing when compared to traveling to several hours-away healthcare providers, or, in the urban site where services are closer, in comparison to having to arrange a clinic-visit. Outreach-facilitated HIV testing could easily fit in with farming or other day-work in town, or with social visits to family or friends and did not require planning or transport costs:

> [. . .] If it's here [testing in the community, there's] no need for preparations. If you have the intention, you just go as you are, you only [have to] wash your feet. But if you are going to the government hospital or dispensary you need to get highly prepared: bathing, taking tea, then to find transport and fare. All these things make a person feel lazy.
>
> — *Male, 71, HIV-negative, repeat tester, urban site*

Many repeat HIV testers were acquainted with regular testing and expressed inspiration to test again after hearing announcements in the village, through word of mouth, or because they were passing by the testing tents.

Testing as a 'must': The routinization of testing

HIV-negative participants talked about testing in terms of 'controlling uncertainty'. Regular proof of negative status provided confidence, as one participant explained:

> I come from work and I test every now and then. I decided to pass by. . .The service gives you confidence in living without worries.
>
> — *Male, age unknown, married, sales supervisor, urban site, tested 12 times*

Repeat testers often framed testing as following advice from health services. This is likely a reflection of the fact that between 2004 and 2010 the national Angaza Zaidi campaign widely encouraged people who had tested HIV-negative to return after three months to confirm their negative status [12]

> We were informed by village leaders that health workers will come and test. When you are told to test every time, it is good to follow and respond. . .
>
> — *Female, 66, first-time tester, rural area*

In general, counsellors were following Tanzanian National AIDS Control guidelines and thus screened clients for potential risk behaviours. Based on such assessments, those getting tested were advised to return for a follow up test 1 month, 3 months, 6 months, or 1 year later. While interviewees said they were following advice, they also characterized regular testing as a 'need' or 'must'.

> I have a habit of testing regularly. I am told to retest every three months. I like the hospitality [of the testing campaign] and it was brought to my residence.
>
> — *Female, HIV-negative 24, student, unmarried, urban site, tested 4 times*

> I came to check that the virus truly is not in my body. Experts like you advise to test every three months. I tested 5 days ago at CUAMM; I was not told when to re-test again. I was

> given a card but left it at home. When I find a place where people test, I must test, it does not matter when the last time I tested. I heard the music. I like that I can easily check my health status around here in the community.
>
> *— Male, HIV-negative, 27, farmer, unmarried, rural site, tested 5 times*

Thus, HIV testing was framed as routine by counsellors in discussions with clients. Participants mentioned that testing was even a pre-requisite for membership in some organisations or for partaking in activities of that organisation. This was the case for a youth seminar held by a local organisation advocating entrepreneurial skills that often partnered with the implementing organisation:

> A young HIV-positive woman came to the testing campaign in town because of an entrepreneur workshop. While in the workshop, it was announced that everyone should go for testing, after which all her companions queued. She was unable to discuss this with a counsellor before entering the tent because she did not want others to know her status. She . . . was scolded by the counsellor for wasting resources.
>
> *Notes based on interview with 21-year-old woman, HIV-positive, tested while on ART, observation—urban site*

Religious institutions also stimulated testing, requiring it for marriage proceedings and for caretakers of young children. Despite these 'pressures to test', people were also routinely told that testing was an individual choice; interviewees emphasized that testing was their personal choice and that they had not been influenced by others.

Testing because of feeling 'at risk'

Interviewees' knowledge about the risk of sexual partnerships was a major motivations to test. Many told stories of being placed in risky situations because of their partners; this was true of HIV-positive and HIV-negative people, as well as married and unmarried people. Men mentioned having regular sexual relationships with women other than their wives or mistrusting a partner as reasons to test. Most women said they did not trust their partners, or they wanted to know their health status for future prevention: 'to stay safe and protect myself'. Stories were often offered in explanation for repeat testing.

> I mean, let me honestly tell you why I like to test. As I told you in the beginning, I am a woman who moves often. I can move from Shinyanga to Mwanza, then from Mwanza maybe I can move to Dodoma. I can meet with a man and have sex with him and he becomes my lover. You cannot know how that man lives, or whether he is safe or not because, young people of this generation, if you tell them: 'let's go and test', he tells you 'I am confident about myself'. So, you cannot know, you must have the courage to go to test.
>
> *— Female, 26, unmarried, HIV-negative repeat tester*

A feeling of risk was also influenced by the behaviour, health, or HIV-status of a sexual partner. When a partner would refuse to go for testing, this raised suspicion and could motivate someone to get tested.

> What pushed me most to go and test is because of the kind of husband that I am living with [. . .]. Because when I was telling him 'let's go for testing together', he'd refuse, saying he is

safe and, if it's about testing, I should go and test [alone]. So, then it was just my heart that kept on pushing me to go and test, just that.

— *Woman, 28, tested HIV-positive in campaign, linked to care*

In many of the interviews, testing was about monitoring, checking one's HIV status regularly. Public health messages, counsellors and healthcare providers promote regular testing, and interviewees knew that one 'good result' did not mean that one would stay HIV negative. While a negative status motivated people to 'stay safe' by emphasizing fidelity with their partners and using condoms with irregular partners, HIV-negative testers felt that 'being safe' was a temporary state. HIV-negative clients were told by counsellors that although they were 'safe today' they should continue to protect themselves.

Maybe previously the symptoms were not observable. You know the three months [between tests], you feel like, 'Maybe I was not yet. . .' Because they say: 'To be diagnosed it takes time'. So that's what makes me test every now and then, after being told after three months.

— *Male, 71, HIV-negative, repeated tester*

Feeling at risk was not just related to sexual partnerships. In the in-depth interviews, many noted they lived in an environment where sharp objects, bodily fluids through caring for HIV-positive relatives, or living together could put them at risk for infection. This was what motivated parents to test young children.

She [a 39-year-old woman bringing her children for testing] said 'If a child is cut with a sharp tool sometimes, they don't say at home. . . they might live with HIV infections without knowing, that is why I have brought them here to check their health status'. After the test results were negative the counsellor asked the parent to test them again in September next year.

Observation report, rural testing campaign, 180926

Shinyanga region has a highly mobile population, high rates of illiteracy, and high rates of early marriage. Because of these factors, counsellors advised those participating in testing campaigns to test every 3 months. However even clients who were not categorized as 'at risk' by counsellors, figured themselves at risk. Almost every family in Shinyanga had the experience of caring for a relative with HIV and observing the debilitating consequences of untreated HIV. In this general risk environment, having sexual relations and/or caring for those known to be HIV positive, but also everyday activities such as hand-washing clothes, which exposes people to the bodily fluids of people whose status is unknown, were mentioned as sources of worry. Repeated testing in this context was expressed as a way to maintain control in the face of uncertainty.

A 56-year-old man is a repeat tester. He enters the counselling tent and a conversation ensues in which it is clear that the man is not at much risk for infection: he reports to be married; he is 'done with extra relationships'. The counsellor suggests he come for testing once per year in the future and writes a test-date a year later, on the man's testing card. In the interview after this session the man is not happy. He states that he might run a risk for infection through engaging in farm work, going to hairdressers, and caring for HIV-positive people, and wants to check his health status every three months.

Interviewer: Don't you think that [..] you are not right, [that] it is like a waste of resources since you do not have any risk factors? [. . .]

Respondent: You may trust yourself that you are safe, but you never know what your partner has done, so of course that gives you worries. If you were alone then you could say: 'I am always here at my place', then ok.–*Male*, *71*, *HIV-negative*, *repeated tester*

Testing 'to know early'

Direct experiences of having close family members who waited too long to get tested and died of HIV/AIDS shaped ideas of risk for HIV-negative repeat testers. Most had participated in prolonged caregiving tasks and this experience motivated regular testing in order to identify HIV positive cases early enough and prevent becoming physically dependent on others. While young people tested because they had parents who were HIV-positive or other relatives who had died, many older people had had direct caring experiences and tested because they did not want to burden their families.

When I saw my aunt was sick, that's when I got the confidence to go and test because that disease is very bad. [. . .]When she went to test she was severely sick. When she started to take treatment, I don't know, it's like the medicines did not work or what. . . It did not even take a month before she died.

— *Female 26, HIV-negative, repeated tester*

The thing that makes me test every now and then is to know what exactly my current status is. If I learn I am not okay, I will hurry up for treatment [. . .]. What brings those feelings is the experience of living in a family. . . like if you have a family of many people, especially adults who are sick, that will make you hurry up for early testing.

— *Male, 62, HIV-negative, repeated tester*

In counselling sessions, starting treatment early is framed as being able to stay healthy and live life as normal. In Shinyanga, community members had hands-on experience with the devastating consequences of HIV. Stigma around HIV remains high because of its association with inevitable death, and multiple sexual partnerships. Early diagnosis and early start of treatment then is also associated with the ability to keep one's HIV status a secret and to die with dignity. But while living and dying with dignity was an important motivation for HIV testing, the main reason people gave for repeat testing was that it allowed people to continue living with hope; catching the disease early meant being able to better treat it. A 71-year-old HIV-negative man from urban Shinyanga, who had witnessed the death of many people and was taking care of orphaned children at the time of research, associated hope with early treatment:

It's not like you wait until when a person is weaker and weaker, but as soon as you are diagnosed, treatment begins. It helps. Rather than staying with the hope that 'I am still healthy, no problem', until when you are too weak to start, waiting for CD4 to decrease and start treatment. . .you are already discouraged and approaching death.

— *Male, 71, HIV-negative, repeat tester*

This same man was one of very few people who discussed early treatment as a form of prevention: 'It helps a lot, yes and when they are using (treatment) it helps not to transmit to the other'.

Community leaders also describe a change in the way HIV-testing has come to be seen in the age of Treat All: it has become unfashionable to suffer.

> At the moment a person gets to a stage where he cannot get out of bed because of HIV/AIDS, people nowadays call it suffering the 'old-fashioned way'. And it is an embarrassment, because nowadays people do not suffer in such a way. They'd rather test for HIV, then use medication and have a proper death. [. . .] So lately people in the community feel bad leaving their families with so many sorrows, with such a bad type of death. They'd rather test for the virus to avoid shame and a horrible death'.
>
> Focus group with community leaders, Shinyanga urban site, 180529

Early treatment initiation is thus also framed as a moral duty to remain healthy for the sake of planning one's life and out of responsibility towards family and one's partner.

Counsellors emphasize this message, especially to those diagnosed with HIV. They are told that the diagnosis does not mean the end of life and that by starting treatment early they can live a long and healthy life. Amongst those who tested HIV-positive through the campaign, the desire to start treatment early was clouded by fear of what treatment might mean for their everyday well-being. Antiretroviral drugs were recognized as 'strong medicines' and many remembered people who died just after starting medication. While the UTT message is widely spread and accepted in theory, the reality of starting treatment early is complicated.

> When you use treatment early you keep your body well, nothing will happen to you. Because if you delay, and there are also problems when you go severely [become severely sick] [. . .], everyone will surely know, eh, she was this [HIV-positive]. You know us Tanzanians? [. . .]. But when I am okay [healthy], like the way I am?, who will notice me? Nobody will notice. . .. I will start [medication].
>
> — *Woman, 25, HIV-positive, not linked to treatment*

Testing as 'proof'

A specific motivation for using the testing services at CBTCs was to prove knowledge about the virus' presence in the body to oneself or to one's partner. For young people, testing was related to the fear that parents might not tell youths if they had received a positive diagnosis. Testing was a means to gain knowledge.

> You might have been born with HIV, but you don't know your HIV status and maybe nobody is telling you. Therefore, it is good to test when those testing opportunities come around you in the community.
>
> — *Female, 16, first-time tester, rural site, observation 180905*

Some participants had already tested positive elsewhere but did not believe the result or needed time to come to terms with the results.

> Mmmh, let us say what influenced me: it's when I started living with a woman. The woman asked me to go for a test, then we decided to go and get tested. I was then found infected. After being diagnosed with the infection, honestly, I was not shocked or hurt so much. Instead I felt that maybe these people were deceiving me with their test kits, so we just ignored it. Two or three years later I tested for the second time to prove whether it was true

> or not. [. . .] When I was looking at how healthy I was and what they were telling me, being infected, for sure I did not believe it. The type of jobs I do, it is tough work, but I am managing it without any problems or falling sick.
>
> — *Male, 35, HIV-positive, linked to care, urban site*

People sometimes had trouble accepting an HIV-positive result when their bodily experience was of being healthy and strong, as many continued to associate HIV with a loss of strength and prolonged illness. Experiencing ill-health was a primary motivation for testing amongst clients that tested HIV-positive at the campaign, and again testing was used as a way to get proof.

> What motivated me was that I used to fall sick most of the time at home, sometimes diarrhoea, headaches. My wife said: 'let's go for testing'. There were some service providers [community testing campaign], that's why we came.
>
> — *Male, 45, HIV-positive, linked to care*

Some people retested, even though they were already enrolled in treatment. While one person tested to 'prove' to her disbelieving new partner that she was indeed HIV positive, tests were most often used to prove how the body was progressing on treatment, perhaps confusing the HIV test with viral load testing, or presuming that treatment could eventually result in a negative test outcome.

> I was sick, my body was not in its normal condition. [. . .] I said to myself that all people are going for testing, even those who have never tested before. [. . .] They also took me for testing. So, I decided to test too. [. . .] [The counsellor] told me that 'you have the HIV virus'. [. . .] I wanted to know if the viruses are decreasing.
>
> — *Female, 70, HIV-positive, tested while on treatment*

A final way that testing was used as proof was to confirm or deny HIV status in new relationships or as part of marriage proceedings.

> What made me go there was because I had a husband who died. I have been all alone and thought that I should get a partner to help me. So as days went on I got someone. [. . .] He was a pastor and even his fellow pastors told him to first get tested before proceeding with anything else. [. . .] He told me to wait until he comes [to Shinyanga], we would go for testing. But before he would come, I thought to myself that I would be ashamed if he would use transport fare, so I'd rather go for testing by myself first. So I went and tested and was found with that condition. I was infected.
>
> — *Female, 58, HIV-positive, Linked*

Discussion

The shift to Treat All as the standard of care in Tanzania in 2016 formed an important background to this study, because it encompassed a shift in practice: all people found to be HIV positive were to be directly initiated onto treatment, regardless of their health status. As part of Treat All, the government also rolled out the promotion of testing through the 2018 nationwide 'Furaha Yangu' campaign [13], which aimed at increasing testing especially amongst men and youth.

Within this broader context, this qualitative ethnographic study investigated the motivations of both HIV-positive and HIV-negative community members to test repeatedly through community-based outreach campaigns. We found that repeat testing for both groups was about proof: results could provide information about relationships, bodily sensations, and the workings of ART.

Amongst people who tested positive, our findings confirm those of previous studies amongst people living with HIV: repeat testing diminishes doubt about an earlier diagnosis or confirms suspicion about the cause of ill-health [14]. Clients who test positive while already on ART re-tested to settle doubts about their diagnosis or to see if the public health message that 'the virus goes to sleep' when on treatment was true. Our findings suggest that, in order to stimulate engagement with HIV services, counselling for people who test HIV-positive must address both doubt and the workings of ART explicitly, while also considering that accepting a positive diagnosis may take time.

For HIV-negative repeat testers, outreach campaigns, with their easy access, provided the means to address 'doubts' created by 'risky' situations, which spurred preventive behaviour and more repeat testing [15]. People's understandings of 'risk' differed from a public health understanding of risk as sexual transmission of HIV. For repeat testers, risk was related to uncertainty about partners in the context of high mobility, the presence of bodily fluids on everyday objects like clothes and sharps, and a history of witnessing suffering. For them, receiving an HIV-negative result provided temporary re-assurance. The message to screen regularly for HIV had been ingrained in the minds of many who participated in testing campaigns, and repeat testing was understood as following government advice. Counsellors and community leaders tasked with mobilization framed regular testing as a moral responsibility for health and family well-being: knowing early allowed one to preserve health, to not become a burden to one's family, and to die with dignity.

Susan Reynolds Whyte has described rapid diagnostic devices such as HIV tests as having 'social lives'; diagnostic devices are used for more than just diagnosis, they are used for different kinds of surveillance of bodies. Whyte and colleagues argue that the increasing use of diagnostic devices, tests to diagnose HIV and determine CD4-count, has become incorporated in people's understandings of the body (Whyte, 15-02-2017 Public lecture). The findings from this study build on their analysis. The 'proof' provided by tests is a form of self-surveillance of the bodies of HIV-negative and HIV-positive people, self-screening that is embedded in social dynamics and responsibilities, but it is also used as a kind of social currency in relationships. Participants of the testing campaigns 'transform' the public health goal of testing from case-finding and prevention, to self-screening and surveillance. In the evaluation of a public health intervention, such as community outreach testing, and whether it is effective, it is worth considering the parameters of 'effectiveness'. As Hardon and Dilger argue, AIDS treatment services are always transformed by users and local implementers to fit local needs [16].

The current shift away from general population testing, towards targeted testing of at-risk groups [17] and people in high-risk locales, makes sense if effectiveness is measured in terms of HIV-positive people found. Recent evidence from three African UTT trial sites show that contrary to expectation, general population testing has a limited effect on population-level HIV incidence [17]. Targeted approaches are therefore considered more cost-effective than general population testing, which is important considering the dwindling global funding for HIV treatment programmes [18].

While repeated testing may not seem cost-effective in the context of high ART coverage nor yield many new HIV cases, the rationale of HIV-negative repeat testers highlight important outcomes of testing campaigns beyond detecting new HIV cases. They show a wish for regular health monitoring, which is crucial for prevention [19].

UTT trials to date have found that proximity to services is a crucial factor in people's decisions to test repeatedly for HIV. Nearby services attract people with fewer economic resources [20] as well as those with increased risk exposure [21]. Before discouraging repeat testing out of concerns for cost-effectiveness or epidemiological reasoning, it is crucial to understand how community members engage with community-based testing campaigns, so that they may be tailored into a service that meets health-related needs that exceed HIV detection.

At the global level, there is a growing recognition that what is needed to identify the remainder of HIV cases is a community-based approach, where HIV testing and care services are tailored to the needs of, and identified by, specific groups of community members, and where HIV services may be integrated into broader health care services [22]. There is a growing consensus that while the uniqueness of the HIV response in including the right to health of often highly marginalized groups should be safeguarded [23], HIV services should increasingly be incorporated into UHC models. Routine health screening using such HIV outreach models offers great potential for the community management of hypertension and diabetes and other non-communicable diseases (NCDs), which are on the rise in Tanzania and for which the primary care system is ill-prepared [24]. Studies in both Tanzania and Uganda have shown the successful integration of HIV and NCDs screening [25]. While the discussion of UHC is currently dominated by financing considerations, the role of community engagement with health services and increasing trust between health service providers and communities is equally important [26, 27].

We find ourselves on the 'eve' of a shift in public health thinking about HIV, moving away from general population to more targeted approaches of individuals considered to be at risk. While this shift is underway, it is worth taking a step back and thinking about the potentially 'normalizing' and destigmatizing effects of population-wide screening for health beyond HIV. In other words, general population outreach programs originally started for HIV could be expanded to include more (wellness) services, including determination of risk factors for NCDs, like elevated blood sugar and blood pressure. This will allow for more timely diagnosis of patients who are chronically ill and prevent unnecessary UHC expenditures on NCDs when diagnosed (too) late. Moreover, there is a social price for targeted HIV testing (like index-testing), which may stigmatize members of epidemiologically defined risk groups, resulting in their 'hiding' from the formal healthcare system. There are ample examples of UTT approaches failing to reduce HIV incidence in Rwanda, Ethiopia, Botswana [17]. In this light and with our current data on community motivation to participate in HIV testing, we question whether the current phasing out of general population testing is wise considering the move towards UHC?

Conclusion

People who participate in HIV testing campaigns in remote Tanzania do so to monitor their health to achieve (temporary) reassurance, to alleviate feelings of being at risk due to suspicions about their partners, and out of feelings of responsibility. Tests are used as proof: to confirm a suspicion of ill health, to confirm an earlier diagnosis, and to gain general knowledge about the body. The implementation of community-based testing campaigns in Shinyanga and Simiyu Regions shows how an originally top-down public health approach has been repurposed by those who participated. Half of the clients reached by the campaigns were repeat testers, and the majority were HIV-negative. Repeat testers have internalized the general public health message that regular testing and knowing of one's health status is beneficial. Testing in the era of Treat All is also used to 'know early' and is thus framed in terms of social dignity and moral responsibility towards others. While community-based testing does not result

in identifying a sufficiently high number of new HIV cases, it does function as an important tool in routine health monitoring, one with great potential for integrating routine health screening on the way to UHC.

Supporting information

S1 File.
(ZIP)

Acknowledgments

We thank all our institutional collaborators, the study participants, the staff at the project clinical sites and laboratories, as well as the project support staff for their invaluable support to this program in general and the current manuscript in particular. The content of this manuscript is solely the responsibility of the authors and does not necessarily represent the official views of any of our implementing partners.

Author Contributions

Conceptualization: Josien de Klerk, Eileen Moyer.

Data curation: Judith Meta, Tusajigwe Erio.

Formal analysis: Josien de Klerk, Judith Meta, Tusajigwe Erio, Eileen Moyer.

Funding acquisition: Tobias Rinke de Wit.

Investigation: Judith Meta.

Methodology: Josien de Klerk, Judith Meta, Eileen Moyer.

Project administration: Josien de Klerk, Tobias Rinke de Wit.

Supervision: Josien de Klerk, Tobias Rinke de Wit, Eileen Moyer.

Validation: Arianna Bortolani.

Writing – original draft: Josien de Klerk, Tusajigwe Erio, Eileen Moyer.

Writing – review & editing: Josien de Klerk, Arianna Bortolani, Tusajigwe Erio, Tobias Rinke de Wit, Eileen Moyer.

References

1. Ministry of Health, Community Development, Gender, Elderly and Children, National AIDS Control Programmee. National Guidelines for the Management of HIV and TB. 6th edition [Internet]. Tanzania; 2017 Oct [cited 2021 Aug 10] p. 1–344. Available from: https://www.differentiatedservicedelivery.org/Portals/0/adam/Content/NqQGryocrU2RTj58iR37uA/File/Tanzania_NATIONAL%20GUIDELINES%20FOR%20MANAGEMENT%20OF%20HIV%20AND%20AIDS%206TH%20EDITION%202017.pdf
2. €UNAIDS. 90-90-90. An ambitious treatment target to help end the AIDS epidemic. [Internet]. Geneva: UNAIDS; 2014 Oct [cited 2020 Jul 1] p. 1–40. Report No.: JC2684. Available from: https://www.unaids.org/sites/default/files/media_asset/90-90-90_en.pdf
3. De Nardo, Pasquale, Bortolani, Arianna, Rinke de Wit, Tobias, Mfaume, R, Pellizer, Giovanni, Kihulya M. The implementation of Universal Test and Treat Programs: one-year experience from Test & Treat Project in Shinyanga and Simiyu Regions, Tanzania. Poster presented at the Amsterdam July 23–27 2018. In Amsterdam; 2018. Available from: https://www.aids2018.org/Portals/4/File/AIDS2018_Abstract_book.pdf?ver=2018-08-06-160624-427
4. Sharma M, Ying R, Tarr G, Barnabas R. Systematic review and meta-analysis of community and facility-based HIV testing to address linkage to care gaps in sub-Saharan Africa. Nature [Internet]. 2015

Dec [cited 2019 May 24]; 528(7580):S77–85. Available from: http://www.nature.com/articles/nature16044 https://doi.org/10.1038/nature16044 PMID: 26633769

5. Sabapathy K, Bergh RV den, Fidler S, Hayes R, Ford N. Uptake of Home-Based Voluntary HIV Testing in Sub-Saharan Africa: A Systematic Review and Meta-Analysis. PLOS Med [Internet]. 2012 Dec 4 [cited 2020 Jan 7]; 9(12):e1001351. Available from: https://journals.plos.org/plosmedicine/article?id=10.1371/journal.pmed.1001351 PMID: 23226107
6. ICAP. Tanzania Summary Sheet [Internet]. 2017. Available from: https://phia.icap.columbia.edu/wp-content/uploads/2017/11/Tanzania_SummarySheet_A4.English.v19.pdf
7. Tanzania 90-90-90 progress | Avert [Internet]. [cited 2020 Jan 7]. Available from: https://www.avert.org/infographics/tanzania-90-90-90-progress
8. Mahachi N, Muchedzi A, Tafuma TA, Mawora P, Kariuki L, Semo B, et al. Sustained high HIV case-finding through index testing and partner notification services: experiences from three provinces in Zimbabwe. J Int AIDS Soc [Internet]. 2019 Jul 19 [cited 2020 Jan 7]; 22(Suppl Suppl 3). Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6639671/ https://doi.org/10.1002/jia2.25321 PMID: 31321918
9. PEPFAR. U.S. President's Emergency Plan for AIDS relief. PEPFAR 2019 Country Operational Plan Guidance for all PEPFAR Countries [Internet]. PEPFAR; 2019 [cited 2020 Aug 10] p. 1–447. Available from: https://www.state.gov/wp-content/uploads/2019/08/PEPFAR-Fiscal-Year-2019-Country-Operationl-Plan-Guidance.pdf
10. Ministry of Health, Community Development, Gender, Elderly and Children. National Guidelines for the Management of HIV and AIDS, 6th edition [Internet]. 2017. Available from: http://www.nacp.go.tz/guidelines/
11. National Bureau of Statistics. Office of Chief Government Statistician President's Office. Population and Household Census 2012. Tanzania [Internet]. 2012 [cited 2021 Aug 10]. Available from: https://www.nbs.go.tz/index.php/en/regional-profiles
12. Meremo A, Mboya B, Ngilangwa D, Dulle R, Tarimo E, Urassa D, et al. Barriers to accessibility and utilization of HIV testing and counseling services in Tanzania: experience from Angaza Zaidi programme. Pan Afr Med J [Internet]. 2016 14 [cited 2020 Jan 7]; 23(189). Available from: https://www.panafrican-med-journal.com/content/article/23/189/full/
13. Conserve DF, Issango J, Kilale AM, Njau B, Nhigula P, Memiah P, et al. Developing national strategies for reaching men with HIV testing services in Tanzania: results from the male catch-up plan. BMC Health Serv Res [Internet]. 2019 May 20 [cited 2020 Jan 7]; 19(1):317. Available from: https://doi.org/10.1186/s12913-019-4120-3 PMID: 31109335
14. Wringe A, Moshabela M, Nyamukapa C, Bukenya D, Ondenge K, Ddaaki W, et al. HIV testing experiences and their implications for patient engagement with HIV care and treatment on the eve of "test and treat": findings from a multicountry qualitative study. Sex Transm Infect. 2017; 93(Suppl 3).
15. Harichund C, Kunene P, Simelane S, Abdool Karim Q, Moshabela M. Repeat HIV testing practices in the era of HIV self-testing among adults in KwaZulu-Natal, South Africa. PLoS ONE [Internet]. 2019 Feb 22 [cited 2020 Jan 7]; 14(2). Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6386490/ https://doi.org/10.1371/journal.pone.0212343 PMID: 30794580
16. Hardon A, Dilger H. Global AIDS Medicines in East African Health Institutions. Med Anthropol [Internet]. 2011 Mar 16 [cited 2020 Jan 6]; 30(2):136–57. Available from: https://www.tandfonline.com/doi/abs/10.1080/01459740.2011.552458 PMID: 21400350
17. Baral S, Rao A, Sullivan P, Phaswana-Mafuya N, Diouf D, Millett G, et al. The disconnect between individual-level and population-level HIV prevention benefits of antiretroviral treatment. Lancet HIV [Internet]. 2019 Sep 1 [cited 2020 Jan 7]; 6(9):e632–8. Available from: https://www.thelancet.com/journals/lanhiv/article/PIIS2352-3018(19)30226-7/abstract https://doi.org/10.1016/S2352-3018(19)30226-7 PMID: 31331822
18. Sarkar S, Corso P, Ebrahim-Zadeh S, Kim P, Charania S, Wall K. Cost-effectiveness of HIV Prevention Interventions in Sub-Saharan Africa: A Systematic Review. EClinicalMedicine [Internet]. 2019 May 20 [cited 2020 Jan 7]; 10:10–31. Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6543190/ https://doi.org/10.1016/j.eclinm.2019.04.006 PMID: 31193863
19. Orne-Gliemann J, Zuma T, Chikovore J, Gillespie N, Grant M, Iwuji C, et al. Community perceptions of repeat HIV-testing: experiences of the ANRS 12249 Treatment as Prevention trial in rural South Africa. AIDS Care. 2016; 28 Suppl 3:14–23.
20. Abongomera G, Kiwuwa-Muyingo S, Revill P, Chiwaula L, Mabugu T, Phillips A, et al. Population level usage of health services, and HIV testing and care, prior to decentralization of antiretroviral therapy in Agago District in rural Northern Uganda. BMC Health Serv Res [Internet]. 2015 Nov 28 [cited 2020 Jan 7]; 15(1):527. Available from: https://doi.org/10.1186/s12913-015-1194-4
21. Ostermann J, Reddy EA, Shorter MM, Muiruri C, Mtalo A, Itemba DK, et al. Who Tests, Who Doesn't, and Why? Uptake of Mobile HIV Counseling and Testing in the Kilimanjaro Region of Tanzania. PLOS

ONE [Internet]. 2011 Jan 31 [cited 2020 Jan 7]; 6(1):e16488. Available from: https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0016488

22. Fakoya AO, Dybul MR, Sands P. Getting local: focusing on communities to achieve greater impact in the next phase of the HIV response. J Int AIDS Soc [Internet]. 2019 [cited 2020 Jan 7]; 22(7):e25366. Available from: https://onlinelibrary.wiley.com/doi/abs/10.1002/jia2.25366 PMID: 31321872

23. Ooms G, Kruja K. The integration of the global HIV/AIDS response into universal health coverage: desirable, perhaps possible, but far from easy. Glob Health [Internet]. 2019 Dec [cited 2020 Jan 26]; 15 (1):41. Available from: https://globalizationandhealth.biomedcentral.com/articles/10.1186/s12992-019-0487-5 PMID: 31215446

24. Peck R, Mghamba J, Vanobberghen F, Kavishe B, Rugarabamu V, Smeeth L, et al. Preparedness of Tanzanian health facilities for outpatient primary care of hypertension and diabetes: a cross-sectional survey. Lancet Glob Health [Internet]. 2014 May [cited 2020 Jan 7]; 2(5):e285–92. Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4013553/ https://doi.org/10.1016/S2214-109X(14)70033-6 PMID: 24818084

25. Chamie G, Clark TD, Kabami J, Kadede K, Ssemmondo E, Steinfeld R, et al. A hybrid mobile approach for population-wide HIV testing in rural east Africa: an observational study. Lancet HIV [Internet]. 2016 Mar [cited 2019 May 24]; 3(3):e111–9. Available from: https://linkinghub.elsevier.com/retrieve/pii/S2352301815002519 https://doi.org/10.1016/S2352-3018(15)00251-9 PMID: 26939734

26. Allotey P, Tan DT, Kirby T, Tan LH. Community Engagement in Support of Moving Toward Universal Health Coverage. Health Syst Reform [Internet]. 2019 Jan 2 [cited 2020 Jan 7]; 5(1):66–77. Available from: https://doi.org/10.1080/23288604.2018.1541497 PMID: 30924744

27. Jay J, Buse K, Hart M, Wilson D, Marten R, Kellerman S, et al. Building from the HIV Response toward Universal Health Coverage. PLOS Med [Internet]. 2016 Aug 16 [cited 2020 Jan 7]; 13(8):e1002083. Available from: https://journals.plos.org/plosmedicine/article?id=10.1371/journal.pmed.1002083 PMID: 27529809

Application of Infection Prevention and Control Assessment Framework (IPCAF) tool in 13 hospitals in Sub Saharan Africa

POSTER PRESENTATIONS

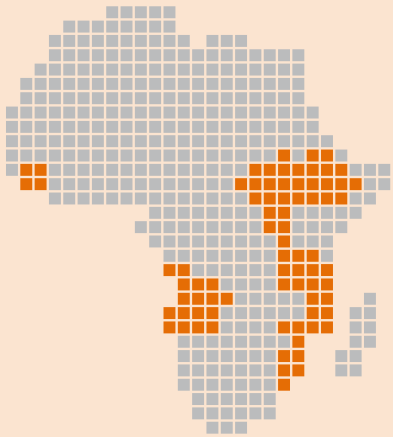
Conference
12th European Congress on Tropical Medicine and International Health (ECTMIH)

Location
Virtual from Bergen, Norway

Presentation date
28 September – 1 October 2021

Authors
Pellizzer G.

Focus country
Multi-countries



Reaching 90-90-90 in the municipality of Kilamba Kiaxi, Luanda, Angola. The experience of PIPSA project

POSTER PRESENTATIONS

Conference
13° Italian Conference on AIDS and Antiviral Research (ICAR 2021)

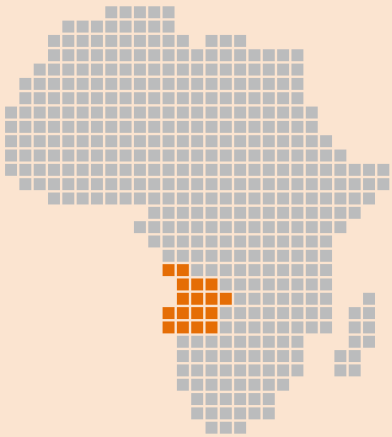
Location
Riccione, Italy

Presentation date
21 – 23 October 2021

Authors
Natali G , Da Silva S., Tembe Y., Almeida T. , Lomba Jamba T., Baldoni T. , Nigro L. for the PIPSA Group

Link
www.icar2021.it/download/AbstractBook.pdf

Focus country
Angola



Epidemiology / Social Sciences III

OP 78 REACHING 90-90-90 IN THE MUNICIPALITY OF KILAMBA KIAXI, LUANDA, ANGOLA. THE EXPERIENCE OF PIPSA PROJECT

G. Natali[1], S. Da Silva[2], Y. Tembe[2], T. Almeida[3], T. Lomba Jamba[4], T. Baldoni[1], L. Nigro[2,5] for the PIPSA Group. The PIPSA Group: E. Do Nascimento, M, Silvestre, S. Rocca, J. Bengui, M. Cardoso, U. Fernandes, M. Fundumuca, B. Gaspar, P. Kalandula, T. Mambo, C. Salvador, R. Salvador, J. Vemba, J. Massango, N. Comandante, B. Gonçalves P. João, M. Miguel, N. Cardoso

[1]Unione Medico Missionaria Italiana, Negrar, Italy, [2]Cuamm - Medicos com Africa, Luanda, Angola, [3]Gabineto Provincial de Saúde, Luanda, Angola, [4]Repartição Municipal de Saúde, Kilamba Kiaxi, Luanda, Angola, [5]LHIVE Diritti e Prevenzione, Catania, Italy

Background: Since 2018 the Angolan government has undertaken the "test and treat" policy to realize the UNAIDS HIV/AIDS target of 90-90-90.
To date, despite the availability of antiretroviral therapy (ART), in sub-Saharan countries adherence is not optimal and people, often, abandon therapy.
In this context an "HIV Prevent/Test/Treat" program, aimed to comunity, to provide information on HIV, increase HIV counseling and testing and support those who tested positive was implemented (PIPSA project).
The project takes place in the municipality of Kilamba Kiaxi, Luanda, and this study was carried out in three health centers, (Palanca II, Kilometro 9A and Whegi Maka).
Methods and materials: Ten community activists, three nurses and a psychologist were recruited and trained.
Activists, daily, go to clinics and use peer-oriented intervention to: inform persons about HIV prevention and importance of getting tested; test persons who agree to be tested; follow up and support, through counseling, those who tested positive in initiating ART.
Address and telephone numbers of the positive persons are recorded, then the activists perform home visits and phone calls to HIV-positives to reinforce them on the importance of: adhering and retain themselves in care; not abandoning ART; and to disclose HIV status to sexual partner and relatives. Some persons, on a team decisions basis, receive more home visit.
In addition, the nurses of the project call people who have missed the visit to book another appointment and the doctor carries out a weekly visit in each center.
Objective: Follow up of people tested positive from november 2018 to august 2020.
Results: During the project observation period: 890 persons tested positive; activists carried out 2094 home visits and 11040 phone calls; nurses made 3548 phone calls; and doctor performed 382 visit.
The results of follow up are showed in Table 1 and 2.
Conclusions: Several studies carried out in sub-Saharan countries have investigated the factors that prevent adherence to ART among PLWHA. Mobility is the first barrier and is due to economic insecurity and social precariousness. Other barriers are stigma, side effects of ART, difficulties in reaching the health center, lack of information, assistance and support and negligence. Improving support of HIV-positive people, through the interventions of community activists (peer operators) and the emotional interest of nurses, psychologists and doctors, may achieve strong reduction in the abandons of therapy and high retention in care rate (90%).
Our observation has several biases, the most important of which are the shortness of the observation time and the fact that the persons in treatment lived fairly close to the health center.
The PIPSA (Integral Protection of Seropositive People in Angola) project is funded by Agenzia Italiana per la Cooperazione e lo Sviluppo and is carried out by Unione Medico Missionaria Italiana and CUAMM - Medici con l'Africa.

Attach: https://www.icar2021.it/public/abstract/Attach_ABS_69.jpg

Prevalence of HIV infection in the PIPSA project carried out in Luanda, Angola. Data analysis by sex and age group

ORAL PRESENTATION

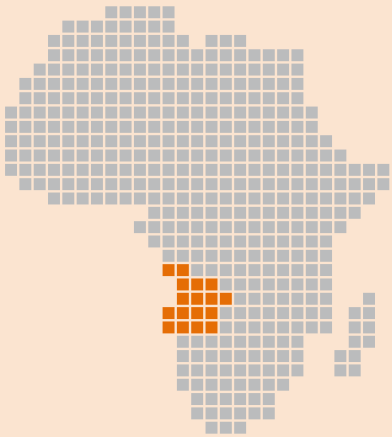
Conference
13° Italian Conference on AIDS and Antiviral Research (ICAR 2021)

Location
Riccione, Italy

Presentation date
21 – 23 October 2021

Authors
Baldoni T.

Focus country
Angola



Nutrition

Effectiveness of screening and treatment of children with severe acute malnutrition by community health workers in Simiyu region, Tanzania: a quasi-experimental pilot study

PAPER

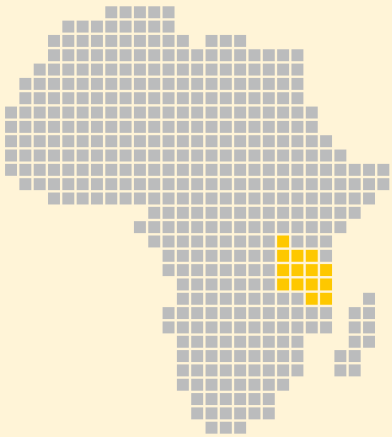
Authors
Wilunda C., Mumba F.G., Putoto G., Maya G., Musa E., Lorusso V., Magige C., Leyna G., Manenti F., Dalla Riva D., Ntoga B.A., Segafredo G.

Published in
Nature Scientific Reports, January 2021

Link
https://doi.org/10.1038/s41598-021-81811-6

Topic
Nutrition

Focus country
Tanzania



www.nature.com/scientificreports

scientific reports

OPEN

Effectiveness of screening and treatment of children with severe acute malnutrition by community health workers in Simiyu region, Tanzania: a quasi-experimental pilot study

Calistus Wilunda[1,2]✉, Fortihappiness Gabinus Mumba[3], Giovanni Putoto[4], Gloria Maya[3], Elias Musa[3], Vincenza Lorusso[3], Chacha Magige[5], Germana Leyna[6], Fabio Manenti[4], Donata Dalla Riva[4], Bupe Abel Ntoga[6] & Giulia Segafredo[3]

Health system constraints hamper treatment of children with severe acute malnutrition (SAM) in Tanzania. This non-inferiority quasi-experimental study in Bariadi (intervention) and Maswa (control) districts assessed the effectiveness, coverage, and cost-effectiveness of SAM treatment by community health workers (CHWs) compared with outpatient therapeutic care (OTC). We included 154 and 210 children aged 6–59 months with SAM [mid-upper arm circumference (MUAC) < 11.5 cm] without medical complications in the control and intervention districts, respectively. The primary treatment outcome was cure (MUAC ≥ 12.5 cm). We performed costing analysis from the provider's perspective. The probability of cure was higher in the intervention group (90.5%) than in the control group (75.3%); risk ratio (RR) 1.17; 95% CI 1.05, 1.31 and risk difference (RD) 0.13; 95% CI 0.04, 0.23. SAM treatment coverage was higher in the intervention area (80.9%) than in the control area (41.7%). The cost per child treated was US$146.50 in the intervention group and US$161.62 in the control group and that per child cured was US$161.77 and US$215.49 in the intervention and control groups, respectively. The additional costs per an additional child treated and cured were US$134.40 and US$130.92, respectively. Compared with OTC, treatment of children with uncomplicated SAM by CHWs was effective, increased treatment coverage and was cost-effective.

Severe acute malnutrition (SAM), defined as weight-for-height Z score < − 3 based on WHO child growth standards, directly affects 14 million children younger than five years globally[1]. However, this figure underestimates the annual SAM burden because it is based on prevalence data[2]. More than 90% of children with SAM reside in low- and middle-income countries[3] where fragile health systems struggle to improve coverage and quality of health care, and climate change is expected to exacerbate the already food insecure situation[4]. SAM increases the risk of child mortality by more than 11-fold[3]. Therefore, there is an urgent need to develop scalable and sustainable strategies to address the problem of SAM in these settings.

In the last two decades, the model to address treatment of SAM shifted from centralized small-scale inpatient treatment to the establishment of decentralized outpatient therapeutic feeding programs through the implementation of the Community Management of Acute Malnutrition (CMAM)[5]. The key strategy of CMAM is the identification of children with SAM by community health workers (CHWs) or volunteers, referral of such children

[1]Maternal and Child Wellbeing Unit, African Population and Health Research Center, APHRC Campus, 2nd Floor, Manga Close, Off Kirawa Road, P.O. Box 10787, Nairobi 00100, Kenya. [2]Epidemiology and Prevention Group, National Cancer Center, Tokyo 104-0045, Japan. [3]Doctors with Africa CUAMM, Simiyu 39101, Tanzania. [4]Doctors with Africa CUAMM, 35100 Padua, Italy. [5]Simiyu Regional Medical Officer's Office, Simiyu 39101, Tanzania. [6]Tanzania Food and Nutrition Centre, Dar es Salaam 11101, Tanzania. ✉email: calistuswilunda@yahoo.co.uk

to health facilities for assessment by professional health workers, and outpatient or inpatient treatment of the undernourished children. This strategy was designed to improve treatment outcomes and coverage through early detection and early treatment initiation of malnourished children. However, a review of 44 CMAM programs in 21 countries showed that most of them did not reach the minimum coverage standards set by the Sphere project (i.e. 50%, 70% and 90% for rural, urban, and camp settings, respectively)[6]. The most important barrier to access was lack of engagement with beneficiary communities[7], suggesting that the current service delivery model is unable to provide the level of access required by beneficiary communities. Thus, innovative delivery strategies—especially community-based delivery platforms—for the scale-up of SAM services are urgently needed[8].

A national nutrition prevalence survey in 2014 found that 4.5% of children in Tanzania had acute malnutrition, with 1.2% having SAM[9]. The country is currently implementing CMAM with community health workers (CHWs) playing a key role in this, although they are not officially integrated in the national health system because they work as volunteers without official remuneration and a scheme of service. Health facilities with units for treatment of malnutrition are often located in towns, creating problems in access to care due to long distances from households to health facilities and between health facilities, weak links between the community and facilities in referring malnourished children, and indirect costs. There are also health system constraints such as staff shortages, limited training and supervision, and lack of necessary equipment and ready to use foods that hamper the management of acute malnutrition[10]. The result is a low coverage of SAM services, a high relapse rate, and a high case fatality rate that is above the acceptable range of 5–10% [10].

Studies from Africa[11,12] and Asia[13] show that malnourished children with no complications treated at home by CHWs have a higher cure rate and lower default rate than those treated in health facilities. There is also evidence that CHWs can deliver good quality care[14] and using them to treat SAM is cost-effective[15]. However, there is no local evidence from Tanzania where the role of CHWs is limited to screening and referring malnourished children to health facilities for treatment. The current national guidelines for Integrated Management of Acute Malnutrition stipulate timely detection of SAM in the community and provision of treatment for those without medical complications with ready-to-use therapeutic foods (RUTF) or other nutrient-dense foods through outpatient therapeutic care (OTC)[10].

To improve access to treatment of SAM, Doctors with Africa *Collegio Universitario Aspiranti Medici Missionari* (CUAMM), an Italian non-governmental organisation operating in Tanzania since 1968, piloted a model to screen and treat children with SAM without complications using CHWs. This pilot study was nested within a large four-year project named "The Next Generation Programme—Integrated Promotion of Nutrition, Growth and Development" in Simiyu and Ruvuma regions funded by Children's Investment Fund Foundation. This study aimed to assess the effectiveness and cost-effectiveness of treatment of SAM by CHWs, and the effect of this intervention on SAM treatment coverage.

Methods

Study setting. This study was conducted in Simiyu Region, northern Tanzania, where in 2018, 4.6% of children were acutely malnourished with 0.5% being severely acutely malnourished[16]. According to the 2012 census, Simiyu Region had a population of about 1.6 million inhabitants and was divided into five districts. In consultation with the local health authorities, three rural wards (Sakwe, Ihusi and Mwadobana) in Bariadi District and three rural wards (Malampaka, Busilili, Shishiyu) in Maswa District were selected purposively as intervention and control areas, respectively. In selecting the intervention and control areas, the following factors were considered: study logistics, distance between the two areas to minimize contamination, comparability between the two areas in terms of the population size, expected number of SAM cases, and health infrastructure—number of CHWs working on the Next Generation Programme, number of health facilities, and distance between wards and SAM treatment centres. The intervention wards had a population of about 45,200 people distributed in 11 villages and served by 13 CHWs, three dispensaries and one health centre. The control wards had a population of about 35,800 people distributed in nine villages and served by 11 CHWs, three dispensaries and one health centre.

Study design and participants. This is a parallel two-arm non-inferiority quasi-experimental pilot study. All children aged 6–59 months with SAM and without medical complications were eligible for inclusion if their primary caretakers provided consent. Eligible children were recruited in the community by CHWs in the intervention wards or by formal health workers in health facilities in the control wards. Only children with good appetite, without severe oedema and no underlying medical condition and/or complications were eligible for enrolment in the study. In the intervention area, CHWs screened children for SAM by measuring their mid-upper arm circumference (MUAC) and those with MUAC < 11.5 cm or mild/moderate oedema were classified as having SAM and treated at home using RUTF, with the dosage based on a child's body weight. CHWs followed up enrolled children through weekly home visits to replenish their RUTF and to monitor their progress by assessing their weight, MUAC, and medical symptoms.

In the control wards, CHWs screened and referred malnourished children to nearby health facilities for treatment by health workers according to the standard national guidelines[10]. Caretakers could also take their children directly to health facilities. Health workers enrolled children in the study using criteria similar to that used in the intervention district. Supplemental Fig. S1 shows the flow chart used in this study (adapted from national guidelines[10]) for screening and management of children with acute malnutrition by CHWs. All enrolled children were followed up—either by CHWs in the intervention wards or health care workers through OTC clinics in the control wards—until they exited the study after experiencing one of the study outcomes.

Prior to the intervention, CHWs and their supervisors (who included the program staff and health facility staff who usually supervise CHWs in their catchment areas) were adequately trained to screen and manage

children with SAM. The training, which covered both theory and practice, was delivered by nutritionists from the Tanzania Food and Nutrition Centre and aimed to impart knowledge and skills in management of SAM among children younger than five years old at the community level. CHWs and their supervisors from the intervention area received further training on home treatment of children with SAM without medical complications.

Study outcomes and data collection. We defined study outcomes in a standard way in both the intervention and control groups. The primary study outcome was cure from SAM, defined as MUAC ≥ 12.5 cm. The secondary study outcomes were default, defined as absence on three consecutive visits; non-response, defined as failure to attain discharge criteria after three months on treatment; transfer to inpatient therapeutic care (ITC); or death. The criteria for ITC transfer were loss of appetite, development of medical complications, development of oedema, weight loss or static weight on three consecutive visits, and request by the caregiver. Other secondary outcomes were length of stay, defined as the number of days from treatment initiation to recovery and average weight gain, defined as weight change (g per kg per day) from treatment initiation to recovery. Baseline maternal and child's sociodemographic data (child's sex and age; mother's vital status, age, education, and household wealth variables) and child's physical assessment and health status data (MUAC, weight, exposure to HIV, type of admission, and presenting symptoms) were collected at enrolment. Child's MUAC, weight and the amount of RUTF dispensed were recorded at each weekly visit. All collected data were recorded in case report forms contained in an enrolment and follow-up register. Children were enrolled into the study from August 2018 to December 2019 in the intervention group and from August 2018 to February 2020 in the control group. Follow-up ended on 26 March 2020.

We obtained data to estimate coverage from SAM registers in health facilities in the control wards and from CHWs in the intervention wards. We also reviewed SAM registers at three health facilities (Maswa, Somanda and Songambele) offering ITC in the study districts and counted all children from the study wards who were treated in these health facilities. The main source of cost data was the accounting records of Doctors with Africa CUAMM (the implementing agency). We collected additional cost data on human resources (salaries and time allocation), capital and consumables using a questionnaire administered to health facility staff in the control areas.

Sample size. We estimated the minimum required sample size of 258 (129 per group) assuming that treatment of children with SAM by CHWs was non-inferior compared to treatment of children with SAM in health facilities, an overall proportion of cured children in both arms of 88% (pi = 0.88), a non-inferiority margin of 10% (delta = 0.1), a power of 80%, and a one-sided alpha of 0.025. We used the *ssi* module in Stata (College Station, TX, USA) to calculate the sample size.

Data management and analysis. *Effectiveness analysis.* Data were entered in EpiData in duplicate, validated and exported to Stata 15 for cleaning and analysis, which was performed based on the intention-to-treat principle. Characteristics of participants were summarized using descriptive statistics and differences between intervention and control groups were compared using independent samples t-tests (for continuous variables) or chi-squared tests (for categorical variables). Six children in the control group had missing outcome data because follow-up ended before we could ascertain their outcomes, thus, we performed both complete-case analysis and analysis after multiple imputation to account for the missing data. We used multiple imputation with chained equations with 20 iterations based on all maternal and child characteristics listed in Table 1. We calculated risk ratios (relative effects) and risk differences (absolute effects) with 95% CIs for cure and default using Poisson regression models with robust error variances[17]. We assessed the effect of the intervention on length of stay and weight gain using linear regression to obtain mean differences with 95% CIs. We adjusted the models for variables that showed some imbalance ($P < 0.1$) between control and invention groups. Estimates across imputed datasets were automatically combined using Rubin's rules[18]. To evaluate non-inferiority of the intervention compared to the usual care, we compared the lower bound of the 95% CI for the effect of the intervention on cure with the pre-specified non-inferiority margin (− 10%). We did not assess the effect of the intervention on death, transfer and non-response to treatment because of a small number of observations.

Because the results of both multiple imputation and complete-case analysis may be biased given that only the control group had children with missing outcome data, we performed sensitivity analysis (using the same approach as above) after excluding 31 children enrolled in the study during the same period as the children with missing data (i.e. after 28th December 2019). In other words, we restricted the analysis to only those children we could have potentially followed up for the maximum follow-up period of three months.

Coverage analysis. The effect of the intervention on coverage, defined as the proportion of the children with SAM being reached with treatment in the intervention and control wards, was assessed using data on the number of children treated over a 12-month period from September 2018 to August 2019. We estimated coverage using an indirect method by dividing the number of children aged 6–59 months with SAM who received treatment (including ITC) by the expected number of children aged 6–59 months with SAM over the reference period (the annual SAM burden). Where $AnnualSAMburden = numberofchildren6-59months * SAMprevalence * (1 + K)$; K being the incidence correction factor, whose value was assumed to be 4.82 based on a meta-analysis of studies from three West African countries[19] (similar data for Tanzania/East Africa are not available). We used a SAM prevalence 0.5% for Simiyu Region based on the National Nutrition Survey 2018[16]. To estimate the effect of the intervention on coverage, we calculated both relative and absolute changes in coverage.

Cost-effectives analysis. We performed cost-effectives analysis from the provider's perspective. The time horizon was 1 year: from September 2018 to August 2019. We calculated costs using the activity-based costing

Characteristics	Control (N = 154)	Intervention (N = 210)	P-value
Child's sex			0.622
Male	70 (45.5)	90 (42.9)	
Female	84 (54.5)	120 (57.1)	
Child's age, months	15.1 ± 7.8	15.0 ± 8.5	0.983
MUAC, cm	11.0 ± 0.7	11.1 ± 0.5	0.156
Weight, kg	6.7 ± 1.3	6.7 ± 1.2	0.702
Exposed to HIV			< 0.001
No	116 (75.3)	181 (86.2)	
Yes	28 (18.2)	10 (4.8)	
Not known	10 (6.5)	19 (9.1)	
Mother alive			0.146
No	7 (4.6)	4 (1.9)	
Yes	147 (95.5)	206 (98.1)	
Caretaker's age, years	29.0 ± 9.8	27.5 ± 8.5	0.177
Mother's education			0.382
None	46 (30.5)	77 (37.8)	
Primary	101 (66.9)	123 (60.3)	
Secondary +	4 (3.7)	4 (2.0)	
Missing	3	6	
Household wealth index[a]			< 0.001
Lowest	53 (34.4)	26 (12.4)	
Second	20 (13.0)	47 (22.4)	
Middle	18 (11.7)	57 (27.1)	
Fourth	22 (14.3)	51 (24.3)	
Highest	41 (26.6)	29 (13.8)	
Type of admission			0.431
New admission	144 (93.5)	198 (94.3)	
Re-admission	4 (2.6)	8 (3.8)	
Transfer from ITC	6 (3.9)	4 (1.9)	
Poor appetite	42 (27.3)	44 (30.0)	0.161
Cough	35 (22.7)	38 (18.1)	0.276
Vomit	13 (8.4)	14 (6.7)	0.523
Diarrhoea	28 (18.2)	29 (13.8)	0.257
Fever	39 (25.3)	34 (16.2)	0.032
Skin abnormality	12 (7.8)	13 (6.2)	0.551

Table 1. Characteristics of study participants at recruitment. Data are presented as n (%) for categorical variables or Mean ± SD for continuous variables. [a]Derived using principal components analysis of household assets, access to utilities and type of housing material.

method by identifying the activities of the project, determining the cost of each activity and calculating the overall and unit costs. Cost analysis focused on treatment of children with SAM without complications at the ward level. Thus, we did not consider ITC costs. We included costs related to sensitization and mobilization, training of CHWs and their supervisors (transportation of trainers, training hall and meals, and per diems), supervision and monitoring (fuel costs and per diems), personnel costs (staff salaries and benefits, and incentives for CHWs and supervisors), consumables (RUTF purchase and transportation, photocopying and binding, drugs, bicycle maintenance and spare parts) and capital costs (weighing scales, thermometers, MUAC tapes, clinic furniture, and room rent). The quantity of RUTF dispensed was as reported in the child enrolment and follow-up register (from admission to discharge). Personnel costs were adjusted for time spent on the project. All costs were expressed in 2019 US dollars (1 TZ = 0.0004 US$). Capital items (any item that can be used for more than one year), were annualized using a 3% interest rate and corresponding useful life. The same strategy was used in estimating the cost of sensitization/mobilization and trainings. We computed the unit cost i.e. cost per child treated and cost per child cured. In addition, we calculated incremental cost-effectiveness ratio (ICER) by dividing the difference in costs incurred in the intervention and control areas by the difference in the number of children treated or cured in the intervention and control areas (i.e. $C_1 - C_0/E_1 - E_0$). We analysed the data using Microsoft Excel.

Outcome	Control		Intervention (N = 210)
	Missing outcomes excluded (N = 148)	Missing outcomes imputed (N = 154)	
	n (%)	n (%)	n (%)
Cured	112 (75.7)	116 (75.3)	190 (90.5)
Defaulted	31 (21.0)	32 (20.8)	13 (6.5)
Transferred to ITC	3 (2.0)	3 (2.0)	3 (1.4)
Died	1(0.7)	1 (0.7)	2 (1.0)
No response	1 (0.7)	2 (1.3)	2 (1.0)
Length of stay (days)[a]	30.8 ± 18.6	31.0 ± 18.4	34.3 ± 18.2
Average weight gain (g/kg/day)[a]	6.4 ± 4.3	6.3 ± 4.3	6.3 ± 3.9

Table 2. Treatment outcomes. [a]Applies to cured children only. Data presented as Mean ± SD.

Ethical considerations. The National Health Research Ethics Committee at the National Institute of Medical Research, Tanzania (NIMR/HQ/R.8a/Vol.IX/2532) approved the study protocol. This study complied with the ethical standards set by the National Health Research Ethics Committee on research regarding human subjects and with the Helsinki Declaration. Written informed consent was obtained from caretakers of all participating children before recruitment. This study was registered in the Pan African Clinical Trial Registry (Trial number PACTR201901856648139) on 21/12/2018.

Disclaimer. Views expressed in this study are solely those of the authors and do not necessarily represent the official position of Doctors with Africa CUAMM or Children's Investment Fund Foundation.

Results

Three hundred and sixty four children (154 in the control group and 210 in the intervention group) were recruited in the study. In the intervention group, all recruited children were followed up until they exited the study according to the protocol. However, in the control group, the study ended before outcomes for six children (3.9%) could be ascertained. Overall, children in the intervention group were followed up for a median of 6 weeks [interquartile range (IQR) 5–8] while those in the control group were followed up for a median of 4 weeks (IQR 3–5). Table 1 shows the characteristics of the study participants at recruitment by study arm. More than half of the children (54.5% in the control group and 57.1% in the intervention group) were female. Overall, children in this study had a mean MUAC of 11 cm, a mean weight of 6.7 kg and more than 93% were new admissions. There was no statistically significant difference between the control and intervention groups with respect to most of the children's and maternal characteristics including child's age; sex; MUAC; and weight, mother's age; vital status; and education, and type of admission. Significant differences were observed for HIV exposure status, wealth index and fever. Children in the control group were more likely to have been exposed to HIV and to have fever than those in the intervention group. Most of the children in the control group were in the lowest (34.4%) and highest (26.6%) wealth quintiles. On the contrary, in the intervention group, the middle wealth quintile had the highest the proportion of children (27.1%).

Treatment outcomes. Treatment outcomes were similar in the control group with or without imputation of missing outcomes (Table 2). Cure rate was higher in the intervention group (90.5%) than in the control group (75.7%) while defaulter rate was higher in the control group (21.0%) than in the intervention group (6.5%). Only a small number of children were transferred to ITC, died, or did not respond to treatment. The two deaths reported in the intervention area occurred while the children were under the care of professional health workers after being referred by CHWs because of illness. Length of stay was slightly higher in the intervention group (34.3 days) than in the control group (30.8 days) but children in both groups had similar average weight gain (6 g/kg/day).

Effect of the intervention on treatment outcomes. Table 3 shows that after adjustment for wealth index, exposure to HIV, and fever at baseline, children in the intervention group were more likely to be cured than those in the control group (RR 1.17, 95% CI 1.05, 1.31 and RD 0.13; 95% CI 0.04, 0.23). In line with this, the probability of defaulting was significantly lower in the intervention group than in the control group (RR 0.29, 95% CI 0.15, 0.56 and RD − 0.16; 95% CI − 0.23, − 0.08). Accounting for missing outcomes through imputation did not materially change the effect estimates. The intervention did not have a statistically significant effect on length of stay or weight gain before or after adjustment for potential confounders (Table 3).

Based on the pre-specified non-inferiority margin of 10% (RD − 0.1), the intervention was non-inferior compared to the usual care: the lower bound of the 95% CI for the RD (0.5%) is above the non-inferiority margin (Fig. 1). Because the 95% CI excludes the null value, the intervention was also superior compared to the usual care.

Sensitivity analysis after excluding all children enrolled in the study during the same period as the children with missing data did not materially change our results (Supplemental Tables S1–S3). In the control group, cure

Outcome	Unadjusted				Adjusted[1]			
	RR (95% CI)	P value	RD or MD (95% CI)	P value	RR (95% CI)	P value	RD or MD (95% CI)	P value
Missing outcomes excluded								
Cure (N = 358)	1.20 (1.08, 1.32)	0.001	0.15* (0.07, 0.23)	< 0.001	1.17 (1.05, 1.31)	0.006	0.13* (0.04, 0.23)	0.005
Default (N = 358)	0.30 (0.16, 0.55)	< 0.001	− 0.15* (− 0.22, − 0.07)	< 0.001	0.29 (0.15, 0.56)	< 0.001	− 0.16* (− 0.23, − 0.08)	< 0.001
Length of stay (N = 302)	–		3.49† (− 0.81, 7.79)	0.112	–		3.70† (− 0.46, 7.86)	0.081
Average weight gain (N = 302)	–		− 0.05† (− 1.02, 0.91)	0.911	–		− 0.65† (− 1.72, 0.42)	0.234
Missing outcomes imputed								
Cure (N = 364)	1.20 (1.09, 1.33)	< 0.001	0.15* (0.07, 0.23)	< 0.001	1.18 (1.05, 1.32)	0.004	0.14* (0.05, 0.23)	0.003
Default (N = 364)	0.30 (0.16, 0.55)	< 0.001	− 0.15* (− 0.22, − 0.07)	< 0.001	0.30 (0.16, 0.58)	< 0.001	− 0.15* (− 0.23, − 0.08)	< 0.001
Length of stay (N = 306)	–		3.32† (− 0.93, 7.56)	0.125	–		4.02† (− 0.15, 8.20)	0.059
Average weight gain (N = 306)	–		− 0.02† (− 0.97, 0.94)	0.974	–		− 0.49 † (− 1.55, 0.57)	0.366

Table 3. Effect of the intervention on treatment outcomes. RR: Risk ratio; RD: Risk difference; MD: Mean Difference. [1]Adjusted for wealth index, exposure to HIV, and fever. * Risk difference. †Mean difference. The effects of the intervention on transfer, death and no response were not evaluated because of the small number of cases.

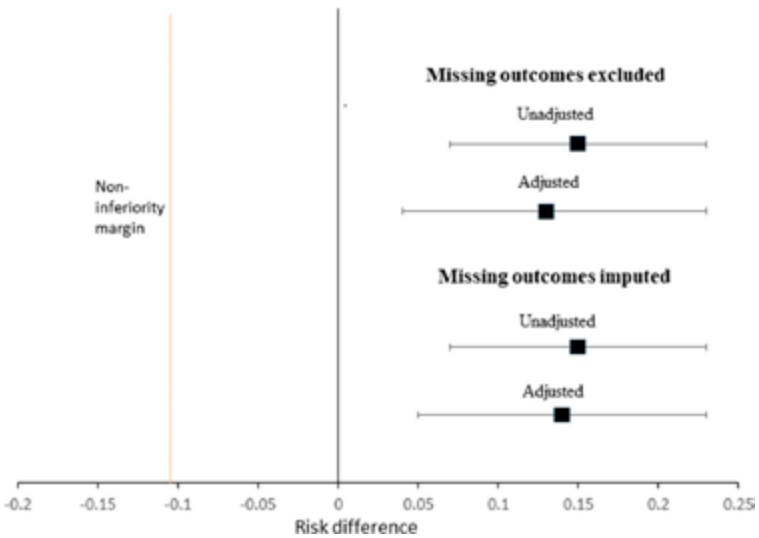


Figure 1. Assessment of non-inferiority based on cure rate. The risk difference (RD) is adjusted for wealth index, exposure to HIV, and fever at baseline. The error bars represent 95% CIs around the point estimate (black square).

rate was 76.1% while the default rate 20.5%. There was no major change in the effect estimates (RR for cure was 1.15; 95% CI 1.02, 1.29 while the RD was 0.12; 95% CI 0.02, 0.21), demonstrating the robustness of our results.

Coverage. Table 4 shows that SAM treatment coverage was higher in the intervention area (80.9%) than in the control area (41.7%); RD 39.2 (95% CI 30.9, 47.6) and RR 1.94 (95% CI 1.63, 2.31).

Cost-effectiveness. Table 5 shows that the total cost was higher in the intervention group (US$ 26,369.15) than in the control group (US$ 12,929.35). Consumables, mainly the cost of RUTF and its shipment, accounted for the highest share of the total cost in both the intervention group (57.0%) and the control group (50.2%). The

	Control	Intervention
No. of children aged 0–59 months[a]	9461	11,195
No. of children aged 6–59 months[b]	8465	10,016
SAM prevalence[c]	0.005	0.005
Incidence correction factor (K)[d]	4.82	4.82
Expected annual SAM cases in children aged 6–59 months[e]	204	241
No. of children treated in 1 year (Sept 2018–Aug 2019)	85	195
SAM treatment coverage	41. 7%	80.9%
Relative change (intervention/control)	1.9 (95% CI 1.6, 2.3)	
Absolute change (intervention-control)	39.2% (95% CI 30.9%-47.6%)	

Table 4. Estimation of coverage of severe acute malnutrition treatment services. [a]Based of the 2015 projected census data for 2018/2019. [b]89.47% of the < 5 population based on the 2015/16 DHS data. [c]National Nutrition survey 2018, Simiyu Region. [d]Based on meta-analysis of studies from West Africa[19]. [e]No. of children aged 6–59 months × SAM prevalence × (1 + K). The 95% CIs were calculated using a calculator based on published formulae.

	Control group		Intervention group	
	Cost (US$)	% Total cost	Cost (US$)	% Total cost
Total cost				
(1) Sensitization and mobilization	0	0.0	422.69	1.6
(2) Training	763.67	5.9	2590.18	9.8
(3) Monitoring and supervision	560.00	4.3	3062.86	11.6
(4) Consumables	6,492.05	50.2	15,018.51	57.0
(5) Human resources	4,555.95	35.2	4868.73	18.5
(6) Capital costs	557.68	4.3	406.19	1.5
Total cost	12,929.35	100.0	26,369.15	100.0
Unit cost (US$)				
Number of children treated	80		180	
Number of children cured	60		163	
Cost per child treated	161.62		146.50	
Cost per child cured	215.49		161.77	
Incremental cost-effectiveness ratio	**Treated**	**Cured**		
C1-C2	13,439.80	13,439.80		
E1-E2	100	103		
ICER (C1-C2/E1-E2)	134.40	130.92		

Table 5. Cost analysis. *C* cost, *E* effect, *ICER* Incremental Cost Effectiveness Ratio.

shares of training and supervision/monitoring costs were higher in the intervention group than in the control group while the share of human resource cost was higher in the control group than in the intervention group.

The cost per child treated was lower in the intervention group (US$ 146.50) than in the control group (US$ 161.62). Similarly, the cost per child cured was lower in the intervention group (US$ 161.77) than in the control group (US$ 215.49). The additional cost per an additional child treated (ICER) was US$134.40 while that per an additional child cured was US$130.92.

Discussion

This study showed that using CHWs to treat children with uncomplicated SAM was superior compared to the standard OTC model. Children treated by CHWs attained a higher cure rate and were less likely to default compared with those treated in health facilities. Moreover, the intervention increased coverage of SAM treatment services. Given Tanzania's per capita GDP of $1105 in 2019, the ICERs of $134.4 per treated child and $130.92 per cured child suggest that the intervention is cost-effective in this setting.

Our findings are consistent with the accumulating evidence on the effectiveness and cost-effectiveness of treatment of SAM by CHWs. A recent review that included 12 peer-reviewed articles and 6 grey literature from Africa and Asia on management of uncomplicated SAM by CHWs showed that CHWs could identify and treat uncomplicated cases of SAM, achieving cure rates above the minimum standards and reducing default rates[20]. Despite the discrepancies in treatment protocols used (in terms of admission criteria, treatment and discharge criteria), the review found cure rates of above 75% in the intervention group in eight out of nine studies. Cure rates of > 90% were reported in Angola[21], Bangladesh[13], Malawi[22], and Mali[12]. Default rate was < 8% across all the

studies, ranging from 3.6% in Malawi to 7.5% in Bangladesh. The review further found that only three studies (from Angola, Mali and Bangladesh) reported coverage; the post intervention coverage ranged from 82.1% in Angola to 89% in Bangladesh. Although coverage in these studies was assessed directly using the semi-quantitative evaluation of access and coverage (SQUEAC)/simplified lot quality assurance sampling evaluation of access and coverage methods, these results are consistent with what we found in our study based on indirect assessment using service use data. A SQUEAC assessment conducted in Simiyu Region in 2018 found a SAM treatment coverage of 39.9% (95% CI 29.2–52.0%) [unpublished report], which is similar to our estimated coverage of 41.7% in the control area. It is worth noting that, in the intervention area, the treatment outcomes and coverage were above the Sphere standards (i.e., > 75% recovered, < 15% defaulted, < 10% died, and > 50% SAM treatment coverage in rural areas)[6]. In the control area, only the recovery rate met the Sphere standards.

Assessment of SAM treatment via CHWs was found to be cost-effective[11]. Two studies have assessed the cost-effectiveness from the community perspective. In Bangladesh, in the group treated by CHWs, the costs per child treated and child recovered were $165 and US$180, respectively[15]. In Malawi, it cost US$244 per child treated and US$259 per child recovered in the intervention area. The respective costs in the control group were US$442 and US$501. In an evaluation of a CMAM program in Ethiopia where costing was assessed from the provider's perspective, the average cost per treated child was US$110, ranging from US$90 to US$152[23], which is close to our finding. In line with other studies, our study shows that the cost of RUTF accounts for the highest share of the total cost. Further analysis showed that shipment cost was the main driver of the cost of RUTF. This was mainly because RUTF was imported from Europe. Thus, local manufacture of RUTF could significantly lower the cost of SAM treatment. Overall, consistent with other studies, the intervention was cost-effective.

To our knowledge, this is the first study to assess the effectiveness of SAM treatment by CHWs in Tanzania. This was a pilot study with some limitations worth highlighting. First, due to budgetary constraints, we did not assess the quality of care by CHWs. Despite this, studies have shown that CHWs generally provide good quality care in SAM management[20]. Moreover, the good treatment outcomes observed in the intervention area indicate that the quality of care provided by CHWs was good. Secondly, we did not assess the perceptions of different stakeholders, including CHWs and beneficiaries, towards this new SAM treatment model. Such information can be useful in designing a bigger study or in scaling up the intervention. Thirdly, this being a non-randomised study, there is a possibility of confounding. In particular, there was a higher proportion of children exposed to HIV in the control group than in the intervention group. This is likely to yield better treatment outcomes in the intervention group. Moreover, there was an imbalance in the socio-economic status of children between the study groups, with a seemingly greater socio-economic disparity in the control group than in the intervention group. Nonetheless, adjustment for these factors did not change the effect estimates. Although a randomized controlled trial (RCT) would be ideal in addressing the limitations of this quasi-experimental study, the difficulty of conducting an RCT and the required financial resources means this type of study design may provide the best evidence about the intervention in this resource-limited setting. We estimated coverage indirectly based on utilisation data. Nonetheless, our estimated coverage in the control area was similar to that of Simiyu Region obtained through a direct method. Finally, we performed costing analysis at the ward level and did not include costs incurred in treating children referred to higher levels. However, given that the number of children referred to ITC was low and equal between the groups, this is unlikely to influence the ICER.

In conclusion, treatment of children with SAM without complications by CHWs was more effective and non-inferior compared with the usual care. The intervention led to higher coverage of SAM treatment and was cost-effective. The results from this study together with the accumulating evidence from elsewhere form a strong case for promoting the use of CHWs to manage children with SAM at home in Tanzania and other resource limited settings. This is particularly relevant in the context of the ongoing COVID-19 pandemic where limiting visits to the health facilities to the minimum needed is highly desirable.

Received: 26 September 2020; Accepted: 11 January 2021
Published online: 27 January 2021

References

1. United Nations Children's Fund, World Health Organization & The World Bank. *Levels and trends in child malnutrition: Key Findings of the 2020 Edition of the Joint Child Malnutrition Estimates.* (WHO, 2020).
2. Hure, A., Oldmeadow, C. & Attia, J. Invited commentary: Improving estimates of severe acute malnutrition requires more data. *Am. J. Epidemiol.* **184**, 870–872. https://doi.org/10.1093/aje/kww131 (2016).
3. Olofin, I. *et al.* Associations of suboptimal growth with all-cause and cause-specific mortality in children under five years: A pooled analysis of ten prospective studies. *PLoS ONE* **8**, e64636. https://doi.org/10.1371/journal.pone.0064636 (2013).
4. Woodward, A. *et al.* Climate change and health: On the latest IPCC report. *Lancet* **383**, 1185–1189. https://doi.org/10.1016/s0140-6736(14)60576-6 (2014).
5. World Health Organization, World Food Programme, United Nations System Standing Committee on Nutrition & United Nations Children's Fund. *Community-based Management of Severe Acute Malnutrition: A Joint Statement by the World Health Organization, the World Food Programme, the United Nations System Standing Committee on Nutrition and the United Nations Children's Fund.* (WHO, 2007).
6. Sphere Association. *The Sphere Handbook: Humanitarian Charter and Minimum Standards in Humanitarian Response* 4th edn. (Sphere Association, New York, 2018).
7. Rogers, E., Myatt, M., Woodhead, S., Guerrero, S. & Alvarez, J. L. Coverage of community-based management of severe acute malnutrition programmes in twenty-one countries, 2012–2013. *PLoS ONE* **10**, e0128666–e0128666. https://doi.org/10.1371/journal.pone.0128666 (2015).
8. Black, R. E. *et al.* Maternal and child undernutrition and overweight in low-income and middle-income countries. *Lancet* **382**, 427–451. https://doi.org/10.1016/s0140-6736(13)60937-x (2013).
9. Tanzania Food Nutrition Centre. *Tanzania National Nutrition Survey 2014* (TFNC, Dar es Salaam, 2014).

10. Ministry of Health Community Development. *Integrated Management of Acute Malnutrition: National Guidelines* (Tanzania Food and Nutrition Centre, Dar es Salaam, 2018).
11. López-Ejeda, N. *et al.* Bringing severe acute malnutrition treatment close to households through community health workers can lead to early admissions and improved discharge outcomes. *PLoS ONE* **15**, e0227939. https://doi.org/10.1371/journal.pone.0227939 (2020).
12. Alvarez Morán, J. L. *et al.* The effectiveness of treatment for Severe Acute Malnutrition (SAM) delivered by community health workers compared to a traditional facility based model. *BMC Health Serv. Res.* **18**, 207. https://doi.org/10.1186/s12913-018-2987-z (2018).
13. Sadler, K., Puett, C., Mothabbir, G. & Myatt, M. *Community Case Management of Severe Acute Malnutrition in Southern Bangladesh* (Tufts University, Feinstein International Center, 2011).
14. Alvarez Morán, J. L., Alé, F. G. B., Rogers, E. & Guerrero, S. Quality of care for treatment of uncomplicated severe acute malnutrition delivered by community health workers in a rural area of Mali. *Matern. Child Nutr.* **14**, e12449. https://doi.org/10.1111/mcn.12449 (2018).
15. Puett, C. *et al.* Cost-effectiveness of the community-based management of severe acute malnutrition by community health workers in southern Bangladesh. *Health Policy Plan.* **28**, 386–399. https://doi.org/10.1093/heapol/czs070 (2013).
16. Ministry of Health Community Development Gender Elderly and Children [Tanzania Mainland] *et al. Tanzania National Nutrition Survey using SMART Methodology 2018*. (MoHCDGEC, MoH, TFNC, NBS, OCGS, and UNICEF, 2018).
17. Zou, G. A modified poisson regression approach to prospective studies with binary data. *Am. J. Epidemiol.* **159**, 702–706. https://doi.org/10.1093/aje/kwh090%JAmericanJournalofEpidemiology (2004).
18. Rubin, B. D. *Multiple Imputation for Nonresponse in Surveys* (Wiley, Hoboken, 2008).
19. Isanaka, S., Boundy, E. O., Grais, R. F., Myatt, M. & Briend, A. Improving estimates of numbers of children with severe acute malnutrition using cohort and survey data. *Am. J. Epidemiol.* **184**, 861–869. https://doi.org/10.1093/aje/kww129 (2016).
20. López-Ejeda, N., Charle Cuellar, P., Vargas, A. & Guerrero, S. Can community health workers manage uncomplicated severe acute malnutrition? A review of operational experiences in delivering severe acute malnutrition treatment through community health platforms. *Matern. Child Nutr.* **15**, e12719. https://doi.org/10.1111/mcn.12719 (2019).
21. Morgan, S., Bulten, R. & Jalipa, H. Community case management approach to SAM treatment in Angola. *Field Exchange* **49**, 3 (2015).
22. Amthor, R. E., Cole, S. M. & Manary, M. J. The use of home-based therapy with ready-to-use therapeutic food to treat malnutrition in a rural area during a food crisis. *J. Am. Diet. Assoc.* **109**, 464–467. https://doi.org/10.1016/j.jada.2008.11.028 (2009).
23. UNICEF. *Evaluation of Community Management of Acute Malnutrition (CMAM) Ethiopia Country Case Study* (UNICEF, New York, 2012).

Acknowledgements
We acknowledge the support we received in the course of this study from the health authorities of Bariadi and Maswa districts, and Simiyu Region. We grateful to Children's Investment Fund Foundation for funding this study under "The Next Generation Programme—Integrated Promotion of Nutrition, Growth and Development in Tanzania". Finally, we thank the study participants and community health workers, whose cooperation and voluntary participation made this study successful.

Author contributions
C.W., V.L., G.S. F.M. and D.D.R. conceptualised and designed the study; C.W., F.G.M., G.M., E.M. and G.S. supervised data collection; C.W. managed data, analysed data, drafted the manuscript and integrated comments from the co-authors; G.P., F.M. and D.D.R. acquired funding. All the authors interpreted the results, critically reviewed the manuscript for important intellectual content and read and approved the final version of the manuscript.

Competing interests
The authors declare no competing interests.

Additional information
Supplementary Information The online version contains supplementary material available at https://doi.org/10.1038/s41598-021-81811-6.

Correspondence and requests for materials should be addressed to C.W.

Reprints and permissions information is available at www.nature.com/reprints.

Publisher's note Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

Open Access This article is licensed under a Creative Commons Attribution 4.0 International License, which permits use, sharing, adaptation, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons licence, and indicate if changes were made. The images or other third party material in this article are included in the article's Creative Commons licence, unless indicated otherwise in a credit line to the material. If material is not included in the article's Creative Commons licence and your intended use is not permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder. To view a copy of this licence, visit http://creativecommons.org/licenses/by/4.0/.

© The Author(s) 2021

Nutritional education during rehabilitation of children 6–24 months with acute malnutrition, under unavailability of therapeutic/supplementary foods: a retrospective study in rural Angola

PAPER

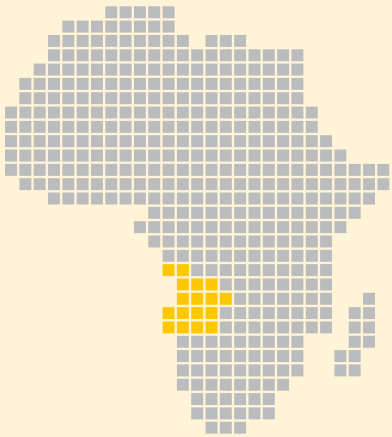
Authors
Pietravalle A., Scilipoti M., Cavallin F., Lonardi M., Makonga Tshikamb I., Robbiati C., Trevisanuto D., Putoto G.

Published in
BMC Pediatrics,
February 2021

Link
https://doi.org/10.1186/s12887-021-02560-z

Topic
Nutrition

Focus country
Angola



Pietravalle *et al. BMC Pediatrics* (2021) 21:94
https://doi.org/10.1186/s12887-021-02560-z

BMC Pediatrics

RESEARCH ARTICLE Open Access

Nutritional education during rehabilitation of children 6–24 months with acute malnutrition, under unavailability of therapeutic/supplementary foods: a retrospective study in rural Angola

Andrea Pietravalle[1*], Martina Scilipoti[2], Francesco Cavallin[3], Magda Lonardi[2], Ivo Makonga Tshikamb[4], Claudia Robbiati[2], Daniele Trevisanuto[5] and Giovanni Putoto[1]

Abstract

Background: Dietary counseling can play an important role in managing child malnutrition but is often inadequate or absent. Moreover, little emphasis is given to the usefulness of local available foods in the rehabilitation of malnourished children. This study aimed to evaluate the adherence and effectiveness of nutritional education during rehabilitation of children (6–24 months) with acute malnutrition, in a setting of unavailability of therapeutic/supplementary foods.

Methods: Retrospective observational study on the adherence to dietary counseling and the impact on growth in children 6–24 months who were referred for acute malnutrition at the Catholic Mission Hospital of Chiulo (Angola) from August 2018 to January 2019. Main outcome measures were change in dietary habits and growth gain.

Results: Sixty-four out of 120 children returned at first follow-up visit (default rate 47%). A change in dietary habits was reported in 32/64 (50%) children. Changing dietary habits was associated with an improved change in weight gain (MD 9.3 g/kg/day, 95%CI 4.2 to 14.3; $p = 0.0005$) and in weight/height ratio (MD 1.1 SD, 95%CI 0.7 to 1.4; $p < 0.0001$).

Conclusions: A change in dietary habits after discharge was noted in only half of the patients who returned at first follow up visit, but it provided some advantages in term of weight gain and weight/height ratio. Further studies are needed to identify children at risk of low adherence to follow-up visits and low compliance to the nutritional recommendations, in order to increase the effectiveness of rehabilitation programs.

Keywords: Education, Nutritional rehabilitation, Acute malnutrition

* Correspondence: apietravalle@gmail.com
[1]Doctors with Africa CUAMM, Padua, Italy
Full list of author information is available at the end of the article

© The Author(s). 2021 **Open Access** This article is licensed under a Creative Commons Attribution 4.0 International License, which permits use, sharing, adaptation, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons licence, and indicate if changes were made. The images or other third party material in this article are included in the article's Creative Commons licence, unless indicated otherwise in a credit line to the material. If material is not included in the article's Creative Commons licence and your intended use is not permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder. To view a copy of this licence, visit http://creativecommons.org/licenses/by/4.0/. The Creative Commons Public Domain Dedication waiver (http://creativecommons.org/publicdomain/zero/1.0/) applies to the data made available in this article, unless otherwise stated in a credit line to the data.

Introduction

In 2017, nearly 51 million of under-5 children were affected by acute malnutrition worldwide, with more than a quarter of them living in Africa [1]. The greatest risk of developing malnutrition occurs in the first 1000 days of life, from conception to 24 months of age [2]. Several factors concur to the incidence of malnutrition, including political and civil conflicts, environmental degradation, natural disasters, poverty, inadequate household access to food, infectious disease, inadequate breastfeeding and complementary feeding practices [3]. Malnutrition is the underlying cause in over 45% of all deaths among under-5 children [2]. Nonetheless, malnutrition is often associated with impaired growth and development, with adverse consequences in later life concerning health, intellectual ability, school achievement, work productivity, and earnings of survivors [2]. Ideally, the health-system infrastructure should integrate both prevention and treatment of malnutrition [4]. The most effective pathway to prevent malnutrition includes: adequate maternal nutrition before and during pregnancy and lactation; breastfeeding in the first 2 years of life; nutritive, diverse and safe foods in early childhood; healthy environment (i.e. access to basic health, water, hygiene and sanitation services); and opportunities for safe physical activity [5]. Ready-to-Use Therapeutic or Supplementary Foods (RUTF/RUSF) represent an effective and endorsed tool for the rehabilitation of children with severe and moderate acute malnutrition in both emergency and non-emergency settings, but the recurrent unavailability of these products is a frequent cause of nutrition program failure [6]. In addition, their long-term adverse effects should be taken into consideration [7]. Dietary counseling can play an important role in managing malnutrition thus should be an integral part of the treatment plan. However, dietary counseling is often inadequate or absent, and is often performed by health staff or volunteers with poor knowledge and communication skills [4]. Little emphasis is currently given to the usefulness of local available foods in the rehabilitation of malnourished children and improvements in counseling skills may help in conveying the most appropriate message [4]. This study aimed to evaluate the adherence to dietary counseling and the impact of changing dietary habits on growth, among children aged 6–24 months who were admitted with acute malnutrition at a rural district hospital, in a low-income setting where therapeutic and supplementary foods were lacking.

Materials and methods

This is a retrospective observational study on the adherence to dietary counseling and the impact on growth in children who were referred for acute malnutrition at the Catholic Mission Hospital of Chiulo (Angola) from August 2018 to January 2019. The study was approved by the Ethics Committee of the Angolan Ministry of Health (ref. number 032020), which waived the need for written informed consent given the retrospective nature of the study and the use of anonymized data from hospital records. All methods were performed in accordance with the relevant guidelines and regulations.

Setting

The Hospital of Catholic Mission of Chiulo is located in the province of Cunene (Angola). It is a district hospital implementing the Community Management of Acute Malnutrition (CMAM) program in a rural area of 12, 263 km^2 with 345,490 inhabitants (including 60,392 under-5 children) [8]. Chiulo Hospital is part of a network of 36 healthcare facilities involved in the national nutrition program and it works as a Stabilization Center (SC) for the inpatient care of malnourished children with complications, as well as an Outpatient Treatment Unit (OTU) for the rehabilitation phase after discharge. The nutritional rehabilitation unit counts 10 beds and is managed by a dedicated staff of doctors, nurses and paramedics. In 2018, 253 admissions were registered at the nutritional rehabilitation unit. In Angola, 90% of population living in rural areas belongs to the poorest social classes (54% to I quintile and 36% to II quintile) [8]. Education level is low among women aged 15–49 (35% attended only primary school and 22% received no education), while teenage childbearing involves 35% of adolescent women aged 15–19. Exclusive breastfeeding ranges from 62% among children aged 0–1 month to 17% among those aged 4–5 months, with a median duration of 3.1 months. Only 13% of children aged 6–24 months reach the WHO minimum acceptable diet standard. More than one-third (38%) of under-5 children are stunted while 5% are affected by acute malnutrition. Under-5 mortality rate differs by residence, province and household wealth, ranging from 68 deaths per 1000 live births in urban areas to 98 in rural areas.

Community Management of Acute Malnutrition (CMAM) program

CMAM program identifies malnourished children at community level and refers them to SC or Outpatient Treatment Programs (OTP) according to the severity of malnutrition. Children with SAM/MAM without medical complications are treated in OTP, which provides routine medical treatment and nutrition rehabilitation with RUTF or RUSF for children with SAM or MAM respectively. Children attend outpatient care at regular intervals (every one or 2 weeks) until recovery is achieved (usually 2 months) [9]. Children with severe (SAM) or moderate (MAM) acute malnutrition and medical complications are admitted to SC until their clinical

conditions are stabilized and complications resolved (usually four to 7 days). During this phase, F75 and F100 therapeutic milks are provided. Thereafter, children are usually treated in OTUs until nutritional recovery is achieved. Follow-up is performed in the OTUs, and relapsed children are referred again to the SC. At Chiulo Hospital, drugs, antibiotics, Resomal and F75-F100 therapeutic milk were properly offered, while the availability of therapeutic food was hampered by discontinued provision from the supply chain. A simple and prescriptive nutritional education, designed according to the WHO minimum acceptable diet standards [10] and using foods easily available in the study area, was provided before starting outpatient rehabilitation (detailed description in Supplementary Material: Table S1). Availability and affordability of the recommended foods were defined on the basis of the local health workers indications.

Patients

All children aged 6–24 months with SAM/MAM discharged from SC were eligible for inclusion.

Outcome measures

The outcome measures included the change in dietary habits and the weight change at first and second follow-up visits. The adherence to follow-up and the status (recovery, default, relapse, readmission) was also evaluated.

Data collection

All data were retrospectively collected from hospital charts. Child characteristics included malnutrition status (MAM, SAM), age, sex, birth weight, duration of exclusive breastfeeding, comorbidities. Caregiver characteristics included age, education, number of pregnancies, and age of first pregnancy. Weight gain and status were retrieved at discharge and during follow-up. Dietary habits were recorded at admission and at each follow up visit. A "typical day" questionnaire was used to investigate the minimum meal frequency and the minimum dietary diversity (see section 2.6).

Definitions

According to WHO classification [11], malnutrition was defined by the combination of clinical assessment and anthropometric measurements (Weight for Height ratio or Mid-Upper Arm Circumference). Weight for Height ratio < 3 Standard Deviation and Mid-Upper Arm Circumference ≤ 115 Millimeters indicated SAM, while values ≥3 and < 2 Standard Deviation or > 115 and < 124 Millimeters indicate MAM [11]. Dietary habits included minimum meal frequency and minimum dietary diversity [10]. Minimum meal frequency was defined as assuming daily solid/semi-solid foods at least 2 times for breastfed infants 6–8 months, 3 times for breastfed children 9–23 months, and 4 times for non-breastfed children 6–23 months. Minimum dietary diversity was defined as assuming at least 4 of the following 7 food groups: 1) grains, roots and tubers; 2) legumes and nuts; 3) dairy products; 4) flesh foods (meat, fish, poultry and liver/organ meats); 5) eggs; 6) vitamin-A rich fruits and vegetables; 7) other fruits and vegetables. Consumption of any amount of food from each food group was considered in the assessment. Achieving both minimum meal frequency and minimum dietary diversity was considered as change in dietary habits.

Weight change was evaluated in terms of weight-for-height ratio (expressed as standard deviations) and weight gain (expressed as g/kg/day) [11]. The rate of weight gain is used to monitor progress and effectiveness of rehabilitation phase. The WHO standards define the weight gain as poor (< 5 g/kg per day), moderate (5–10 g/kg per day) and good (> 10 g/kg per day) [11]. An admission represents the first contact with the program for treatment. WHO consider recovery when weight-for-height ratio is at least ≥ − 2 Standard Deviation or Mid-Upper-Arm Circumference is ≥125 mm and there is no edema for at least 2 weeks [11]. A default indicates a beneficiary who is absent for two consecutive weightings. A relapse is defined as a beneficiary readmitted to the program after having been successfully discharged as recovered within the last 2 months. A readmission identifies a beneficiary readmitted to the program within 2 months of leaving it for a reason other than recovery (e.g. defaulting or non-response) [9].

Statistical analysis

The study included a convenient sample of all children who were referred for acute malnutrition at Chiulo Hospital (Angola) from August 2018 to January 2019. Categorical data were expressed as frequency (n) and percentage (%). Weight gain and weight/height ratio were expressed as mean and standard deviation (SD). The changes in weight gain and weight/height ratio during follow-up were compared among groups (according to change in dietary habits) using mixed-effect models. Effect sizes were reported as mean differences (MD) with 95% confidence intervals (CI). All tests were 2-sided and a p-value below 0.05 was considered statistically significant. Statistical analysis was performed using R 3.5 (R Foundation for Statistical Computing, Vienna, Austria) [12].

Results

From August 2018 to January 2019, 139 children were admitted to the SC. Nineteen children (14%) died during hospitalization (13 of them died within 24 h from admission), while 120 (86%) were discharged and were

Table 1 Child and caregiver characteristics

	N of subjects	120
Children	**Moderate acute malnutrition (MAM)**	8 (7)
	Severe acute malnutrition (SAM)	112 (93)
	Male:female	56:64
	Age:	
	6–12 months	61 (51)
	13–24 months	59 (49)
	Birth weight:	
	< 2.5 kg (or defined as very small)	27 (22)
	≥2.5 kg	51 (42)
	Unknown	42 (35)
	Duration of exclusive breastfeeding:	
	< 1 month	3 (2)
	1–2 months	3 (2)
	3–6 months	66 (56)
	> 6 months	15 (12)
	Unknown	33 (28)
	HIV	6 (5)
	Tuberculosis	16 (13)
	Dietary habits at admission:	
	Get minimum meal frequency	5 (4)
	Get minimum dietary diversity	0 (0)
Caregivers	**Mother**	106 (88)
	Others	14 (12)
	Age:	
	≤ 14 years	0 (0)
	15–19 years	10 (8)
	20–30 years	50 (42)
	> 30 years	28 (23)
	Unknown	32 (27)
	Educational status:	
	Never attended school	76 (63)
	Primary school	19 (16)
	Secondary school	9 (8)
	Unknown	16 (13)
	Number of pregnancies:	
	< 3	31 (26)
	3–5	37 (31)
	> 5	31 (26)
	Unknown	21 (17)
	Age of first pregnancy:	
	< 15	22 (18)
	15–19	60 (50)
	20–30	10 (8)
	> 30	0 (0)
	Unknown	28 (24)

included in the analysis. RUTF and RUSF were not available during the study period. Child and caregiver characteristics are reported in Table 1.

Data expressed as n (%)

At admission, eight children had MAM (7%) and 112 SAM (93%). The majority of caregivers were mothers (79%) and had not received formal education (67%). Fifty-six children (47%) were lost to follow-up after discharge, with a default rate of 78% during the follow-up period (Fig. 1). Lost to follow-up after discharge was not statistically associated with any child or caregiver characteristics (Supplementary Materials: Table S2). Only 26 children (22%) regularly attended the follow-up visits: 25 of them achieved recovery and one was readmitted for relapse (Fig. 1).

At admission, none of the enrolled children was reaching the minimum acceptable diet standards. Among 64 children who returned at first follow-up visit, caregivers reported a change in dietary habits in 32 children (50%). Data on weight gain and weight/height ratio are shown in Fig. 2. Changing dietary habits was associated with an improved variation in weight gain (MD 9.3 g/kg/day, 95% CI 4.2 to 14.3; $p = 0.0005$) and in weight/height ratio (MD 1.1 SD, 95% CI 0.7 to 1.4; $p < 0.0001$). Seven children with changed dietary habits were considered recovered at the first visit. Among 36 children who returned at second follow-up visit, caregivers reported a change in dietary habits in 28 children (78%): 14 of them changed after discharge and 14 after the first follow-up visit. Data on weight gain and weight/height ratio are shown in Fig. 3.

In children who changed dietary habits after discharge, the variation in weight gain was not statistically different at first (MD 6.0 g/kg/day, 95% CI − 1.1 to 13.0; $p = 0.11$) or second (MD 0.8 g/kg/day, 95% CI − 6.3 to 7.9; $p = 0.83$) when compared to children who did not change dietary habits. However, they had improved change in weight/height ratio at first (MD 1.1 SD, 95% CI 0.5 to 1.6; $p = 0.0004$) and second (MD 1.0 SD, 95% CI 0.4 to 1.5; $p = 0.001$) follow-up visits. In children who changed dietary habits after first follow-up visit, the variation in weight gain was not statistically different at first (MD − 4.5 g/kg/day, 95% CI − 11.2 to 2.5; $p = 0.23$) or second (MD 6.4 g/kg/day, 95% CI − 0.7 to 13.5; $p = 0.09$) follow-up visits, when compared to children who did not change dietary habits. Their variation in weight/height ratio at first (MD 0.0 SD, 95% CI − 0.5 to 0.5; $p = 0.90$) and second (MD 0.1 SD, 95% CI − 0.4 to 0.7; $p = 0.67$) follow-up visits was also not statistically significant. Thirteen children with changed dietary habits were considered recovered at the second follow-up visit.

Discussion

This study investigated the impact of a nutritional intervention involving children with SAM/MAM when RUTF

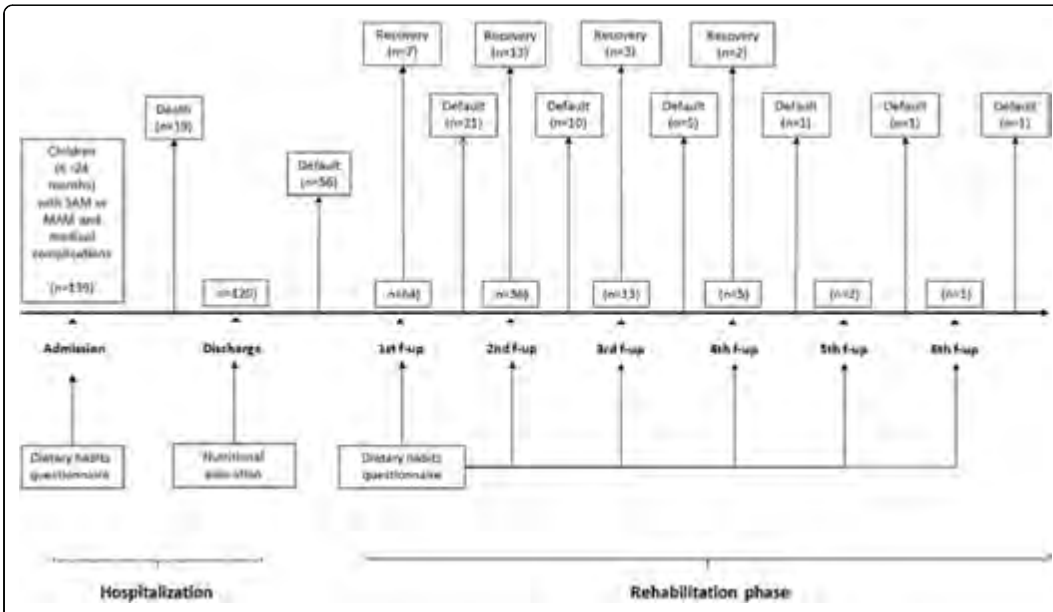


Fig. 1 Study flow chart and scheme of intervention

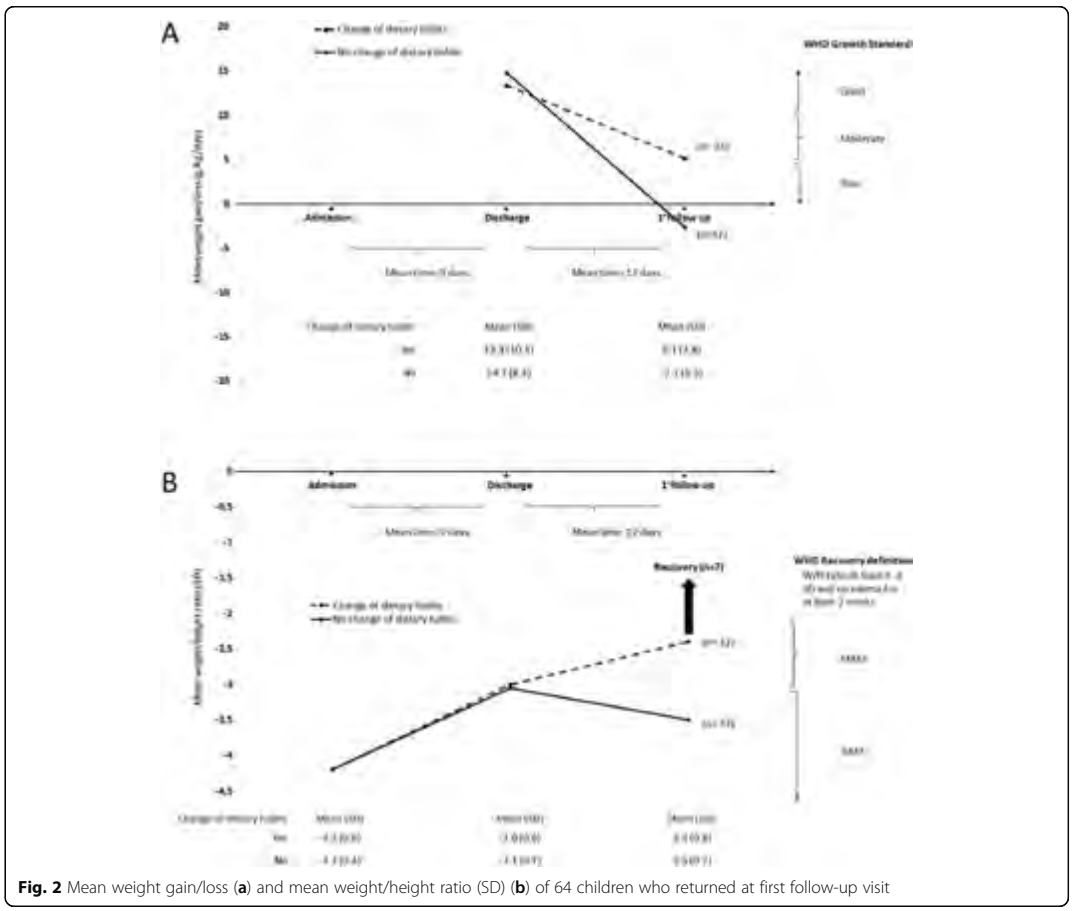


Fig. 2 Mean weight gain/loss (**a**) and mean weight/height ratio (SD) (**b**) of 64 children who returned at first follow-up visit

and RUSF were unavailable. Half of the children were lost at the first follow-up visit, with an overall default rate of 78% during the follow-up period. A change in dietary habits after discharge was noted in only half of the patients who returned at first follow up visit, but it provided some advantages in term of weight gain and weight/height ratio.

Ready to use foods have proven effective at treating SAM and MAM in both emergency and non-emergency settings. However, their availability is often not guaranteed, and their limitations and potential impact on life course, health and nutrition should be taken into consideration [7]. Although effective in the short term, these products seem to have long-term adverse effects on preferences and eating habits, as well as on consumption patterns, thus increasing the risk of life-course exposure to the double burden of malnutrition (early undernutrition followed by later overweight) [13]. The absence of therapeutic foods usually leads to a complete paralysis of the CMAM program [14]. In such situation, OTUs are no longer able to provide nutritional rehabilitation at community level, and this prevents the SC from discharging patients, thus hindering the necessary turnover. The use of therapeutic foods can only be considered as a temporary remedy for the recovery of children from an acute state of malnutrition. Without a deep and sustained change in dietary habits, a durable improvement in health outcomes cannot be achieved. A change in dietary habits with the establishment of proper nutrition can be a sustainable, cost-effective and lasting strategy for prevention and treatment of undernutrition. In settings with locally available foodstuffs, nutritional education can improve feeding habits [15] and dietary diversity [16].

To our knowledge, available information on the effectiveness of family foods utilization in domiciliary rehabilitation of severe acute malnutrition is limited to two reports. In both of them, caregivers received nutritional

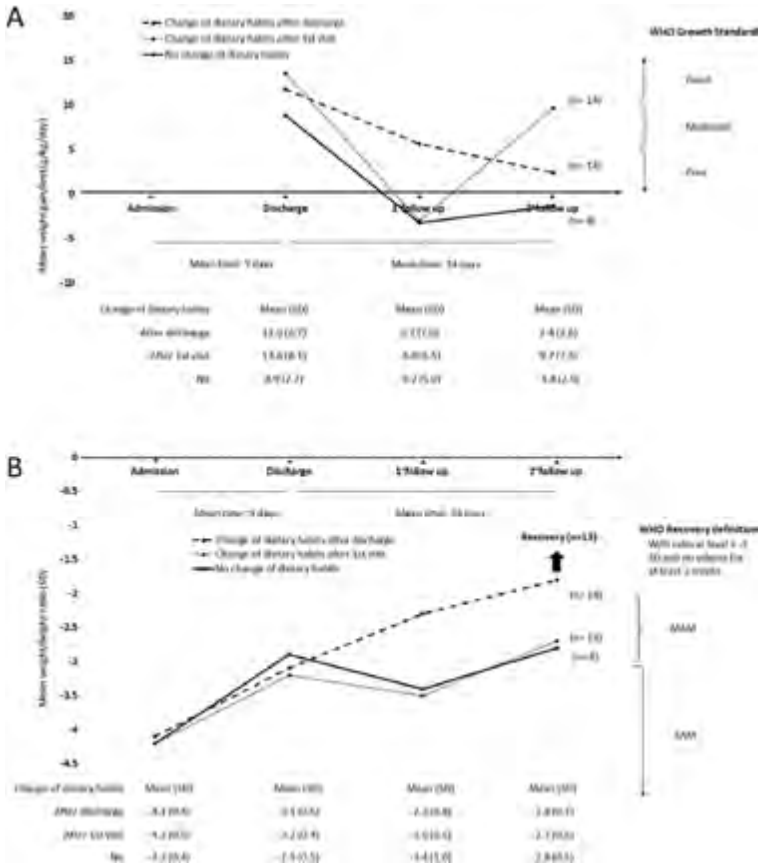


Fig. 3 Mean weight gain/loss (**a**) and mean weight/height ratio (SD) (**b**) of 36 children who returned at second follow-up visit

education before discharge from SC, and multivitamins, iron [17] and zinc [18] were provided in addition to family foods. Their findings suggested that domiciliary administration of a proper diet, based on family foods, could effectively support catch-up growth during rehabilitation phase (with enhanced outcomes if micronutrient supplementation was provided). Our findings indicated a catch-up growth comparable with available report without zinc supplementation [17], thus strengthening the role of education on use of family food in domiciliary rehabilitation of severe acute malnutrition. Moreover, our data showed the association between growth gain and compliance to dietary recommendations. The caregivers only occasionally reported the possible inhibiting factors to practice the prescribed dietary behaviors. Although the information was not systematically collected, lack of affordability and lack of knowledge about food preparation were the most frequently reported factors. In our opinion, the enabling factors for the adoption of correct dietary behaviors, are to be found in the offered quality of care (in terms of time spent supporting and educating the caregivers) and in the recommendation of available and affordable food according to setting and seasonality. Of note, overall default rate was very high during follow-up period, with a relevant number of children who were lost at the first follow-up visit, thus confirming the role of default as the main cause of CMAM program failure [9]. Lack of community sensitization (i.e. awareness about the program and malnutrition), financial/opportunity costs (busy caregiver, distance to health facility, sick caregiver, lack of money) and low quality of care have been recognized as the main driving factors for default in malnutrition programs [6]. The high default rate can limit the impact of nutritional interventions for child malnutrition, as counseling during follow-up visits enhances adherence

to nutritional indications and plays an important role in successful rehabilitation programs [4].

This study has some limitations that should be considered. First, the retrospective observational design limited quality and availability of data. Second, the low sample size and the high default rate restricted data analysis. Third, information about children not attending follow-up visits was lacking.

These limitations could be overcome by planning prospective studies with pre-established data collection forms, enhanced communication on importance of adherence to follow-up visits and retrieval of information on children not compliant to follow-up visits. Further studies are also needed to identify children at risk of low adherence to follow-up visits and low compliance to the nutritional recommendations, in order to increase the effectiveness of rehabilitation programs.

Our findings support the hypothesis that family foods can play an important role in the rehabilitation phase of children with acute malnutrition. Adequate dietary counseling should be implemented as part of CMAM programs, in order to enhance the impact of the rehabilitation intervention. However, the suboptimal proportion of children with changed dietary habits suggests the need for strategies to ensure full adherence to the counseling. Effective approaches may include the frequent, regular exposure to a few simple, uniform, age-appropriate and prescriptive messages, and the involvement of the community for social support (i.e. peer support groups and shared experience) [4, 19]. In addition, the high default rate during follow-up period calls for appropriate actions to increase adherence to follow-up visits. Building a strong relationship between health care staff and child caregivers, and fostering active participation of the community can play an important role in strengthening CMAM implementation.

Conclusions

In this nutritional program, half of the children were lost at the first follow-up visit. A change in dietary habits after discharge was noted in only half of the children who returned at first follow up visit, but it provided some advantages in term of weight gain and weight/height ratio. Further studies are needed to identify children at risk of low adherence to follow-up visits and low compliance to the nutritional recommendations, in order to increase the effectiveness of rehabilitation programs.

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s12887-021-02560-z.

Additional file 1: Table S1. "Description of the prescriptive nutritional education provided by health caregivers to child caregivers at Chiulo Hospital before starting outpatient rehabilitation."

Additional file 2: Table S2. "Comparison of child and caregiver characteristics between children who attended first follow-up visit and those who were lost to follow-up after discharge."

Abbreviations

RUTF/RUSF: Ready-to-Use Therapeutic /Supplementary Foods; CMAM: Community Management of Acute Malnutrition; SAM: Severe Acute Malnutrition; MAM: Moderate Acute Malnutrition; SC: Stabilization Center; OTP: Outpatient Treatment Program; OTU: Outpatient Treatment Unit

Acknowledgements

We are very grateful to the nurses and medical staff of the Missionary Catholic Hospital of Chiulo, Cunene, Angola for the passion they show in their daily work.

Authors' contributions

Conceptualization: AP; data curation: AP and MS; formal analysis, FC and AP; investigation: AP and MS and ML and IMT; project administration: AP and CR and GP; supervision: FC and DT and GP; visualization: AP and FC; writing—original draft preparation: AP and FC and DT; writing—review and editing: MS and ML and IMT and CR and GP. All authors approved the final version to be published and agreed to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

Funding

This research received no external funding.

Availability of data and materials

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Ethics approval and consent to participate

The study was approved by the Ethics Committee of the Angolan Ministry of Health (ref. number 032020), which waived the need for written informed consent given the retrospective nature of the study and the use of anonymized data from hospital records.

Consent for publication

NA (Not applicable).

Competing interests

The authors declare no conflict of interest.

Author details

[1]Doctors with Africa CUAMM, Padua, Italy. [2]Doctors with Africa CUAMM, Chiulo, Angola. [3]Independent statistician, Solagna, Italy. [4]Missionary Catholic Hospital of Chiulo, Ombadja Municipality, Angola. [5]Department of Woman's and Child's Health, University of Padua, Padua, Italy.

Received: 19 October 2020 Accepted: 9 February 2021
Published online: 24 February 2021

References

1. UNICEF/WHO/The World Bank Group Joint child malnutrition estimates. Levels and trends in child malnutrition, 2018 edition.
2. Ashworth A. Nutrition, Food Security, and Health, Chapter 46. In: Kliegman RM, Stanton BMD, St. Geme J, Schor NF, editors. Nelson Textbook of Pediatrics. 20th ed: Elsevier Health Sciences; 2015.
3. FAO; IFAD; UNICEF; WFP; WHO. The State of Food Security and Nutrition in the World 2018. Building climate resilience for food security and nutrition, 2018.
4. Ashworth A, Ferguson E. Dietary counseling in the management of moderate malnourishment in children. Food Nutr Bull. 2009;30(3 Suppl): S405–33.
5. UNICEF. The state of the World's children 2019. Children, Food and Nutrition: Growing well in a changing world, 2019.
6. Candidate number: 1404081. Key factors influencing programme coverage in the outpatient treatment of acute malnutrition, MSc Project Report, London School of Hygiene & Tropical Medicine, 2015.

7. Bazzano AN, Potts KS, Bazzano LA, Mason JB. The life course implications of ready to use therapeutic food for children in low-income countries. Int J Environ Res Public Health. 2017;14:4.
8. Instituto Nacional de Estatística; Ministério do Planeamento. Recenseamento Geral da População e Habitação, Angola. 2014
9. World Vision international. Review of current Community Management of Acute malnutrition (CMAM) practice and outcomes in 12 countries using the Minimum Reporting Package, 2012.
10. WHO; UNICEF. Indicators for assessing infant and young child feeding practices, 2008.
11. WHO. Severe acute malnutrition, Chaper 7. In: Pocket book of hospital care for children, guidelines for the management of common illnesses with limited resources; 2013.
12. R Core Team. R: A language and environment for statistical computing. Vienna: R Foundation for Statistical Computing; 2018.
13. Wells JC, Sawaya AL, Wibaek R, Mwangome M, Poullas MS, Yajnik CS, Demaio A. The double burden of malnutrition: aetiological pathways and consequences for health. Lancet. 2020;395(10217):75–88.
14. Tadesse E, Ekström EC, Berhane Y. Challenges in implementing the integrated community-based outpatient therapeutic program for severely malnourished children in rural southern Ethiopia. Nutrients. 2016;8(5):251.
15. Nguefack F, Chiabi A, Nguetsa NR, Tarla NN, Dongmo R. Feeding practices and impact of nutritional counseling coupled with home-based follow-up on the knowledge of mothers of children hospitalized for severe acute malnutrition. JMR. 2018;4(1):42–7.
16. Moramarco S, Amerio G, Chafula ML, Bonvecchio D, Abramo E, Palombi L, Buonomo E. Nutritional counseling improves dietary diversity and feeding habits of Zambian malnourished children admitted in rainbow nutritional programs. Biomed Prev. 2017;1:70–6.
17. Khanum S. A comparison of the cost-effectiveness of alternative approaches to the treatment of severely malnourished children. PhD thesis, London School of Hygiene and Tropical Medicine, University of London; 1994.
18. Ahmed T, Islam MM, Nahar B, Azam MA, Salam MA, Ashworth A, Fuchs GJ. Home-based nutritional rehabilitation of severely-malnourished children recovering from diarrhoea and other acute illnesses. Bangladesh: Paper presented at the 10th Annual Scientific Conference, International Centre for Diarrhoeal Disease Research; 2002.
19. WHO. The role of mother support groups. 1993. [Jan 22, 2021]. Available at: http://apps.who.int/iris/bitstream/10665/58728/2/WHO_NUT_MCH_93.1_%28part2%29.pdf.

Publisher's Note

Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

Ready to submit your research? Choose BMC and benefit from:

- fast, convenient online submission
- thorough peer review by experienced researchers in your field
- rapid publication on acceptance
- support for research data, including large and complex data types
- gold Open Access which fosters wider collaboration and increased citations
- maximum visibility for your research: over 100M website views per year

At BMC, research is always in progress.

Learn more biomedcentral.com/submissions

BMC

Effectiveness of integrated nutrition interventions on childhood stunting: a quasi-experimental evaluation design

PAPER

Authors
Elisaria E., Mrema J., Bogale T., Segafredo G. & Festo C.

Published in
BMC Nutrition, May 2021

Link
https://doi.org/10.1186/s40795-021-00421-7

Topic
Nutrition

Focus country
Multi-countries

Elisaria *et al. BMC Nutrition* (2021) 7:17
https://doi.org/10.1186/s40795-021-00421-7

BMC Nutrition

RESEARCH ARTICLE Open Access

Effectiveness of integrated nutrition interventions on childhood stunting: a quasi-experimental evaluation design

Ester Elisaria[1*], Jackline Mrema[1], Tariki Bogale[2], Giulia Segafredo[3] and Charles Festo[1]

Abstract

Background: Although malnutrition particularly stunting is recognized as multi-causal, there has been limited integrated nutrition interventions to reduce its burden in children under-fives and those existing are not well evaluated. This study tested the effectiveness of provision of health and nutrition education and promotion of home gardening in child stunting.

Methods: The study used a quasi-experimental evaluation design. Two rounds of household surveys were done to assess changes in behaviors (uptake of Antenatal Care services and child feeding practices) and stunting among children under-5 years. The sample size was calculated to detect a 10% percent absolute baseline-to-end-line change in stunting. A two-stage stratified sampling process was used to sample 896 and 1736 households at each round of data collection in the intervention and control districts respectively. Mothers delivered in the past 24 months preceding the survey and all children under-5 years residing in selected households were eligible. The difference in difference (DID) analysis was used to estimate effect of the interventions. All ethical clearances were obtained from relevant authorities prior to data collection.

Results: A total of 3467 and 4145 children under 5 years were recruited at baseline and endline respectively. The proportional of stunted children decreases from 35.9 to 34.2% in intervention and from 29.3 to 26.8% in the control sites. Overall, no statistically significant stunting reduction was observed between intervention and control sites. However, a significant effect was observed in intermediate outcomes; Uptake of iron folic acid (DID: 5.2%, (95% CI: 1.7–8.7), $p = 0.003$), health facility delivery (DID: 6.5%, (95% CI: 1.8–11.2), $p = 0.006$), pre-lacteal feeding (DID: − 5.9%, (95%CI: − 9.2, − 2.5), $p = 0.001$), breast feeding within 1 h after birth (DID: 7.8%, (95%CI: 2.2–13.4), $p = 0.006$) and exclusive breast feeding in children under 6 months (DID:20.3%, (95% CI: 10.5–30.1), $p = 0.001$).

Conclusion: The 3 years program did not result in significant evidence of stunting reduction, but the observed effect on health and nutrition behavioural indicators are at the causal pathways to improved child nutritional outcomes in the long run. Implementation of these integrated packages over a longer duration is needed to witness significant reduction in the prevalence of stunting.

Keywords: Health education, Malnutrition, Stunting

* Correspondence: eelisaria@ihi.or.tz
[1]Ifakara Health Institute, Mikocheni, Keko Avenue. Dar es Salaam Branch, Dar es Salaam, Tanzania
Full list of author information is available at the end of the article

© The Author(s). 2021 **Open Access** This article is licensed under a Creative Commons Attribution 4.0 International License, which permits use, sharing, adaptation, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons licence, and indicate if changes were made. The images or other third party material in this article are included in the article's Creative Commons licence, unless indicated otherwise in a credit line to the material. If material is not included in the article's Creative Commons licence and your intended use is not permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder. To view a copy of this licence, visit http://creativecommons.org/licenses/by/4.0/. The Creative Commons Public Domain Dedication waiver (http://creativecommons.org/publicdomain/zero/1.0/) applies to the data made available in this article, unless otherwise stated in a credit line to the data.

Background

Although the world has observed positive progress in improvement of child and maternal health and nutrition indicators, levels of undernutrition, particularly stunting, continue to be high with approximately 149 million children under-five were stunted in 2018 [1]. African continent is by far the hardest hit by stunting with 30 countries out of 41 ranked worldwide with highest number of people experiencing more than one form of malnutrition (childhood stunting, anaemia in women of reproductive age and overweight among women) [2]. The consequences of stunting are profound including increased susceptibility to infections, mortality, reduced cognitive development, diminished educational attainment, less economic productivity in the later stage of life and lower birth weight of offspring [3]. There is also a close link between deprivation of food in early life and increased chances of adulthood chronic diseases [3]. The collective consequences of stunting cost up to 12% of the country Gross Domestic Product of developing countries [4].

Nearly 45% of all under-five deaths were attributed to malnutrition which translates to approximately 3.1 million deaths per year globally. Sub-optimal infant feeding alone contributes to 800,000 deaths per year and the prevalence of deaths was much higher in South Asia and sub-Saharan Africa than in other parts of the world [5]. Tanzania has made huge progress in reducing stunting in under-five children, from 43% in 1991 to 34% in 2015 [6]. However, disparities exists between regions with six regions (Ruvuma, Iringa, Rukwa, Kigoma, Njombe and Songwe) out of 26 having over 40% of stunted children [6]. This is unacceptably high by the WHO standards [7]. Several studies have linked poor nutritional status among pregnant women and women of reproductive age with adverse birth and nutritional outcomes among newborns and children [8, 9]. Evidence in Tanzania suggests that the prevalence of underweight (BMI < 18.5) among women of reproductive age has remained low and unchanged over the past 20 years. However, overweight and obesity (BMI > 18.5) has increased substantially. The 2015/2016 Demographic and Health Survey indicates, one in ten women aged 15–49 years were either underweight or obese and 18% were overweight [6]. Further, 45% of women of reproductive age and 57% of pregnant women were anemic [6].

Several studies focusing on implementation of integrated nutrition-specific interventions to reduce stunting yielded inconsistence findings [10–13]. In a controlled intervention study on complementary food supplements and dietary counseling on anemia and stunting, no impact on stunting among children 6–23 months was observed in China [14]. Another evaluation conducted in Ethiopia among children aged 6–36 months observed no improvement in stunting when an integrated approach (water, sanitation and hygiene (WASH), health and nutrition education) was implemented in a food-insecure population with very high stunting prevalence [15]. Haselow (2016) presented two studies implemented by Hellen Keller international in Baitadi and Kailali districts of Nepal and the Chittagong Hill Tracts in Bangladesh. In Baitadi, a cluster randomized control trial was used where communities were assigned to integrated interventions (Enhanced Homestead Food Production, Promotion of good nutrition and WASH), women's empowerment, income generation and advocacy) or control. The study did not observe any impact on stunting. However, when a similar set of interventions was implemented in Kailali and Chittagong in a non-randomized control study, the Kailali district of Nepal revealed a 10.5% decline in stunting while the Chittagong Hill Tracts in Bangladesh achieved an 18% decline in stunting [13]. Methodological approach, packaging of intervention, duration of implementation and fidelity are some of the possible explanations for the observed variations.

Description of the interventions

The government of Tanzania is aiming to eliminate stunting as a significant public health problem by 2030 [16]. As part of several initiatives, an integrated intervention program with the aim of reducing stunting in children under 5 years was implemented in Simiyu and Ruvuma regions of Mainland Tanzania from 2016 to 2019 by an Italian organization called Doctors with Africa CUAMM. The program targeted pregnant and lactating women and children underfive years and focused on provision of nutrition education and promotion of use of health services during the 1000-day window from conception to 2 years of child life. CUAMM local project team members, health care providers and Community Health care Workers (CHW) were main actors in the management and implementation program activities. The role of health care providers on program activities was to deliver the routine services (nutrition education, education on infant feeding, Iron and folic acid supplementation and management of Severe Acute Malnutrition (SAM) at the health facility which is beyond the scope of this paper.

Stunting screening, cooking demonstration, health and nutrition education were the core project activities done during the village health days. Since stunting is a chronic condition, it was screened twice a year. Cooking demonstration and community health education sessions were done quarterly (every 3 months) in each of the study village with each session lasting for half a day. The training materials known as *Mkoba wa Siku 1000* were adopted from the Ministry of Health, Community Development,

Gender, Elderly and Children (MoHCDEC) and were used during facilitation of health education sessions. The training package had materials related to health education during pregnant and lactating, infant and young child feeding, handwashing, waste product management and birth preparedness.

The program also facilitated the formation of peer support group at village level with each having a maximum of 10 members and headed by community health care workers. The purpose of the groups was to facilitate provision of health and nutrition education among group members and the community at large and promote home gardening to ensure households availability of diversified food. The actual number of peer groups formed throughout the program implementation was not documented since this was not one of the core project implementation strategy. This paper generates an evidence from an evaluation work of these community program activities.

Methods and design

The evaluation employed a quasi-experimental design to test the hypothesis that health and nutrition education and promotion of use of antenatal care (ANC) services in the first 1000 days of life will reduce stunting in children underfive years. Repeated household surveys were done in both control and interventions sites at baseline in June–September 2016, and endline in July–September 2019.

Setting

The study was conducted in five regions of Tanzania mainland. Simiyu and Ruvuma regions were purposively selected as interventions sites by the implementers as they had a high prevalence of stunting, 33 and 44% respectively [6]. Simiyu is located in the Northern part of Tanzania and the South East of Lake Victoria while the Ruvuma is located in the Southern part of Tanzania. Four districts matched on health services availability, population, nutrition and mortality indicators were purposeful selected as controls. Uyui and Nzega districts located in Tabora region were paired with Simiyu region while Rufiji and Ruangwa districts in Coast and Lindi region respectively were paired with Ruvuma region. Districts with ongoing or planned similar nutrition program at the beginning of program activities were excluded from the controls sampling frame.

Sample size and sampling

The sample size was calculated to detect a 10% percent absolute baseline-to-end-line change in stunting as a key indicator, using a baseline rate of stunting in the intervention and control districts of 40 and 26% respectively. Assuming a 15 and 5% absolute drop in stunting in intervention and control districts respectively over the 4-year period, a 5% type I error and 80% power, and an intervention to control ratio of 1:2, a total of 840 households in intervention districts and 1680 in control districts was dimmed sufficient after accounting for the 10% non-response. A two-stage cluster sampling process was used, with the first stage involving sampling of 56 villages, 28 from each site proportional to the district population size. This was followed by random sampling of 32 and 64 households from each village located in the intervention and control site respectively. All households with children under 2 years in the selected villages formed part of a sampling frame for the second stage sampling. Two and four households were purposeful added in the sample as replacement household in the intervention and control sites respectively. This resulted in interviewing more households than what was required due to mis-communication among team members in areas with poor phone network coverage. This has resulted in 13 and 49 more households being interviewed at baseline and endline survey from all study sites. These extra households were included in the final analysis.

Study participants and eligibility

Mothers who delivered within the 24 months preceding the survey and all children under-5 years residing in the selected households were eligible. The 24 months were selected because child nutrition deteriorates in the period 6–24 months and after that age, the growth stagnates [17]. Infant feeding information was collected for all children under 24 months, as longer duration will introduce feeding pattern misclassification due to recall bias [18]. In household with two or more women with children less than 24 months of age, the one with the youngest child was interviewed to reduce recall bias.

Measurement

Anthropometric measurements

Anthropometric measurements (weight and height) were taken from all under-five children who slept in the selected household a night preceding the survey and also to the blood parents of the children under-fives. Weight was assessed using the calibrated United Nations Children Funds (UNICEF) Electronic Scales [19]. The scale was placed on a flat surface, and children aged 2 years and above weighed while standing on a scale while those aged less than 2 years had their weight taken as a difference of weight of mother or caretakers with the child combined to that of the mothers alone. Weight was recorded to the nearest 0.1 kg. Height was measured using a height board. Children less than 2 years were measured lying on the length board while those aged 2 years and above were measured standing upright on the board. Height was recorded to the nearest 0.1 cm.

Measurement procedures adhered to standardized protocols for anthropometry used in the construction of the international growth reference [19].

Study questionnaires

A modified version of the validated Demographic and Health Survey (DHS) questionnaire was used during the interviews [6]. The tools captured i) mother's demographic and reproductive history; ii) alcohol consumption and cigarette smoking history iii) history of health service utilization during ANC and the postnatal period, including Iron and Folic Acid supplementation, presumptive treatment for malaria and use of insecticide-treated bed nets during pregnancy and the postnatal period; iv) sources of breastfeeding information and a series of questions testing maternal knowledge on breastfeeding, complementary feeding and healthy eating during pregnancy and lactation; and v) infant feeding practices.

Data management and analysis

Data was analyzed using STATA version 13 software. Descriptive statistics was done to establish the markers of household-level characteristics, health and nutrition indicators at each round of data collection. The anthropometry Z-scores were calculated using the WHO 2006 growth references [20]. The impact of a program was calculated using the difference in difference estimates with a *p*-value less than 0.05 at 95% level considered as significant. Principal components analysis was used to create a wealth index for each household based on the asset's availability at household level.

Quality assessment and control

All study tools were reviewed by relevant experts prior to data collection. Questionnaires were translated to Kiswahili and back-translated to English to ensure meaning was maintained. Field workers were trained for 4 days prior to each round of data collection to reduce within and between inter and intra-data variability. The training was followed by a day of field-testing of data collection tools. Weight and height/length measurements were standardized using FANTA guidelines [21]. All weighing scales were calibrated using an object of known weight prior to use. Data collection was done using electronic devices and uploaded to a central data server on daily basis allowing instant review and feedback to the field team.

Ethical consideration

Ethical clearance from institutional (IHI/IRB/No:09–2016) and national (NIMR/HQ/R.8a/Vol.IX /2208) Research Ethics Committee were obtained. The study team paid courtesy visit to regional and district authority prior to beginning data collection activities. Permission letters were obtained and presented to village leaders during data collection activities. Before interviews, Research Assistants (RA's) informed all study participants about the study objectives, risk and benefit of participating and study procedures. Only respondent who provided written consent were interviewed.

Result

Overall, 2533 households were interviewed at baseline, and 2559 at end-line. Baseline and end-line population was characterized by a large family size (> 5). Closer to two third (> 64%) of the population had 5 or more family members. Teenage pregnancy ranged from 11.9 to 17.5% between baseline and end-line. Majority (> 79.1%) of the women interviewed were married. Most (> 63%) of the women had at least primary level education in both surveys. Generally, control sites had higher proportion of mothers with no education and poor socio-economic status compared to intervention sites at baseline and education continued to vary at end-line. Less than 7.4% of the mothers had BMI of < 18.5 (Table 1).

Coverage of the interventions

Interviews with 2559 women were done at endline to assess the uptake of the intervention in both control and intervention sites. Out of these, 16.8% reported to ever attended at least one village health visit day in the intervention sites and 0.8% in the control. Of those who ever attended in the intervention sites, a half (51.4%) attended only once, and a quarter (24.7%) attended either twice or three times in a year. Forty percent of individual who ever attended village health visit day reported being trained on how to prepare food for children, and 17.8% on how to make a home garden and its benefits. Only 9% of interviewed women were members of peer support groups overall, 16.7% in the intervention and 4.6% in the control groups. A third, 31.5% (28.5–34.6) and 19.4% (17.7–21.5) of women reported having a vegetable garden at home in the intervention and control sites respectively.

Nutritional outcomes of children

A total of 3467 and 4145 children under 5 years were recruited at baseline and endline respectively. Overall, there was no statistically significant difference in prevalence of stunting 3 years post the program implementation (DID: 0.8, 95%CI: − 3.4–5.1 and $p = 0.704$). However, the percentage of stunted children declined slightly from 35.9% (95% CI: 33.3–38.5) at baseline to 34.2% (95% CI: 31.9–36.6) at end-line in the intervention and from 29.3% (95% CI: 27.5–31.2) at baseline to 26.8% (95% CI: 25.2–28.6) at end-line in the control sites (Table 2).

Table 1 Household and Socio-demographic characteristic of respondents the intervention and control sites, 2016 and 2019

Indicator	Baseline		End-line	
	Intervention N (%)	Control N (%)	Intervention N (%)	Control N (%)
Number of Household	853	1680	871	1688
Household size				
Median household size (range)	6 (2–30)	5 (2–30)	6 (2–28)	5 (2–27)
Family size				
2–4	277 (32.5)	604 (36.0)	267 (30.8)	564 (33.4)
5–7	344 (40.4)	663 (39.5)	369 (42.5)	686 (40.6)
8+	232 (27.1)	413 (24.6)	235 (27.0)	438 (26.0)
Household wealth				
1 (Poorest)	229 (26.9)	424 (25.3)	184 (21.1)	472 (28.0)
2 (Poor)	170 (19.9)	458 (27.3)	227 (26.1)	405 (24.0)
3 (Medium)	214 (25.1)	419 (25.0)	196 (22.5)	437 (25.9)
4 (Better off)	240 (28.1)	379 (22.6)	264 (30.3)	374 (22.2)
Mother's age (years)				
15–19	149 (17.5)	252 (15.0)	104 (11.9)	240 (14.2)
20–29	453 (53.1)	911 (54.3)	491 (56.4)	883 (52.3)
30–39	208 (24.3)	446 (26.6)	237 (27.2)	472 (28.0)
40–49	43 (5.0)	70 (4.2)	39 (4.5)	93 (5.5)
Marital status				
Married	724 (84.9)	1328 (79.1)	760 (87.3)	1418 (84.0)
Single	81 (9.5)	226 (12.1)	65 (7.5)	174 (10.3)
Widow	8 (0.9)	12 (0.7)	7 (0.8)	4 (0.2)
Divorce	40 (4.7)	114 (6.8)	36 (4.1)	89 (5.3)
Mother's education				
No schooling	135 (15.8)	432 (25.7)	114 (13.1)	439 (26.0)
Primary	588 (68.9)	1092 (65.0)	598 (68.7)	1062 (62.9)
Secondary +	130 (15.2)	155 (9.2)	159 (18.3)	187 (11.1)
[a]Mother's BMI				
Thinness BMI < 18.5	52 (6.3)	103 (6.4)	40 (4.7)	121 (7.4)
Normal 18.5 < BMI < 25.0	624 (75.5)	1189 (73.3)	626 (74.1)	1132 (69.5)
Overweight ≥25.0	125 (15.1)	256 (15.8)	133 (15.7)	282 (17.3)
Obese ≥30.0	26 (3.1)	74 (4.6)	46 (5.4)	93 (5.7)

[a] Pregnant women were excluded from the BMI calculations. The numbers in brackets are row percent unless stated

Table 2 Nutritional indicators for children under-5 years between 2016 and 2019

Nutritional outcomes	Intervention		Control		Program effect (DID estimates)	
	Baseline	Endline	Baseline	Endline		
	Prev (%). (CI)	Prev (%). (CI)	Prev (%).(CI)	Prev (%). (CI)	% DID (95% CI)	*P* value
	N = 1334	*N* = 1540	*N* = 2333	*N* = 2605		
Stunting						
Overall	35.9 (33.3–38.5)	34.2 (31.9–36.6)	29.3 (27.5–31.2)	26.8 (25.2–28.6)	0.8 (−3.4–5.1)	0.704
Severe	11.3 (9.7–13.1)	11.6 (10.2–13.4)	7.7 (6.7–9.9)	7.1 (6.2–8.2)	1.0 (−1.6–3.6)	0.442

Uptake of maternity care

Almost all women (98%) interviewed received antenatal care during their most recent pregnancy from a skilled attendant at least once. There was no evidence of change in the number of ANC visits and timing of first ANC visit as a result of the intervention. However, a significant increase was observed in uptake of iron and folic acid (DID: 5.2, 95%CI: 1.7–8.7, $p = 0.003$), delivery at health facility (DID: 6.5, 95%CI: 1.8–11.2, $p = 0.006$), pre-lacteal feeding (DID: -5.9, 95% CI: − 9.2- -2.5, $p = 0.001$), breastfeeding within 1 h (DID: 7.8, 95% CI: 2.2–13.4, p = 0.006) and exclusive breast feeding from birth to 6 months (DID:20.3, 95%CI: 10.5–30.1, $p = 0.001$) (Table 3).

Discussion

This study investigated the effectiveness of integrated intervention (nutrition education, promotion of use of health services and home gardening) in the first 1000 days of a child's life on reduction of child stunting. The findings show a slight reduction in stunting 3 years post the program implementation in both intervention and control sites, though not statistically significant. Although both groups have shown a non-significant decrease in stunning, this decrease is more pronounced in control group. This could be due to the high use of ANC services (early ANC attendance, at least 4 ANC visit, Iron and folic acid, and health facility delivery (Table 3)).

The no significant reduction of stunting in the intervention sites were unexpected findings but could be explained by the shorter duration of program implementation as stunting is a chronic condition that requires a longer period to change and low coverage of interventions at the community. Results from similar integrated interventions implemented in Ethiopia and Mozambique [15, 22] also found no improvement in child stunting. A systematic review by Goudet et al. in 2019 exploring the effect of these similar intervention reported no or moderate effect of the interventions on stunting [23]. The literature shows high mobility, lack of social services, and high loss to follow-up as possible explanation for this kind of findings [23].

Despite the program showing no impact on child stunting, a significant improvement was observed in the uptake of iron and folic acid, health facility delivery, pre-lacteal feeding, initiation of breastfeeding within 1 h of birth, and exclusive breastfeeding in children aged below

Table 3 Maternity care uptake and breastfeeding practice among mothers interviewed in 2016 and 2019

Indicator of interest	Intervention		Control		Program effect (DID estimates)	*P*-value
	Baseline	Endline	Baseline	Endline	% diff (95% CI)	
	Prev (%). (CI)	Prev (%). (CI)	Prev (%). (CI	Prev (%). (CI)		
	N = 853	*N* = 871	*N* = 1680	*N* = 1688		
Number of ANC visit						
Ever attended	98.6 (97.5–99.2)	98.0 (96.9–98.8)	98.0 (97.2–98.6)	97.5 (96.6–98.2)	−0.1 (−1.7–1.6)	0.924
At least 4 visits	48.2 (44.8–51.5)	69.0 (65.8–72.0)	51.8 (49.4–54.1)	71.0 (68.8–73.1)	1.5 (−4.0–7.1)	0.593
Gestation age at First ANC (Months)						
0–3	21.7 (19.0–24.6)	42.2 (39.0–45.6)	23.4 (21.4–25.5)	43.0 (40.7–45.4)	0.9 (−4.4–6.3)	0.728
4–6	68.0 (64.8–71.0)	50.9 (47.5–54.2)	64.3 (61.9–66.5)	48.5 (46.1–50.9)	−1.4 (−7.0–4.3)	0.636
7–9	9.6 97.8–11.8)	6.2 (4.8–8.0)	11.2 (9.8–12.9)	7.4 (6.3–8.8)	0.4 (−2.9–3.7)	0.825
Uses of Iron and folic acid						
Ever took	87.6 (85.2–89.6)	95.2 (93.5–96.4)	87.9 (86.2–89.3)	90.2 (88.7–91.6)	5.2 (1.7–8.7)	0.003
Took for 90+	17.9 (15.3–20.9)	40.6 (37.3–44.0)	29.1 (26.9–31.5)	47.4 (44.8–49.9)	4.5 (−1.2–10.2)	0.118
Delivered at HF	70.1 (66.9–73.1)	81.7 (79.0–84.2)	78.6 (76.5–80.5)	83.7 (81.9–85.4)	6.5 (1.8–11.2)	0.006
Given pre-lacteal feeds	14.2 (11.2–16.7)	7.1 (5.6–9.0)	9.3 (8.0–10.8)	8.2 (7.0–9.6)	−5.9 (−9.2- ¯2.5)	0.001
Ever breastfed	98.7 (97.7–99.3)	99.7 (98.9–99.9)	99.0 (98.4–99.4)	99.8 (99.4–99.9)	0.2 (−0.8–1.1)	0.728
Breastfeeding within 1 h	59.1 (55.8–62.4)	66.2 (63.0–69.3)	66.3 (63.9–68.5)	65.6 (63.3–67.8)	7.8 (2.2–13.4)	0.006
EBF per age (months)						
0–1	91.9 (83.7–97.1)	94.6 (87.4–97.8)	95.1 (89.9–97.7)	88.6 (82.5–92.7)	9.2 (0.8–19.1)	0.070
2–3	75.0 (65.0–82.9)	84.3 (74.6–90.8)	68.5 (60.4–75.6)	53.1 (44.9–61.2)	24.7 (7.6–41.9)	0.005
4–5	47.6 (38.1–57.3)	61.5 (51.2–70.8)	43.9 (36.9–51.1)	28.7 (22.3–36.0)	29.1 (12.3–45.9)	0.277
0–5	70.0 (64.3–75.1)	79.7 (74.5–84.1)	66.7 (62.3–70.8)	56.1 (51.6–60.5)	20.3 (10.5–30.1)	< 0.001

EBF Exclusive breastfeeding, *hr* hour, *ANC* Antenatal clinic

6 months. These results are in the intermediate or distal causal pathways for children's stunting [24] and may results stunting reduction in the long run.

Further, these behavioural indicators have been defined by WHO as essentials nutrition action and recommended in early child life for optimum health, growth, and neurodevelopment [17]. Supplementation of iron during pregnancy, initiation of breastfeeding, exclusive breastfeeding, and appropriate complementary feeding practices during 1000 days were found to have a significant effect with child stunting [25]. In-depth analysis of demographic and health surveys in many sub-Saharan African countries has indicated an improvements in uptake of maternity care reduces the prevalence of stunting [26]. Based on these pieces of evidence from other studies, there is an indication that, the observed changes in behaviour among pregnant women using health services as well as infant and changes in child feeding practises impacted by the program in intervention communities could contribute to the reduction of child stunting in the future.

There were a number of methodological limitations in this study, many of which were outside the control of the project. Information collected from the mothers/caregivers was based on recall over varying time periods, which may introduce memory bias, particularly for infant feeding practices and other retrospective data relying on mother's memory of the past events. Further, problems with implementation might be a possible explanation of the low coverage of intervention especially due to high staff turnover within CUAMM project management team, early phasing out of project activities due to shortage of funding. It remains unclear about the quality of training and supervision offered to CHW and to the community. So, no effect of the program on stunting reduction should be interpreted with care.

Conclusion

Even though the program did not show an evidence of stunting reduction, a significant effect was observed in nutrition behaviours, ameliorating the uptake of iron and folic acid, health facility delivery, pre-lacteal feeding, and breastfeeding practices. These are in the causal pathway in reducing child undernutrition. More intensive intervention that are implemented at longer duration might be needed to see the effect of these interventions.

Abbreviations

BMI: Body Mass Index; CI: Confidence interval; DID: Difference in difference; HAZ: Height-for-Age Z-score; TDHS: Tanzania Demographic and Health Survey; WHO: World Health Organization

Acknowledgments

We acknowledge the financial support from the Child International Fund Foundation for funding this study "The Next Generation Programme" We also appreciate the support we received from Bariadi, Simiyu, Tabora, Lindi and Coast Region authorities. Finally, we thank the study participants and community health workers, whose cooperation and voluntary participation made this study successful.

Authors' information (optional)

Ifakara Health Institute (IHI).
Mikocheni, Keko Avenue.
Dar es Salaam Branch.
Children Investment Fund Foundation (CIFF).
ABC Place, 3rd floor Waiyaki Way,
Westlands, Nairobi, Kenya.
Doctors with Africa CUAMM.
Bagamoyo Road, Dar es Salaam.

Authors' contributions

E.E and C. F conceptualised, designed the study and reviewed manuscript; J. M supervised data collection, drafted manuscript and respond to comments from co-authors; C. F and T. B managed data, analysed data. G. S reviewed and edited manuscript. All the authors interpreted the results, critically reviewed the manuscript for important intellectual content and read and approved the final version of the manuscript.

Funding

The study was funded by Child Investment Fund Foundation (CIFF).

Availability of data and materials

The study datasets are available from the corresponding author on request.

Declarations

Ethics approval and consent to participate

The study protocol was approved by Ifakara Health Institute review board with reference IHI/IRB/No:09–2016 and the National Health Research Ethics Committee at the National Institute of Medical Research, Tanzania (NIMR/HQ/R.8a/Vol.IX/2208). Written informed consent was obtained from all mothers/caretakers of eligible children selected households.

Consent for publication

Not applicable.

Competing interests

The authors declare that they have no competing interests.

Author details

[1]Ifakara Health Institute, Mikocheni, Keko Avenue. Dar es Salaam Branch, Dar es Salaam, Tanzania. [2]Children's Investment Fund Foundation, ABC Place, 3rd floor Waiyaki Way, Westlands, Nairobi, Kenya. [3]Doctors with Africa CUAMM, Bagamoyo Road, Dar es Salaam, Tanzania.

Received: 20 November 2020 Accepted: 15 March 2021
Published online: 15 May 2021

References

1. UNICEF. The State of the World's Children: Children, food and nutrition,. 2019.
2. Fanzo J, Hawkes C, Udomkesmalee E, Afshin A, Allemandi L, Assery O, et al. Global Nutrition Report: Shining a light to spur action on nutrition; 2018. p. 2018.
3. Victora CG, Adair L, Fall C, Hallal PC, Martorell R, Richter L, et al. Maternal and child undernutrition: consequences for adult health and human capital. Lancet. 2008;371(9609):340–57. https://doi.org/10.1016/S0140-6736(07)61692-4.
4. Horton S, Steckel RH. Malnutrition: global economic losses attributable to malnutrition 1900–2000 and projections to 2050. How Much Have Glob Probl Cost Earth? A Scorec from 1900 to. 2013;2050:247–72.
5. Black RE, Victora CG, Walker SP, Bhutta ZA, Christian P, De Onis M, et al. Maternal and child undernutrition and overweight in low-income and middle-income countries. Lancet. 2013.

6. MoHCDGEC, MoH, NBS, OCGS, ICF. Tanzania Demographic and Health Survey and Malaria Indicator Survey (TDHS-MIS) 2015–16. Dar es Salaam, Tanzania, and Rockville, Maryland, USA; 2016.
7. World Health Organization. Nutrition Landscape Information System (NLIS) country profile indicators: interpretation guide. 2019;
8. Valente A, Borges A, Almeida F, Neves E, Afonso C. Relationship between the mothers ' nutritional status with that of a child population from São Tomé Principe , " Africa.". RevBrasSAude Matern Matern. 2017;17(2):327–35.
9. Dessie ZB, Fentie M, Abebe Z, Ayele TA, Muchie KF. Maternal characteristics and nutritional status among 6–59 months of children in Ethiopia : further analysis of demographic and health survey. BMC Pediatr. 2019;19(83):1–10.
10. Bhutta ZA, Ahmed T, Black RE, Cousens S, Dewey K, Giugliani E, et al. What works? Interventions for maternal and child undernutrition and survival. Lancet (London, England). 2008;371(9610):417–40.
11. Nurhayati R, Utami RB, Irawan AA. Health education about stunting nutrition in mothers to weight stunting children aged 2-5 years. J Qual Public Heal. 2020;4(1):38–43. https://doi.org/10.30994/jqph.v4i1.148.
12. Haselow NJ, Stormer A, Pries A, Fenn B, Bulti AT, Nduna T, et al. An evaluation of an operations research project to reduce childhood stunting in a food-insecure area in Ethiopia. Public Health Nutr. 2012;15(9):1746–54.
13. Haselow NJ, Stormer A, Pries A. Evidence-based evolution of an integrated nutrition-focused agriculture approach to address the underlying determinants of stunting. Matern Child Nutr. 2016;12(Suppl 1):155–68.
14. Zhang Y, Wu Q, Wang W, van Velthoven MH, Chang S, Han H, et al. Effectiveness of complementary food supplements and dietary counselling on anaemia and stunting in children aged 6–23 months in poor areas of Qinghai Province, China: a controlled interventional study. BMJ Open. 2016; 6(10):e011234 Available from: http://bmjopen.bmj.com/content/6/10/e011234.abstract.
15. Fenn B, Bulti AT, Nduna T, Duffield A, Watson F. An evaluation of an operations research project to reduce childhood stunting in a food-insecure area in Ethiopia. Public Health Nutr. 2012;15(9):1746–54. https://doi.org/10.1017/S1368980012001115.
16. Kavishe F. Towards Eliminating Malnutrition in Tanzania : Vision 2025 THE UNITED REPUBLIC OF TANZANIA; 2015.
17. World Health Organization. Essential Nutrition Actions: improving maternal, newborn, infant and young child health and nutrition. Geneva, Switzerland; 2013.
18. Li R, Scanlon KS, Serdula MK. The validity and reliability of maternal recall of Breasfeeding practice. Nutr Rev. 2005;63(4):103–10. https://doi.org/10.1111/j.1753-4887.2005.tb00128.x.
19. de Onis M, Onyango AW, Van den Broeck J, Chumlea WC, Martorell R. Measurement and standardization protocols for anthropometry used in the construction of a new international growth reference. Food Nutr Bull. 2004; 25(1_suppl_1):S27–36.
20. WHO. WHO Child Growth Standards. 2006.
21. Cashin K, Oot L. GUIDE TO ANTHROPOMETRY A Practical Tool for Program Planners , Managers , and Implementers; 2018.
22. Martinez S, Naudeau S, Pereira V. The promise of preschool in Africa: a randomized impact evaluation of early childhood development in rural Mozambique; 2012.
23. Goudet SM, Bogin BA, Madise NJ, Griffiths PL. Nutritional interventions for preventing stunting in children (birth to 59 months) living in urban slums in low-and middle-income countries (LMIC). Cochrane Database Syst Rev. 2019;(6).
24. Hien N, Hoa N. Nutritional status and determinants of malnutrition in children under three years of age in Nghean. Vietnam Pakistan J Nutr. 2009; 8.
25. Nur R, Teuku T, dan Kartini H. Specific Interventions During the First 1000 Days of Life Program And Toddlers' Nutritional Status. In: Proceedings of the 7th AIC-ICMR on Health and Life Sciences. Banda Aceh: ReseachGate; 2017. p. 10.
26. Buisman LR, Van de Poel E, O'Donnell O, van Doorslaer EKA. What explains the fall in child stunting in sub-Saharan Africa? SSM-population Heal. 2019;8: 100384. https://doi.org/10.1016/j.ssmph.2019.100384.

Publisher's Note

Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

Ready to submit your research? Choose BMC and benefit from:

- fast, convenient online submission
- thorough peer review by experienced researchers in your field
- rapid publication on acceptance
- support for research data, including large and complex data types
- gold Open Access which fosters wider collaboration and increased citations
- maximum visibility for your research: over 100M website views per year

At BMC, research is always in progress.

Learn more biomedcentral.com/submissions

BMC

Analysis of risk and prognostic factors in a population of pediatric patients hospitalized for acute malnutrition at the Chiulo hospital, Angola

PAPER

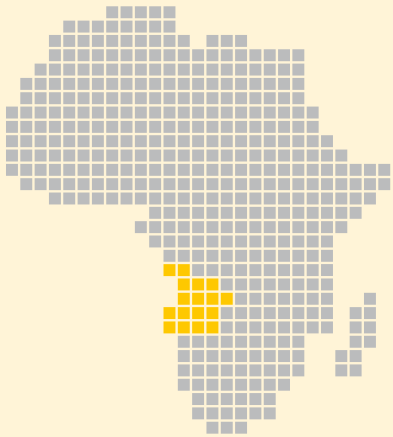
Authors
Tripoli F. M., Accomando S., La Placa S., Pietravalle A., Putoto G., Corsello G., Giuffrè M.

Published in
Italian Journal of Pediatrics,
September 2021

Link
https://doi.org/10.1186/s13052-021-01140-2

Topic
Nutrition

Focus country
Angola



Tripoli *et al. Italian Journal of Pediatrics* (2021) 47:184
https://doi.org/10.1186/s13052-021-01140-2

Italian Journal of Pediatrics

RESEARCH Open Access

Analysis of risk and prognostic factors in a population of pediatric patients hospitalized for acute malnutrition at the Chiulo hospital, Angola

Federica Maria Tripoli[1,2], Salvatore Accomando[1], Simona La Placa[1], Andrea Pietravalle[2], Giovanni Putoto[2], Giovanni Corsello[1] and Mario Giuffrè[1*]

Abstract

Background: Malnutrition is a multifactorial pathology in which genetic, epigenetic, cultural, environmental, socio-economic factors interact with each other. The impact that this disease has on the health of children worldwide is dramatic. Severe acute malnutrition in particular is a disease affecting nearly 20 million preschool children worldwide, most of them in Africa and South East Asia.

Objectives: This work aims to investigate potential prognostic factors in the clinical evolution of acute malnutrition and potential risk factors for the development of the disease.

Methods: Our study was carried out at the "Hospital da Missão Catolica do Chiulo", in Angola, where the NGO Doctors with Africa CUAMM has been operating since 2000. In the first part of the study we analyzed the characteristics and clinical evolution of 163 patients hospitalized for acute malnutrition at the UEN (Unidade Especial de Nutrição) of the Chiulo Hospital over a period of 6 months, in order to identify potential prognostic factors of the disease. The second part of our study was carried out by administering a questionnaire to a group of caregivers of malnourished children and to a group of caregivers of non-malnourished children admitted to Pediatrics for other causes, with the aim of identifying potential risk factors for the development of malnutrition.

Results and conclusions: The analysis of prognostic factors revealed that the most relevant are the WHZ (weight for height z-score) at the time of admission, the presence of Stunting and the presence of other pathologies or clinical conditions associated with severe acute malnutrition.
The analysis of risk factors has shown that not only food shortages, but also errors in the timing of the suspension of breastfeeding and the timing of the introduction of complementary foods play an important role. Equally important were some family risk factors, including the size of the family unit and the presence of deceased children.
It also emerged that the lack of knowledge of what a child needs to grow up healthy often affects the development of malnutrition. It follows that a useful and low-cost tool for preventing child malnutrition would be

* Correspondence: mario.giuffre@unipa.it
[1]Department of Health Promotion, Mother and Child Care, Internal Medicine and Medical Specialties, University of Palermo, Palermo, Italy
Full list of author information is available at the end of the article

© The Author(s). 2021 **Open Access** This article is licensed under a Creative Commons Attribution 4.0 International License, which permits use, sharing, adaptation, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons licence, and indicate if changes were made. The images or other third party material in this article are included in the article's Creative Commons licence, unless indicated otherwise in a credit line to the material. If material is not included in the article's Creative Commons licence and your intended use is not permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder. To view a copy of this licence, visit http://creativecommons.org/licenses/by/4.0/. The Creative Commons Public Domain Dedication waiver (http://creativecommons.org/publicdomain/zero/1.0/) applies to the data made available in this article, unless otherwise stated in a credit line to the data.

large-scale nutrition education campaigns.

Keywords: Severe acute malnutrition, Wasting, Risk factors, Prognostic factors, Sub-Saharan Africa, Breastfeeding

Background

Doctors with Africa CUAMM is an NGO that works to ensuring the right to health and to make access to health services available to everyone. It is active today in eight countries of sub-Saharan Africa with long-term health care projects, including Angola were this study was carried out [1].

Angola is a country with a high fertility rate (5.6 births per woman of childbearing age) and a population growth rate of 2.7% per year [2]. The infant mortality rate is 44 deaths under the first year of life for every 1000 live births and under 5 mortality is 68 for every 1000 live births. 30% of the Angolan population and 58% of that of rural areas lives below the poverty line [3]. In a context such as the one described, malnutrition among childhood pathologies, is certainly one of the most widespread. In Angola the prevalence of moderate chronic malnutrition under the age of 5 is 38%, the prevalence of severe chronic malnutrition is 15%. The percentage of children under 5 who suffer from moderate acute malnutrition is 5%, the percentage of those who suffer from a severe acute form is 1%.

The province of Cunene, where this study was carried out, is the one with the highest percentage of acute malnutrition (11% of children under 5 years). It is estimated that only 13% of children between 6 and 23 months meet the WHO criteria for minimum acceptable diet (only 2% In the provinces of Luanda Norte and Cunene [3].

Our study took place at the "Hospital da Missão Catolica do Chiulo", owned by the Catholic diocese of Ondjiva but also supported by the Angolan government and CUAMM. Its reference population is about 300,000 people organized in family groups and residing in rural areas without telephone networks, public transport, electricity and water [1].

There are three main forms of malnutrition: undernutrition, hidden hunger and overweight [4].

Our work has focused on the study of childhood undernutrition. In the following discussion, for simplicity, the term "malnutrition" will be used to refer to the condition of undernutrition.

Malnutrition is both a consequence and one of the main causes of poverty and deprivation. The impairment of the physical and cognitive development of citizens, inevitably, has repercussions on the development of the entire country. A state of malnutrition, especially in the first thousand days, has significant consequences. In fact, it is a crucial period for the establishment of proper linear growth and adequate neurological development.

In the context of undernutrition, we can distinguish at least three different clinical conditions with reference to 2006 WHO growth charts:

- "Stunting", term that indicates the state of chronic malnutrition, defined by a height/length for age z-score less than − 2 SD. It is an expression of linear growth retardation.
- "Wasting", term that indicate s the state of acute malnutrition, defined by a weight for height/length z-score less than − 2 SD. This index is an expression of body mass in relation to height and describes the current nutritional status. It is further distinguished into SAM (Severe Acute Malnutrition) when the WHZ is <−3SD, and MAM (Moderate Acute Malnutrition) when the WHZ is between − 2 SD and -3SD.
- "Underweight", a composite index that takes into account both chronic malnutrition and acute malnutrition but does not distinguish between the two and which is defined by a weight for age z-score less than − 2 SD [5].

So, it is essential for the diagnosis and clinical management of malnutrition, to get accurate anthropometric measurements and therefore proper tools and specifically trained personnel. This can be a challenge, especially in rural contexts [6]. It is estimated that SAM affects nearly 20 million preschool children around the world, most of them are in Africa and South East Asia [7]. Globally, acute malnutrition triggers more than 50% of childhood mortality in children under 5 years old, which implies that about 3.5 million children die of malnutrition each year [8, 9].

According to the WHO guidelines of 2013 (the latest published), the diagnosis of Severe Acute Malnutrition is placed in the presence of at least one of the following three criteria: 1) weight for height/lenght z-score < − 3 SD; 2) MUAC < 11,5 cm in children between 6 and 59 months; 3) presence of bilateral pitting edema.

The diagnosis of SAM imposes the need to include the patient in a program for clinical management and follow-up of malnutrition. First, it will be established whether the patient's condition requires hospitalization and consequent "intensive" treatment or an outpatient management may be sufficient, ideally in the health center closest to home [10].

Objectives

The objective of this study is to investigate potential prognostic factors in the clinical evolution of acute malnutrition and potential risk factors for the development of this disease, by studying a low-resource hospital setting in a country with poor health indicators.

Patients and methods

Our study consists of two parts. In the first one, we analyzed a sample of 163 patients admitted to the UEN (Unidade Especial de Nutrição) of the Chiulo Hospital for acute malnutrition, over a period of 6 months (November 2018–May 2019). For each patient we collected data on age, sex, anthropometric data at entry (weight, length, MUAC, weight for height z-score, weight for age z-score, height for age z-score), presence or absence of edema, anthropometric data at discharge, outcome (discharged, escaped or deceased), average weight gain (g/Kg/die), length of hospitalization and presence of pathologies or associated clinical conditions. The goal of this first part was to identify possible prognostic factors in the clinical evolution of the disease. The analysis was carried out by dividing the patients into groups on the basis of some variables, considered as potential prognostic factors (age, sex, severity of malnutrition, presence of stunting, presence of associated pathologies), and comparing the different groups in relation to the following clinical outcomes: length of hospitalization, average weight gain, difference between discharge weight and target weight (weight for which WHZ is − 2 DS), difference between MUAC at admission and at discharge and mortality. The averages of the parameters evaluated as outcomes, have been calculated without considering the patients who died and escaped, so that these data were not influenced by mortality. In the comparison between the different groups, the evaluation of statistical significance was carried out by applying the Student's T test.

The second part of our study was carried out by administering a questionnaire to a group of malnourished children's caregivers and to a group of caregivers of non-malnourished children admitted to Pediatrics for other causes. The questionnaire consisted of a first part with the patient's personal and anthropometric data, a section on perinatal anamnesis, with particular attention to the opportunities of access to health services, then the nutritional anamnesis, the maternal anamnesis and some data relating to socio-economic conditions of the family nucleus (Fig. 1). The goal of this second part of the study was to identify possible risk factors for the development of acute malnutrition. The questionnaires were administered to the caregivers with the help of Angolan nurses who acted as interpreters, translating the questions from

NAME: _____, GROUP: UEN / PEDIATRICS

Age (months)_____ lenght/height_____ Weight_____

WHZ _____ MUAC_____

PERINATAL ANAMNESIS

Born at home Born in Hospital/ Health center

Vaccinations: YES / NO Antenatal Visits: YES / NO

Birth weight: <2500 g >2500 g

He/She lives with mom: YES / NO

NUTRITIONAL ANAMNESIS

Age of introduction of water: < 6 months ≥ 6 months

Age of suspension of breastfeeding: < 6 months 6-12 > 12 months

Interval between suspension of breastfeeding and hospitalization:
< 3 months 3-6 months > 6 months

Reason for suspension of breastfeeding:
_____

Age of introduction of complementary foods:
≤3 months 4- 6 months > 6 months

Reason for early introduction (<6 months) of complementary foods:
_____

Number of meals per day:_____

Food category	Consumed by the child	Available at home
Cereals, roots and tubers		
Legumes and nuts		
Dairy products		
Flesh foods		
Eggs		
Fruits and vegetables		
Cereals, roots and tubers		

NOTES_____

MATERNAL ANAMNESIS

Age of the mother: <20 years 20-30 years 30-40 years >40 years

Maternal education: YES / NO

Maternal BMI < 18,5 18,5-25 25-30 >30

HIV SI / NO in treatment SI / NO

TB SI / NO

Number of children _____

Deceased children: YES / NO (how many_____age:_____)

Type of house: hut made of sheet metal made of cement

Type of Kitchen: wood gas

Fig. 1 Questionnaire on risk factors for malnutrition

Portuguese to the local dialect to make them understandable to mothers who did not speak Portuguese (most of them). Each questionnaire took about 20 min, making that moment an opportunity to perform nutritional education. Given the time required for administration, and the need for local staff available for translation, the final number of questionnaires was limited (52 mothers of malnourished children and 22 mothers of non-malnourished children interviewed) compared to the size of the sample of the first part of the study (163 malnourished). This is the main limitation of our study, which is why we considered carrying out a simple descriptive work on the questionnaires, which however provides us with a fairly representative picture of the socio-economic and family context in which the malnutrition pathology typically occurs.

Results

Sample characteristics

The 163 patients in our sample ranged in age from 6 to 48 months, the median was 12 months, with most (63.2%) in the 6–12 months range, only three patients were over 2 years. There was no significant prevalence of one sex over the other (48.5% male, 51.5% female).

By analyzing the degree of severity of acute malnutrition at admission, indicated by the value of the weight for height z-score (WHZ), it was observed that only 6.8%, showed a moderate acute malnutrition (− 3 SD ≤ WHZ < -2 SD), 47.2% had a severe acute malnutrition (− 4 SD ≤ WHZ < -3 SD), 46% were suffering from very severe acute malnutrition ("Malnutrição aguda muito severa- MAMS", WHZ < -4 SD). The evaluation of the height for age z-score allowed us to highlight that only 60% of patients had a stunting pattern associated with wasting. In a significant proportion therefore acute malnutrition had arisen in the absence of a previous impairment of linear growth.

The diagnosis of SAM was made for the presence of at least one of the three WHO criteria. In particular only in 7 patients all three criteria were satisfied, in 112 patients the criteria met were MUAC < 11.5 cm and WHZ < -3 SD, in 20 patients only the WHZ criterion, in 11 patients only the MUAC criterion, only one patient had MUAC < 11.5 cm associated with edema, only one was diagnosed for the presence of edema only. So not always all three diagnostic criteria were satisfied.

Another aspect that we wanted to study is the presence of other pathologies or clinical conditions that can sometimes accompany severe acute malnutrition. We do not clearly refer to those acute intercurrent pathologies but to pre-existing clinical conditions, congenital, chronic or long-lasting pathologies.

In our sample, 21 of 163 patients (13%) had the following conditions (Fig. 2): Tuberculosis, HIV, Tuberculosis + HIV, sickle cell disease, encephalopathy, congenital heart disease, preterm birth.

The average length of hospitalization of the patients studied was 7.9 days. If we exclude deceased and escaped patients, the average length of hospitalization for regularly discharged patients is 8.8 days.

The mortality recorded in our sample was 11.7%. In fact, 19 patients died, whose average hospital stay was 3.4 days. In addition, 4 escapes were recorded, a fairly widespread phenomenon that generally concerned very serious patients, with minimal chances of survival outside the hospital. Combining the two groups (deceased and escaped) we have 14.5% of cases in which there has been a therapeutic failure.

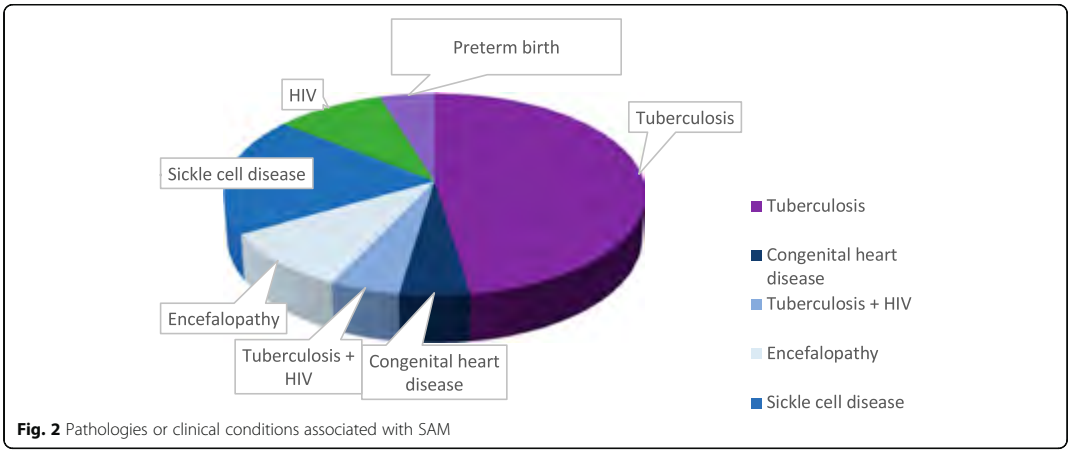


Fig. 2 Pathologies or clinical conditions associated with SAM

Analysis of potential prognostic factors

We first divided the population into two groups based on age. The first group (103 patients), was aged between 6 and 12 months and with a similar representation of both sexes, the second group (60 patients) aged> 12 months and higher prevalence of females (55% F, 45% M). The variable "age" was not related to a statistically significant difference in the severity of malnutrition at admission or to a different prognosis in terms of length of hospitalization, weight gain and mortality.

We then divided the population into two groups based on the variable "sex", we saw that males and females showed slight differences in terms of average age (slightly lower in males, 13.5 months vs 14.6) and severity of malnutrition at admission (average WHZ – 4.3 SD in males, – 3.7 SD in females). Even in this case, however, the variable considered (sex) was not significantly associated with a difference in terms of outcomes. Only minimal differences emerged regarding the outcomes considered, but were not statistically significant in the Student's T test. Mortality was also similar in the two groups (11.4% M, 11.9% F).

Another variable analyzed, as a potential prognostic factor, is the severity of acute malnutrition at the time of admission, represented by the WHZ. We have divided the population into three severity groups: patients with moderate acute malnutrition or MAM (– 3 SD ≤ WHZ < -2 SD); patients with severe acute malnutrition or SAM (– 4 SD ≤ WHZ < -3 SD); patients with very severe acute malnutrition or MAMS (WHZ < - 4 SD). (Table 1).

As shown in Table 1, there are some significant differences between these three groups of patients, especially regarding the presence of pathologies/clinical conditions associated with malnutrition. Furthermore, observing the analyzed outcomes, as the severity of the pathology at entry increases, the average length of stay increases (Fig. 3).

The comparison between the average length of hospitalization of the three groups of patients was made using the Student's T test. The comparison between the MAMS group and the MAM group allowed us to demonstrate the existence of strong evidence against the hypothesis 0 that the averages are equal (p value 0.01). So, the difference between the average length of hospitalization of the MAMS group and the MAM group is statistically significant. However, this difference was not as significant in the comparison between the SAM group and the MAMS group (p-value 0.53), nor between the SAM group and the MAM group (p-value 0.18).

The average weight gain of most patients is concentrated in the range between 0 and 20 g/kg/day, but the cases of greater average weight gain (> 20 g / kg / day) mainly concerned those patients starting from a lower WHZ. The application of Student's T test in this case, however, revealed that the differences are not statistically significant. Probably a greater number of the sample could have confirmed the significance of this difference, especially in the comparison between the MAMS group and the MAM group, which is the one that reported the lowest p value (0.18).

We also analyzed whether and how the coexistence of a state of chronic malnutrition (stunting) can influence the prognosis of patients suffering from acute malnutrition. Some differences between patients with and without stunting, emerged regarding the average age, the severity of malnutrition at admission and the prevalence of associated diseases (Table 2, Fig. 4). The analysis of the outcomes related to growth showed that patients with stunting grow on average more during hospitalization, but the Student's T test did not give us a value of statistical significance (p-value 0.26). The mortality was instead significantly higher in the stunting group than in patients without stunting.

By subdividing the population based on the presence or absence of associated pathologies, substantial differences emerged both in terms of individual characteristics and in prognostic terms (Table 3). Regarding the average age, the application of the Student's T test allowed us to demonstrate that this difference is statistically significant (p-value 0.007).

Table 1 Anlalysis of the variable "Severity of acute malnutrition at the time of admission"

Severity of acute malnutrition	Average age	Associated pathologies	Lenght of hospitalization[a]	Average weight gain[a]	Difference target weight/ discharge weight[a]	Difference MUAC at admission/ MUAC at discharge[a]	Mortality
Moderate (MAM) 11 patients	12.8 months	27%	6.2 days	12.3 g/Kg/die	–30 g	0.3 cm	18%
Severe (SAM) 77 patients	14.3 months	8%	8.2 days	14.7 g/Kg/die	180 g	0.4 cm	5.2%
Very severe (MAMS) 75 patients	14.3 months	16%	10.3 days	16.3 g/Kg/die	640 g	0.7 cm	17%

[a]Deaths and escapes were excluded from the average

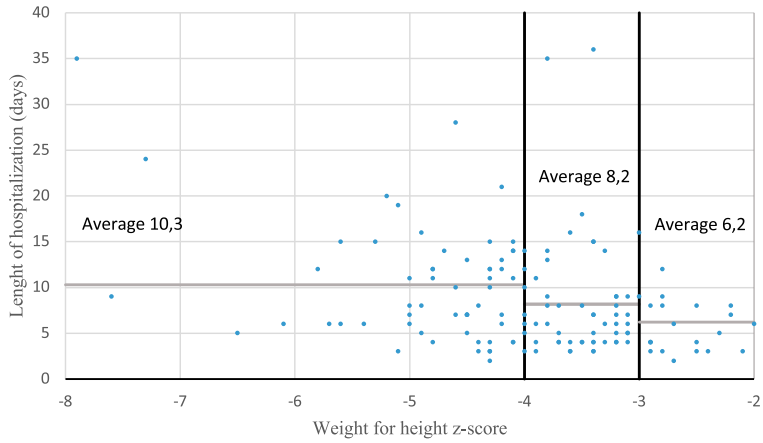


Fig. 3 Length of hospitalization in relation to the WHZ value at admission

Patients with associated diseases had a longer average length of hospitalization and a lower average weight gain. Also in these cases it has been shown that the difference between the averages is statistically significant, being the p-value 0.007 in the case of the average weight gain, even lower in the case of the duration of hospitalization (< 0.0001).

Analysis of potential risk factors

We first evaluated the characteristics of the sample of 52 malnourished whose mothers were interviewed, to verify that it was representative of the entire malnourished population. The average age of this group was 12 months, 46.2% were male, 53.8% female, the mean WHZ in the interviewed sample was − 3.9 and the mean MUAC was 10.6. For all these aspects, the sample studied could be considered quite representative of the UEN patient population. The only data that differs is that of mortality, which is lower in the sample of the 52 patients interviewed (5.8%).

The average age of the sample of 23 non-malnourished children, whose mothers were interviewed, was 14.6 months, the median of 12 months. 52% were male children, 48% female. Only one of these children died.

In perinatal anamnesis, the first aspect that we have analyzed is access to health services. We investigated the place of birth (home or hospital), the execution of antenatal visits and vaccinations. In both groups most patients were born in hospital or health center, had vaccinations and most mothers had visits during pregnancy (Table 4).

Another risk factor analyzed is birth weight, which however cannot always be known precisely. In fact, there is no habit of memorizing the birth weight of children and almost always there is no health document to certify it. As the exact birth weight was often not known,

Table 2 Analysis of the variable "presence of stunting"

Lenght for age	Average age	Average WHZ at admission	Associated pathologies	Lenght of hospitalization[a]	Average weight gain[a]	Difference target weight/ discharge weight	Difference MUAC at admission/ MUAC at discharge[a]	Mortality
< −2 SD (Presence of stunting) 98 patients	14.2 months	−4.2 SD	17%	8.9 days	15.9 g/Kg/die	260 g	0.6 cm	13.3%
≥ − 2 SD (Absence of stunting) 65 patients	12.5 months	−3.9 SD	6%	8.4 days	13.5 g/Kg/die	460 g	0.4 cm	9.2%

[a]Deaths and escapes were excluded from the average

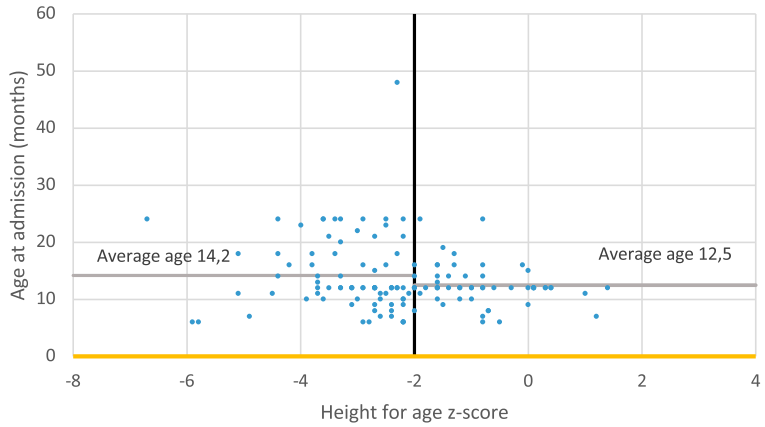


Fig. 4 Age of the patients in relation to height for age z-score

mothers were asked if their baby at birth was very small or normal/large. Although we are aware of the considerable approximation of this data, differences between the two groups emerged in this regard. Among the mothers of malnourished patients, 54% reported that their child was born large or normal, 42% that it was born very small, 4% did not know. Among the mothers of the non-malnourished, 91% reported that their child was born large or normal, 9% that they were born small. Being born small could indicate prematurity or low weight for gestational age and could be a sign of maternal malnutrition [11].

The next part of the questionnaire was based on the patient's eating habits with particular regard to breastfeeding and introduction of complementary foods. Table 5 shows that critical issues emerged in this regard in both groups, but with some differences (Table 5).

The WHO in 2008 published the document "Indicators for assessing infant and young child feeding practices" in which it describes indicators for the evaluation of infant and child nutrition, among these it introduces the concept of minimum acceptable diet - MAD), an index composed of the "minimum dietary diversity" and the "minimum meal frequency" for children aged between 6 and 23 months [12].

The criterion of minimum dietary diversity (intake of foods belonging to at least 4 different groups) in the group of malnourished patients was met in only 33% of cases. On average the patients in this group ate foods belonging to 2.8 different groups. If we consider the availability of food for the family unit, however, it emerges that 79% of the mothers interviewed report having food available at home belonging to at least four different groups. In the group of non-malnourished patients, 65% meet the criterion of minimum dietary diversity, with an average of 3.7 different food groups. Even in this case, however, there is a difference with the percentage of families who have food from at least 4 different groups (83%). Mothers were also interviewed about the type of food their children eat (Table 6).

The other parameter that constitutes the "minimum acceptable diet" is the "minimum frequency of meals", which is different in breastfed than in non-breastfed children and in relation to age. For breastfed babies the minimum number of solid/semi-solid meals should be 2 per day between 6 and 8 months, 3 per day between 9

Table 3 Analysis of the variable "presence of associated pathologies"

	Average age*	Average WHZ at admission	Presence of stunting	Lenght of hospitalization[a]	Average weight gain[a]	Difference target weight/ discharge weight[a]	Difference MUAC at admission/ MUAC at discharge[a]	Mortality
Presence of associated pathologies 21 patients	16.7 months	- 4.7 SD	80.9%	14.89 days	7.94 g/Kg/die	490 g	0.6 cm	0
Absence of associated patgologies 142 patients	12.9 months	−3.9 SD	55.6%	7.74 days	16.29 g/Kg/die	320 g	0.4 cm	13.4%

[a]Deaths and escapes were excluded from the average

Table 4 Access to health services

Groups	Place of birth				Antenatal visits				Vaccinations			
	Home		*Hospital/ Health center*		*Done*		*Not done*		*Done*		*Not done*	
	N.	%	N.	%	N.	%	N.	%	N.	%	N.	%
Patients admitted to UEN	22	42	30	58	45	86.5	7	13.5	48	92	4	8
Patients admitted to pediatrics	11	48	12	52	23	100	0	0	22	96	1	4

and 23 months. For non-breastfed infants, the minimum frequency of meals (solid/semi-solid and in this group also milk-based meals) is 4 between 6 and 23 months. This criterion was met among the malnourished in only 4 patients out of 52 (7.7%) and all these 4 children were breastfed. In the group of non-malnourished patients, 4 out of 23 met this criterion (17.4%), also in this case they were all children still breastfed.

Patients who meet both WHO criteria (minimum frequency of meals and minimum dietary diversity) are 2 out of 52 among the malnourished (3.8%) and 3 out of 23 among the non-malnourished (13%).

To conclude our analysis on risk factors for malnutrition, we analyzed family risk factors, with particular regard to maternal ones.

First was asked if the child's caregiver was the mother or another figure (usually another female family member). In the malnourished group, 83% of children lived with their mother, 17% with another family member, often because they were orphans. Among the non-malnourished, 95.5% lived with their mother, 4.5% did not.

Among the potential maternal risk factors, we considered age, education, BMI and the presence of HIV and Tuberculosis.

In the malnourished group, 13.5% of mothers were under the age of 20, 50% were between 20 and 30, 17.3% between 30 and 40 and 19.2% had more than 40 years. The group of mothers of non-malnourished patients did not show great differences in terms of age (13% < 20 years, 65% between 20 and 30, 9% between 30 and 40 and 9% > 40, 4% age not known).

Another factor considered is the maternal education, also in this case the two samples were comparable in both cases being constituted by approximately 50% of mothers who had attended the school and 50% of mothers who had never attended the school.

Regarding the BMI, no relevant differences emerged between the two groups. In both groups, most of the mothers were of normal weight (BMI between 18.5 and 25).

With regard to the presence of associated pathologies, in the malnourished group one of the mothers was infected with HIV and had died, another was suffering from tuberculosis. None of the mothers in the non-malnourished group presented these pathologies.

To analyze the characteristics of the family unit, we asked the mothers how many children they had and if all were still alive or, if not, how many of them had died. On this aspect, important differences emerged between the two groups.

On average, the mothers of the malnourished had 4.2 live children compared to 2.7 for the mothers of the non-malnourished. Malnourished children therefore seem to belong on average to larger families. However, the even more striking figure concerns the deceased children. Out of 52 mothers of malnourished patients interviewed 23 (44%) had had at least one deceased child (among these the average was two deceased children each). In the other group, however, 3 mothers out of 23 (13%) had lost at least one child.

Finally, we tried to analyze some characteristics that could be indicative of the socio-economic level of the family unit. We considered the type of house and the type of kitchen in which the meals were prepared. We asked the mothers if they lived in a hut (71% of the malnourished vs 43% of the non-malnourished), in a house made of sheet metal (17% of the malnourished vs 43% of the non-malnourished) or in a house made of cement (12% of malnourished vs 9% of non-malnourished). With regard to the type of cuisine used, 90.4% of the mothers of the malnourished and 91.3% of those of the non-malnourished cooked with wood, 9.6% of the former and 8.7% of the latter with a gas kitchen.

Discussion

From the analysis of the characteristics of our sample, it emerged that hospitalizations for acute malnutrition at the Chiulo Hospital, in accordance with the literature data, mainly concern children aged between 6 and 24 months. This is the age group most susceptible to this disease. This period corresponds with the introduction of complementary foods and unfortunately, very often with an early suspension of breastfeeding [13]. Before 6 months, breastfeeding plays an important protective role, none of our patients were less than 6 months old.

Regarding the diagnostic criteria for SAM, our data confirmed the importance of assessing all the parameters to prevent some cases might escape diagnosis. In fact, not always all three diagnostic criteria were met [14, 15]. In our sample, 21 patients would have escaped the

Table 5 Patient's eating habits

Group	Age of introduction of water		Age of suspension of breastfeeding				Interval between suspension of breastfeeding and hospitalization			Age of introduction of complementary foods			
	< 6 months	> 6 months	Not suspended yet	< 6 months	6–12 months	> 12 months	< 3 months	3–6 months	> 6 months	Not introduced yet	< 3 months	3–6 months	> 6 months
Patients admitted to UEN (malnourished)	65%	35%	35%	4%	27%	33%	42%	11.5%	10%	2%	25%	23%	50%
Patients admitted to pediatrics (not malnourished)	70%	30%	70%	0	13%	17%	4%	4%	22%	–	13%	39%	48%

Table 6 Percentages of patients who eat the foods of the different categories, in the UEN group and in the Pediatrics group

Food category	Patients admitted to UEN	Patients admitted to Pediatrics
Cereals, roots and tubers	96%	91%
Legumes and nuts	31%	52%
Dairy products	42%	52%
Flesh foods	42%	52%
Eggs	27%	57%
Fruits and vegetables	35%	61%

diagnosis with the sole use of MUAC (a widespread practice especially in peripheral centers).

The mortality of our sample was quite high, but similar to that reported in the literature [16]. Most of the deceased were patients who already arrived in extremely serious conditions. The death often occurred a few days after hospitalization, as demonstrated by an average length of hospitalization significantly shorter than the rest of the sample. This data is consistent with those reported in similar studies carried out in other countries [17].

The analysis of prognostic factors has shown that the variables "age" and "sex" do not seem to be associated with significant changes in the clinical outcome. Differences in terms of outcome were instead observed among patients with different degrees of severity at the time of hospitalization as shown in Table 1. In fact, the most serious patients, in terms of WHZ at admission, remain hospitalized longer but seem to grow more both in terms of weight and MUAC (even if the small number of the sample does not allow us to confirm the latter data). Mortality was much higher in the group of patients with lower WHZ. This is probably the data that more clearly confirms that the lower is the WHZ, the worse is the prognosis. Mortality in the MAM group is also high, but this assumes little significance in relation to the low number of the sample and the high percentage, in this group, of patients with associated diseases.

Furthermore, among the most serious patients the percentage of those with associated diseases was higher. This leads us to reflect on the importance of always suspecting an associated disease, especially in those with a WHZ < - 4 DS.

Another variable considered as a possible prognostic factor is the presence of stunting. It should be emphasized that the height for age z-score, in rural contexts such as Chiulo, has an important limit. Most children are not registered at birth and do not present any documents [18]. Furthermore, the date of birth is not given the importance that we are accustomed to attribute to it. So the mothers often did not remember the date of birth of their children. It follows that the reported age did not always correspond to the real one. Any evaluation on the height for age parameter must take this aspect into account. However, we considered it appropriate to make an assessment of chronic malnutrition, while not ignoring these limits.

Regarding the variable "presence of stunting", we observed that the average age is higher in the stunting group as well as the length of hospitalization; in both cases, the difference is not statistically significant. However, a fact to be highlighted is that the very few cases of long-term hospitalizations (over 30 days) are all concentrated in the stunting group. These are patients suffering from diseases associated with SAM, mainly tuberculosis, which justify the longer length of hospitalization and which typically, also compromise linear growth. The presence of associated pathologies and mortality were much higher in the stunting group.

The variable that gave the most significant results is the presence of associated pathologies. Patients with associated pathologies were on average older. Three of these 21 patients were even older than 24 months, and were therefore outside the typical age range for developing SAM. This confirms that in an older patient with SAM it is always important to look for an associated pathology. The "primitive" SAM is typically a pathology of the younger child.

In addition, patients with associated pathologies had a WHZ lower at the admission, they more often presented stunting, and this is easily to understood by knowing the impact that chronic diseases have on linear growth [19]. They remained hospitalized longer and had lower average weight gain. All these differences were statistically significant. A data in contrast with these is that of mortality, no deaths were recorded in the group of patients with associated pathologies. However, it should be considered that the deaths all occurred in the first 2-3 days. So, we cannot exclude that among the deceased there were patients with associated diseases that we did not have time to diagnose.

The second part of our study focused on identifying potential risk factors for acute malnutrition. Due to the time required for the administration of the questionnaire and the need for local staff to act as interpreters, the final number of questionnaires was quite limited. The very small number of mothers of non-malnourished patients interviewed is sadly linked to the very high

prevalence of malnutrition in this geographical area. Often, even patients hospitalized in Pediatrics for other pathologies, presented some degree of malnutrition that did not allow us to include them in the control group. However, despite the limitations linked to the low number of samples, we believe that our data shows a fairly representative picture of the context in which malnutrition occurs.

We first evaluated if the sample of malnourished was representative of the entire population of patients admitted to UEN. The two samples were comparable for most of the characteristics except for mortality. This is influenced by the fact that we have rarely had time to administer the questionnaire to the mothers of the deceased children. The short time of hospitalization, together with the extremely serious conditions of these patients, did not allow creating the conditions for the administration of the questionnaire.

The first aspect we analyzed is access to health services, potential opportunities for health education. In theory, those who have had more opportunities to access services should be more sensitive to certain issues (such as malnutrition) than those who have never or almost never had recourse to a health facility (quite frequent occurrence in such contexts). Any access to services should be an opportunity to carry out health education with particular reference to nutritional education. Our data did not reveal any significant differences between the two groups, in both there had been occasions of access to services. It therefore emerges that access to health services is likely to be opportunities that are not exploited enough. It would be advisable to carry out awareness campaigns and training of health personnel on this aspect. This is an intervention almost at no cost that could have important implications. At the Chiulo Hospital, patients in the waiting room are entertained with the so-called "gyms", that is short and simple lessons by the staff on certain pathologies and their prevention strategies. This habit should be extended to the other wards and health centers.

The analysis of eating habits revealed interesting data, especially on breastfeeding and weaning habits. Breastfeeding is known to be protective against numerous pathologies, for its ideal nutritional characteristics but also for the countless other properties, first of all the immunomodulating ones [20, 21]. In developing countries, its role becomes even more important as it can really make the difference between the survival and death of children [5, 9]. It is the only food that is safe in microbiological terms in the first months of life (scarce availability of safe water sources). In many contexts, it is the only one that can guarantee the nutrients necessary for a growing organism, in consideration of the very limited availability of other foods. It is for these reasons that, despite the small number of our samples, substantial differences emerge between the malnourished group and the non-malnourished group regarding breastfeeding.

Almost none of both groups had suspended breastfeeding before 6 months, but a significant proportion of the malnourished had suspended it between 6 and 12 months. It is also significant that at the time of admission only 35% of the malnourished were still breastfed compared to 70% of the non-malnourished, despite an average age comparable in the two groups. This may be indicative of the protective role of breast milk against SAM. One element that we wanted to investigate is the interval between the suspension of breastfeeding and hospitalization for SAM to highlight a potential role of the suspension of breastfeeding as a trigger for acute malnutrition. Among patients admitted to UEN, 42% had stopped breastfeeding less than 3 months before admission. In these children it is likely that this dietary change was the trigger for SAM. Of the patients admitted to pediatrics (not malnourished), only 4% had stopped breastfeeding less than 3 months earlier.

There was a fairly low prevalence of exclusive breastfeeding in the first 6 months in both groups. In this regard, the analysis of habits related to the weaning revealed critical issues in both groups. Among the malnourished, even 25% had started taking complementary foods before 3 months of life. The extremely early introduction of complementary foods is confirmed to be an important risk factor for the development of malnutrition, as already highlighted by other studies [22]. When other foods are introduced, the intake of breast milk and therefore its production is inevitably reduced. In addition, the risks of administering semi-solid foods to an individual not yet mature enough to take them, together with the poor quality of the foods administered, contribute to the extreme inadequacy of nutrition that these children practice. Another aspect studied is the age of introduction of the water. In the context in which our study was carried out, the administration of water under the age of 6 months was an extremely widespread practice (as shown in Table 5). In such contexts, the recommendation not to give water to small infants should be even stronger. In fact, water is often unsafe and can seriously endanger the survival of these children.

Therefore, despite the high prevalence of breastfeeding (almost 100% of children have practiced it), are absolutely unsatisfactory the percentages of those who only take breast milk in the first 6 months of life, introduce complementary foods at the correct times and continue breastfeeding up to 24 months [3].

With regard to the type of food consumed, there was little dietary variability in both groups. An interesting fact is the discrepancy between the availability of food at

home and its intake by children. Often at the basis of inadequate nutrition, there is not only limited food availability but also cultural factors and lack of knowledge of children's needs [23]. It is clear once again how important it is to carry out nutrition education campaigns to educate families on how to make the most of available resources [24]. The foods in the category of cereals, roots and tubers are the most widely consumed. Many families grow various types of cereals to produce flours that they use in the preparation of "funge" (a staple food typical of Angola). There are many children, especially in rural areas, whose diet consists almost exclusively of foods of this group with consequent very serious nutritional deficiencies. They are low-cost, locally produced foods that easily give a sense of satiety, thus allowing, with a minimum expense, to feed very large families. Foods rich in proteins (legumes, dairy products, meats, eggs) are consumed only by small percentages of children, especially among the malnourished. False beliefs also play their role, such as the belief that that children cannot take eggs or that legumes cause diarrhea. Furthermore, there is no habit of transforming foods such as meat and fish to prepare baby food that also little children can eat. The percentages of those who meet the minimum meal frequency criterion are also very low. In particular, none of the children not breastfed in both groups meets this criterion. It once again emerges that breastfeeding is a fundamental resource for guaranteeing children of this age group a diet that is minimally acceptable, even in the presence of extremely limited economic resources.

The analysis of family risk factors revealed a greater risk of malnutrition in those who do not live with their mother. This may partly be because they are often orphans, who have never been breastfed or have been for a short time.

Among the family risk factors, age, educational level and BMI of the mother, according to our data, do not seem to be significantly associated with childhood malnutrition, although the small number of samples does not allow us to exclude a correlation, which has instead been demonstrated in other studies [7, 25].

The differences in the characteristics of the family unit were relevant. On average, the families of the malnourished were more numerous. The percentage of families in which at least one child had died was higher in this group, although even among the non-malnourished this percentage was high. In both cases, these are dramatic numbers, especially when compared with our realities in which, the loss of a child is an exceptional event. However, once the emotional impact of such data has been overcome, it is evident that the presence of deceased children always represents an important alarm bell that should never be underestimated and that must make us consider that patient at high risk.

Regarding the two indices of socio-economic level considered (type of house and type of kitchen) the first was different in the two groups (with the vast majority of malnourished people living in a hut), the second was instead comparable in the two groups. We believe that more numerous samples would probably have confirmed a correlation between the risk of malnutrition and the socio-economic level, as already demonstrated in other studies.

Conclusions

This work, despite the limitations relating to the short period in which the data collection could be carried out and consequently to the small size of the population studied, wanted to provide a picture of the main issues still open in the field of acute malnutrition.

In some rural contexts, such as the one examined, the malnutrition rate is so high that the vast majority of children, especially under 2 years of age, have some degree of malnutrition. So, in the eyes of their parents, those children seem "normal" when compared to others of the same age [19]. The perception of the malnutrition problem often by caregivers is absolutely non-existent, until one acute event occurs that precipitate the delicate balance that had been created, leading to a full-blown picture of severe acute malnutrition.

Based on the collected data, some interesting elements emerged regarding the risk factors for the development of the disease, the diagnosis of acute malnutrition, but also regarding potential prognostic factors. Our data have confirmed the importance, in the face of a child with suspected malnutrition, to carry out a global clinical evaluation using all the anthropometric measures available to prevent many cases from escaping diagnosis and treatment. In this regard, staff training programs would be essential for identifying and managing cases of malnutrition, especially in more peripheral contexts [26].

Among the prognostic factors, the most relevant were the WHZ at the time of admission, the presence of stunting and the presence of chronic diseases/clinical conditions associated with SAM.

A lower weight for height z-score (WHZ) correlate with longer length of hospitalization, higher mortality, and, in those who survived, a trend towards greater average weight gain.

Patients with Stunting were older on average, had associated diseases more often, and had slightly higher mortality.

Patients with other associated pathologies/conditions had a higher average age than the others, a longer average length of hospitalization and a lower average weight gain. SAM associated with other pathologies has very

different characteristics compared to "primitive" SAM, often the underlying pathology is the main etiological factor of acute malnutrition. While such patients tend to have a more severe disease course, on the other hand if the disease in question is promptly identified and treated (where this is possible as in the case of tuberculosis), the chances of recovery from SAM are much higher.

With regard to risk factors, the importance of breastfeeding as a protective factor against malnutrition has emerged in a striking way.

Even the practice of weaning is often burdened by significant problems and often this is not due solely and simply to the food shortages. Nutritional education campaigns are necessary, they should be based on a deep knowledge of the socio-economic and cultural context in which the patients live, of the available resources and they should be carried out on the territory. Even when these efforts are carried out flawlessly, there are, however, a considerable number of cases in which the basic problem remains the dramatic unavailability of nutrients. So, the best impact is likely to be achieved for those interventions in which the provision of complementary foods is combined with nutrition education [13].

Malnutrition is a multifactorial pathology in which genetic, epigenetic, cultural, environmental, socio-economic factors interact with each other. Unfortunately, it is a pathology that is little known in developed countries but which, due to the dramatic impact it has on children's health worldwide, deserves to be known at all latitudes. In today's world, in fact, having a projected look on global health is now necessary for those involved in health care. Opening up to health problems that have historically been considered of exclusive interest to "distant" countries, is a precious opportunity not only for those who want to spend themselves in the field of international cooperation, but also for those involved in child health in our country, always more multi-ethnic and globalized.

Abbreviations

BMI: Body Mass Index; CUAMM: Collegio Universitario Aspiranti Medici Missionari; HIV: Human Immunodeficiency Virus; IIMS: Inquérito de Indicadores Múltiplos e de Saúde; MAM: Moderate Acute Malnutrition; MAMS: "Malnutrição aguda muito severa" (Very severe acute malnutrition); MUAC: Mid-upper arm circumference; NGO: Non Governmental Organization; RUTF: Ready to Use Therapeutic Foods; SAM: Severe Acute Malnutrition; UEN: "Unidade Especial de Nutrição" (Special Nutrition Unit); WHO: World Health Organization; WHZ: Weight for height z-score

Acknowledgements

We are very grateful to all the nurses of Chiulo Hospital for having acted as interpreters in administering the questionnaires to caregivers and for the deep devotion in every day care for Angolan children.
We are grateful to Dr. Giuseppe Carollo for his support in statistical analysis.
We are grateful to CUAMM for the huge work it does for the right to the health of the children, especially the most marginalized.

Authors' contributions

FMT, SA, SLP and MG: design of the study; FMT and AP: administration of questionnaires to caregivers and data collection; FMT and SA data analysis; GP, GC and MG: supervision; FMT: writing - original draft preparation; SA, GC and MG: writing - review and editing. All Authors approved the final manuscript as submitted.

Funding

This research received no external funding.

Availability of data and materials

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate

The study was approved by the Mother and Child Department of the University of Palermo (Palermo, Italy). All procedures performed in this report were in accordance with the ethical standards of the institutional and national research committee, and with the 1964 Helsinki declaration and its later amendments, or comparable ethical standards.

Consent for publication

Not applicable.

Competing interests

The authors declare that they have no competing interests.

Author details

[1]Department of Health Promotion, Mother and Child Care, Internal Medicine and Medical Specialties, University of Palermo, Palermo, Italy. [2]Doctors with Africa, CUAMM, Chiulo, Ombadja, Angola.

Received: 26 April 2021 Accepted: 26 August 2021
Published online: 10 September 2021

References

1. Doctors with Africa CUAMM, https://doctorswithafrica.org/en/. Accessed 01 March 2021.
2. Núñez Sabarís A, Ruiz R V, Satorras Orriols M, Guillot de la Puente S, Cardús O, José Aniceto do Rosario Mario. Formative Evaluation Report CP Angola. https://www.ungm.org. Accessed 17 Feb 2020.
3. Instituto Nacional de Estatística (INE), Ministério da Saúde (MINSA), Ministério do Planeamento e do Desenvolvimento Territorial (MINPLAN) e ICF. Inquérito de Indicadores Múltiplos e de Saúde em Angola 2015-2016. Luanda, Angola e Rockville: INE, MINSA, MINPLAN e ICF; 2017.
4. UNICEF. The state of the World's children 2019. Children, Food and Nutrition: Growing well in a changing world. New York: UNICEF; 2019. Available at https://www.unicef.org/reports/state-of-worlds-children-2019. ISBN 978-92-806-5003-7.
5. Akombi BJ, Agho KE, Hall JJ, Wali N, Renzaho AMN, Merom D. Stunting, wasting and underweight in sub-Saharan Africa: a systematic review. Int J Environ Res Public Health. 2017;14(8):863. https://doi.org/10.3390/ijerph14080863.
6. Kok MC, Dieleman M, Taegtmeyer M, Broerse JE, Kane SS, Ormel H, et al. Which intervention design factors influence performance of community health workers in low- and middle-income countries? A systematic review. Health Policy Plan. 2015;30(9):1207–27. https://doi.org/10.1093/heapol/czu126 Epub 2014 Dec 11. PMID: 25500559; PMCID: PMC4597042.
7. Pravana NK, Piryani S, Chaurasiya SP, Kawan R, Thapa RK, Shrestha S. Determinants of severe acute malnutrition among children under 5 years of age in Nepal: a community-based case-control study. BMJ Open. 2017;7(8):e017084. https://doi.org/10.1136/bmjopen-2017-017084.
8. Park SE, Kim S, Ouma C, Loha M, Wierzba TF, Beck NS. Community management of acute malnutrition in the developing world. Pediatr Gastroenterol Hepatol Nutr. 2012;15(4):210–9. https://doi.org/10.5223/pghn.2012.15.4.210.
9. Hassen SL, Astatkie A, Mekonnen TC, Bogale GG. Survival status and its determinants among under-five children with severe acute malnutrition admitted to inpatient therapeutic feeding centers in south Wollo zone,

Amhara region. Ethiopia J Nutr Metab. 2019;2019:2643531–9. https://doi.org/10.1155/2019/2643531.
10. Tickell KD, Denno DM. Inpatient management of children with severe acute malnutrition: a review of WHO guidelines. Bull World Health Organ. 2016; 94(9):642–51. https://doi.org/10.2471/BLT.15.162867.
11. Piro E, Serra G, IAM S, Giuffrè M, Corsello GF, et al. Growth restriction: A growth pattern with fetal, neonatal and long-term consequences. EuroMediterr Biomed J. 2019;14(9):38–44. https://doi.org/10.3269/1970-5492.2019.14.09.
12. World Health Organization. Indicators for assessing infant and young child feeding practices: part 1: definitions: conclusions of a consensus meeting held 6–8 November 2007 in Washington D.C., USA. 2008.
13. Dewey KG, Adu-Afarwuah S. Systematic review of the efficacy and effectiveness of complementary feeding interventions in developing countries. Matern Child Nutr. 2008;4(Suppl 1):24–85. https://doi.org/10.1111/j.1740-8709.2007.00124.x PMID: 18289157; PMCID: PMC6860813.
14. Tadesse AW, Tadesse E, Berhane Y, Ekström EC. Choosing anthropometric indicators to monitor the response to treatment for severe acute malnutrition in rural southern Ethiopia-empirical evidence. Nutrients. 2017; 9(12):1339. https://doi.org/10.3390/nu9121339.
15. Schwinger C, Golden MH, Grellety E, Roberfroid D, Guesdon B. Severe acute malnutrition and mortality in children in the community: comparison of indicators in a multi-country pooled analysis. PLoS One. 2019;14(8): e0219745. https://doi.org/10.1371/journal.pone.0219745.
16. Wagnew F, Dessie G, Takele WW, Tadesse A, Islam SMS, Mulugeta H, et al. A meta-analysis of inpatient treatment outcomes of severe acute malnutrition and predictors of mortality among under-five children in Ethiopia. BMC Public Health. 2019;19(1):1175. https://doi.org/10.1186/s12889-019-7466-x PMID: 31455292; PMCID: PMC6712890.
17. Kumar D, Rao SK, Kumar A, Singh TB. Risk factors of mortality in hospitalized children with severe acute malnutrition. Indian J Pediatr. 2019;86(11):1069. https://doi.org/10.1007/s12098-019-03016-0.
18. Bhatia A, Krieger N, Beckfield J, Barros AJD, Victora C. Are inequities decreasing? Birth registration for children under five in low-income and middle-income countries, 1999–2016. BMJ Glob Health. 2019;4(6):e001926. https://doi.org/10.1136/bmjgh-2019-001926 PMID: 31908868; PMCID: PMC6936526.
19. de Onis M, Branca F. Childhood stunting: a global perspective. Matern Child Nutr. 2016;12(Suppl 1):12–26. https://doi.org/10.1111/mcn.12231 PMID: 27187907; PMCID: PMC5084763.
20. Notarbartolo V, Carta M, Insinga V, Giuffrè M. Human milk is not "merely nutritious": How its bioactive role can influence child health. EuroMediterr Biomed J. 2021;16(5):21–6. https://doi.org/10.3269/1970-5492.2021.16.5.
21. Ferrante G, Carta M, Montante C, Notarbartolo V, Corsello G, Giuffrè M. Current Insights on Early Life Nutrition and Prevention of Allergy. Front Pediatr. 2020;8:448. https://doi.org/10.3389/fped.2020.00448 eCollection 2020.
22. Mukuku O, Mutombo AM, Kamona LK, Lubala TK, Mawaw PM, Aloni MN, et al. Predictive model for the risk of severe acute malnutrition in children. J Nutr Metab. 2019;2019:4740825–7. https://doi.org/10.1155/2019/4740825.
23. Sanghvi J, Mehta S, Kumar R. Predictors for weight gain in children treated for severe acute malnutrition: a prospective study at nutritional rehabilitation center. ISRN Pediatr. 2014;2014:808756–5. https://doi.org/10.1155/2014/808756.
24. Imdad A, Yakoob MY, Bhutta ZA. Impact of maternal education about complementary feeding and provision of complementary foods on child growth in developing countries. BMC Public Health. 2011;11(Suppl 3):S25. https://doi.org/10.1186/1471-2458-11-S3-S25 PMID: 21501443; PMCID: PMC3231899.
25. David SM, Pricilla RA, Paul SS, George K, Bose A, Prasad JH. Risk factors for severe acute malnutrition among children aged 6-59 months: a community-based case-control study from Vellore, southern India. J Family Med Prim Care. 2020;9(5):2237–43. https://doi.org/10.4103/jfmpc.jfmpc_211_20.
26. Jackson AA, Ashworth A, Khanum S. Improving child survival: Malnutrition Task Force and the paediatrician's responsibility. Arch Dis Child. 2006;91(8): 706–10. https://doi.org/10.1136/adc.2006.095596 PMID: 16861489; PMCID: PMC2083066.

Publisher's Note

Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

Ready to submit your research? Choose BMC and benefit from:

- fast, convenient online submission
- thorough peer review by experienced researchers in your field
- rapid publication on acceptance
- support for research data, including large and complex data types
- gold Open Access which fosters wider collaboration and increased citations
- maximum visibility for your research: over 100M website views per year

At BMC, research is always in progress.

Learn more biomedcentral.com/submissions

BMC

Children's Nutritional Rehabilitation Program in Beira, Mozambique: A Retrospective Study

PAPER

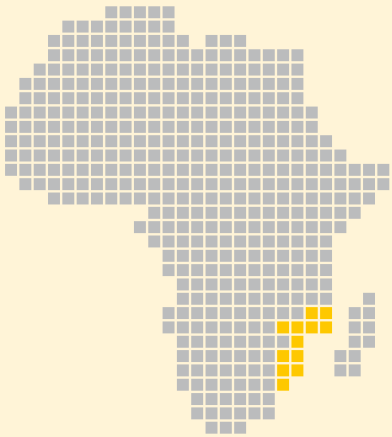
Authors
Calgaro S., Isidoris V., Girotto C., Chhaganlal K., Moiane J., Putoto G., Da Dalt L., Trevisanuto D., Verlato G., Pizzol D.

Published in
The American Society of Tropical Medicine and Hygiene,
September 2021

Link
https://doi.org/10.4269/ajtmh.20-0297

Topic
Nutrition

Focus country
Mozambique



Am. J. Trop. Med. Hyg., 105(6), 2021, pp. 1631–1637
doi:10.4269/ajtmh.20-0297
Copyright © 2021 by The American Society of Tropical Medicine and Hygiene

Children's Nutritional Rehabilitation Program in Beira, Mozambique: A Retrospective Study

Serena Calgaro,[1,2]* Valentina Isidoris,[3] Cristian Girotto,[1] Kajal Chhaganlal,[4] Jorge Moiane,[4] Giovanni Putoto,[2] Liviana Da Dalt,[1] Daniele Trevisanuto,[1] Giovanna Verlato,[1] and Damiano Pizzol[2]

[1]*Department of Woman's and Child's Health, University of Padova, Padova, Italy;* [2]*Operational Research Unit, Doctors with Africa CUAMM, Beira, Mozambique;* [3]*Operational Research Unit, Doctors with Africa CUAMM, Padova, Italy;* [4]*Center for Research in Infectious Diseases, Faculty of Health Sciences, Catholic University of Mozambique, Beira, Mozambique*

Abstract. Malnutrition is still a major public health issue in sub-Saharan Africa and Mozambique. The main aim of this study was to evaluate the adherence to the nutritional rehabilitation program (NRP) and its impact on the growth of malnourished children in Beira, Mozambique. The secondary aim was to verify the prevalence of HIV infection in malnourished children at the time of admission to the NRP. A retrospective observational study in Beira Central Hospital and 10 health centers in Beira, Mozambique, was conducted. All children 0 to 5 years of age with acute malnutrition admitted to the outpatient services of the NRP from March 2016 until February 2017 were included in the study. A total of 1,231 children with the following characteristics have been enrolled: 58% female; 33% severely malnourished; and 16.5% HIV-positive. Of the 198 (21.7%) children who completed the program, 177 (89.4%) recovered from malnutrition and 21 (10.6%) did not. Ten (1.1%) were hospitalized and 706 (77.2%) dropped out of the program. Among children who completed the program, the median weight-for-length and weight-for-height z-scores at admission were ≥ -3 and < -2; at discharge, these median z-scores were ≥ -1 ($P < 0.001$). Children with HIV infection and who were male had a higher prevalence of severe acute malnutrition ($P < 0.001$). Weight gain was found to be significant after 23 days ($P = 0.004$) of consuming supplements (ready-to-use therapeutic food). A diagnosis of the degree of malnutrition was accurate at admission for 70.5%; at discharge, this diagnosis was accurate for 67.2%. The NRP seems to be successful if correctly followed, even if it is limited by adherence problems. However, its effectiveness requires further investigation.

INTRODUCTION

Globally, malnutrition is considered a major public health issue in low-income countries. According to sustainable development goals, by 2025, stunting and wasting in children younger than 5 years of age should end, and by 2030, all forms of malnutrition should end.[1] In 2020, approximately 191 million children younger than 5 years were malnourished worldwide.[2] The majority of malnourished children live in low-income and lower-income to middle-income countries; specifically, 92% of wasting and 91% of stunted children live in these countries.[2] Asia seems to be the most affected region.[2] However, alarming data have emerged from Africa indicating that it is the only region where the number of stunted children has increased from 2000 to 2019; in 2019, the rate of wasting children younger than 5 years was 6.4%.[2]

In Mozambique, according to the National Institute of Statistics, children represent 52% of the national population.[3] From 2009 to 2013, 17% of children had low birth weight and only 11% of children from 6 to 23 months were receiving the minimum recommended acceptable diet.[4] Moreover, moderate and severe acute malnutrition are major reasons for accessing healthcare services in Beira.[5] In Mozambique, approximately 44% of children younger than 5 years have chronic malnutrition (in Sofala 39%) and 4% have acute malnutrition.[6]

In Mozambique, to ensure the effective treatment and nutritional rehabilitation of children with acute malnutrition, the Ministry of Health established the nutritional rehabilitation program (NRP) in 2010. It includes community involvement, inpatient malnutrition treatment, outpatient malnutrition treatment, nutritional supplementation, and nutrition education including cooking demonstrations.[7]

*Address correspondence to Serena Calgaro, Department of Woman's and Child's Health, University of Padova, via giustiniani 2, Padova, Italy. E-mail: serena.calgaro@gmail.com

An additional worsening and mutual risk factor is HIV/AIDS because of the high micronutrient requirements during all stages of the disease. The WHO guidelines advise that children with HIV should increase their energy intake up to 150% of the recommended daily allowance and their micronutrient requirement up to five-times the normal intake.[7] In 2019, 1.8 million children younger than 15 years worldwide[8] had HIV; in Mozambique alone, there were 140,000 children younger than 15 years with HIV in 2018.[9] A study performed in Beira between 2015 and 2017 showed that HIV exposure to children was the main reason for accessing health services.[5] The prevalence of HIV infection increases with age; in Beira, women older than 24 years have a higher prevalence of HIV infection than adolescents.[10] Although the connection between HIV and malnutrition is well-known, insufficient data are available in the Sofala province of Mozambique.

The main aim of this study was to evaluate the adherence to the NRP and its impact on the growth of children 0 to 5 years of age with acute malnutrition in Beira, Mozambique, after its introduction. The NRP is a new national protocol of nutritional rehabilitation. The secondary purpose of this study was to evaluate the prevalence of HIV infection in malnourished children.

This is the first study to describe the adherence to and the impact of the NRP in Mozambique. We believe that an assessment of the effective implementation and impact of the NRP will help to identify specific weaknesses, thereby allowing us to correct them and improve the outcomes of children, particularly those with comorbidities such as HIV infection, which may worsen their clinical situation.

MATERIALS AND METHODS

Study design. We performed a retrospective, observational study of the adherence to the recommendations of the outpatient services of the NRP and the impact of the NRP on the growth of children 0 to 5 years of age treated for acute

malnutrition in Beira (Mozambique) from March 2016 to February 2017.

Setting. Beira is a city located in Sofala province, which is in the central area of Mozambique. The population is approximately 550,000. Beira Central Hospital and 10 health centers (HCs), distributed within the area comprise the health facilities of the NRP for children with acute malnutrition. The Beira Central Hospital is a multispecialist 1,000-bed referral hospital for the entire Sofala province comprising approximately 2 million people. Its nutritional rehabilitation unit serves as stabilization center for patients referred from HCs with complications. It consists of 22 ordinary and 2 semi-intensive care beds, and the medical team comprises one pediatrician, two general physicians, four or five medical students, and two nurses. It also has an outpatient service (OS) department for follow-up after discharge. The HCs involved in the NRP are Munhava, Macurungo, Mascarenha, Chamba, Cerâmica, Ponta Gêa, Nhaconjo, Manga Loforte, Chota, and Nhagao. The HCs have an OS department managed by one nurse. The clinics have a scale, statimeter, and tape measure to obtain anthropometric parameters such as weight, height, and the mid upper arm circumference (MUAC).

Nutritional Rehabilitation Program. The inclusion criteria of the NRP are children with a diagnosis of acute malnutrition with or without medical complications, diagnosis of acute malnutrition obtained through anthropometric measurements such as the weight-for-length z-score (0–2 years) or weight-for-height z-score (older than 2 years) < -2 and/or MUAC $<$ 12.5 cm and/or clinical criteria such as edema, signs of thinness, or signs of rapid weight loss.[7]

Malnourished children older than 6 months without medical complications (bilateral edema, seizures, coma, lethargy, hypoglycemia, hypothermia, severe dehydration, lower respiratory tract infection, high fever, severe anemia, intractable vomiting, lack of appetite, skin changes, signs of vitamin A deficiency) are treated in the OS department of the HCs. The treatment of outpatient children is based on the use of routine medications (such as antibiotics, anthelmintics, antimalarials, vitamins, and trace elements) and the administration of ready-to-use therapeutic food (RUFT) or *Alimento Terapêutico Pronto para Uso*, which is food enriched with vitamins and minerals that has high energetic density and is designated for the treatment of severe acute malnutrition. The most used RUFT is Plumpy Nut (Table 1). In the case of moderate acute malnutrition, a blend of corn and soy flour-enriched formula with vitamins and minerals is used. At the HCs, regular evaluations of these children are performed (usually every 15 days), and the average outpatient program lasts 2 months.[7]

Children younger than 6 months or with medical complications are hospitalized and the program is divided into four phases: stabilization and transition; admission to Beira Central Hospital for approximately 10 days; rehabilitation and monitoring; and admission to the OS department for 19 weeks.[7]

Children treated by the OS department can be discharged when they meet the following criteria: weight-for-length/weight-for-height z-score ≥ -1 at two consecutive follow-up visits, presence of good appetite, and the possibility of eating food at the family home. Children who meet all these criteria at discharge are considered "recovered" from malnutrition.[7] Children who are discharged but do not meet these criteria either died during treatment or did not fully recover after 4 months of treatment without any evident cause of the lack of response. Those children are considered "not recovered" from malnutrition. Children who do not attend more than two consecutive follow-up visits before meeting the criteria are considered to have dropped out of treatment.[7]

TABLE 1
Ready-to-use therapeutic food (Plumpy Nut) nutritional information (per 100 g)

Macronutrients	Vitamins	Minerals
Energy: 545 kcal	Vitamin A: 910 μg	Calcium: 320 mg
Protein: 13.6 g	Vitamin D: 16 μg	Phosphorus: 394 mg
Fat: 35.7 g	Vitamin E: 20 mg	Potassium: 1,111 mg
	Vitamin C: 53 mg	Magnesium: 92 mg
	Vitamin B1: 0.6 mg	Zinc: 14 mg
	Vitamin B2: 1.8 mg	Copper: 1.78 mg
	Vitamin B6: 0.6 mg	Iron: 11.53 mg
	Vitamin B12: 1.8 μg	Iodine: 110 mcg
	Vitamin K: 21 μg	Sodium: $<$ 290 mg
	Biotin: 65 μg	Selenium: 30 μg
	Folic acid: 210 μg	
	Pantothenic acid: 3.1 mg	
	Niacin: 5.3 mg	

Patients. All children 0 to 5 years of age admitted to the OS department (both of the CHB and of the HCs) in Beira for acute malnutrition were included in the study.

Outcome measures. The primary outcome measures were the percentage of children who completed the program (recovered and not recovered from malnutrition) and the differences between the median weight-for-length and weight-for-height z-scores at admission and those at discharge from the NRP to evaluate the impact on growth. Normal nutritional status was indicated by weight-for-length and weight-for-height z-scores ≥ -1; mild malnutrition was indicated by weight-for-length and weight-for-height z-scores ≥ -2 and < -1, respectively; moderate malnutrition was indicated by weight-for-length and weight-for-height z-scores ≥ -3 and < -2, respectively; and severe malnutrition was indicate by weight-for-length and weight-for-height z-scores < -3).[7]

The secondary outcomes measures were the prevalence of HIV infection in children in the study and the prevalence of severe acute malnutrition in children with HIV.

Data collection and statistical analysis. All the variables were retrospectively extracted from individual data routinely collected in the medical records by trained health staff members. Sex, age, HIV infection, weight, length (0–2 years) or height (older than 2 years), weight-for-length and weight-for-height z-scores, percentage of weight-for-length and weight-for-height z-scores correctly interpreted, MUAC, types of supplements used, and outcomes of the patients were evaluated.

Data management was performed using Microsoft Excel 2013. Statistical analysis was performed using R version 3.4.1. Data are expressed as the median and interquartile range (IQR; quartiles I–III). Comparisons of medians were performed using the Wilcoxon test. The Fisher test was applied when the expected values were ≥ 5. Furthermore, the χ^2 test was used to compare categorical variables. Because of the large amount of missing data, only patients with available data were considered for each outcome.

TABLE 2
Children's data regarding sex, age, HIV status, weight, height and mid upper arm circumference

Sex, n (%) (N = 1,221)	Female	708 (58%)
	Male	513 (42%)
Age, median (IQR)	Female	14 months (10–19 months)
	Male	14 months (10–19 months)
HIV infection, n (%) (N = 952)	Negative	795 (83.5%)
	Positive	157 (16.5%)
Weight, median (IQR)	At admission (n = 1,227)	6.9 kg (6.1–7.2 kg)
	At discharge (n = 659)	7.5 kg (6.7–7.8 kg)
Height, median (IQR)	At admission (n = 1,174)	71 cm (67–76 cm)
	At discharge (n = 644)	72 cm (68.76 cm)
Mid upper arm circumference, median (IQR) (N = 635)		At admission: 12 cm (11–12 cm)

RESULTS

Primary and secondary outcomes. We enrolled 1,231 children (708 [58%] were female and 513 [42%] were male) with a median age of 14 months (IQR, 10–19). Clinical data are reported in Table 2.

Data of the outcomes showed that 198 (21.7%) children completed the program; of these, 177 (89.4%) recovered and 21 (10.6%) did not. Ten (1.1%) were hospitalized and 706 (77.2%) dropped out of the program. Outcomes data were unavailable for 317 children (Figure 1).

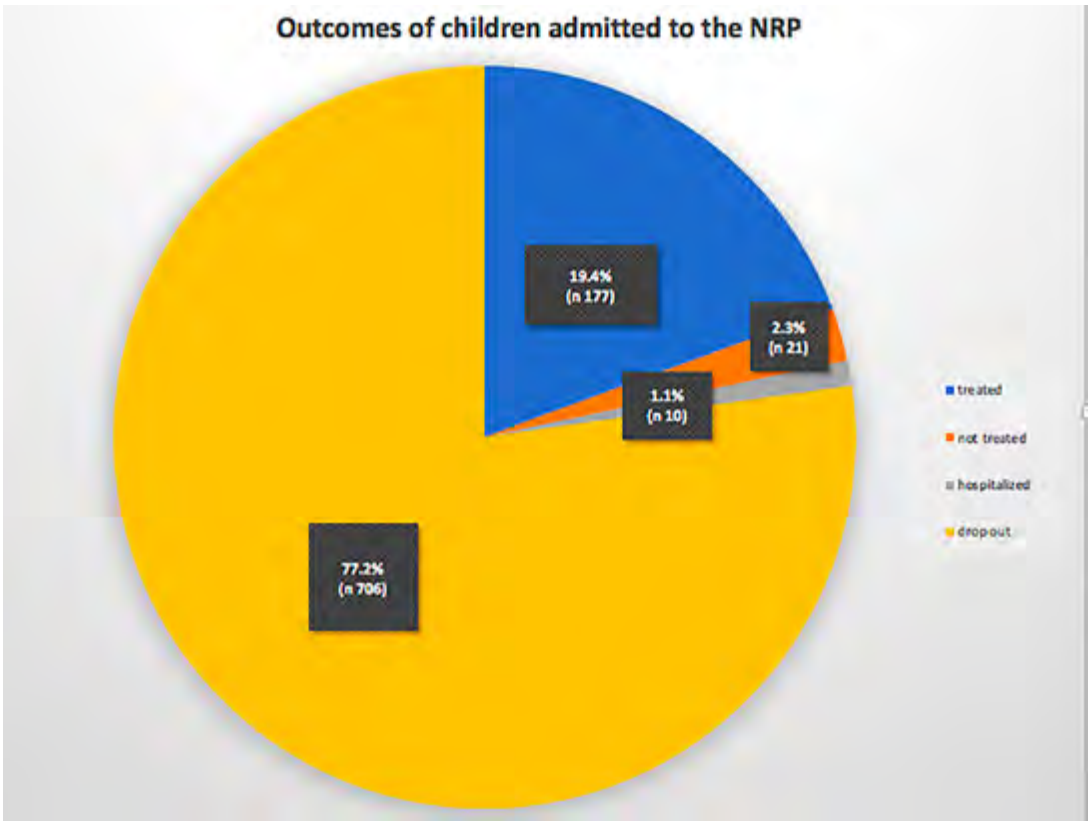


FIGURE 1. Outcomes of children admitted to the nutritional rehabilitation program (NRP). This figure appears in color at www.ajtmh.org.

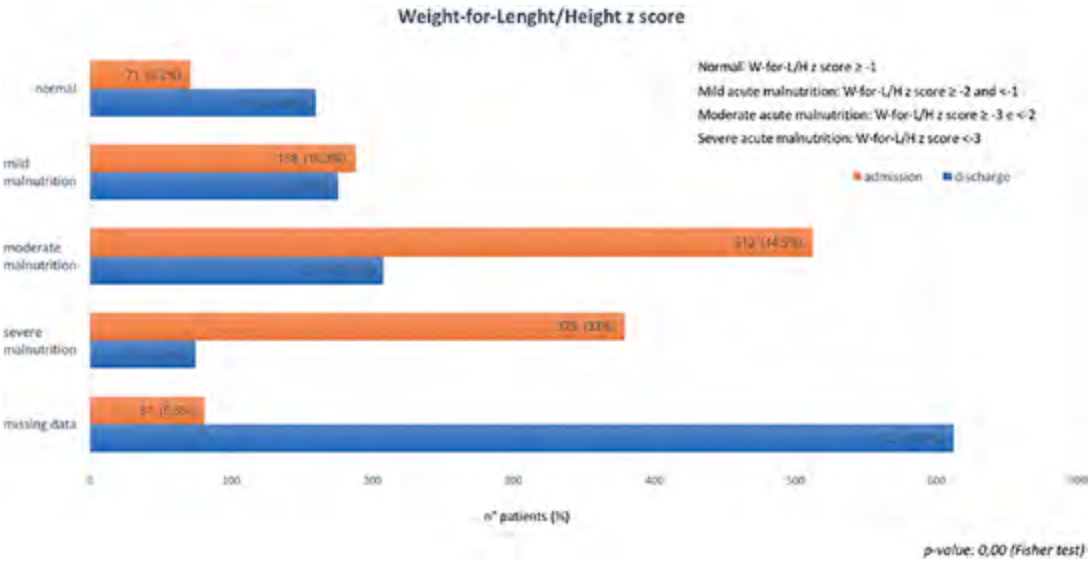


FIGURE 2. Weight-for-length and weight-for-height z-scores at admission and discharge. This figure appears in color at www.ajtmh.org.

Figure 2 shows data regarding the nutritional status evaluated with anthropometric parameters at admission and at discharge. At admission, 512 (44.5%) had moderate and 379 (33%) had severe acute malnutrition; 71 (6.2%) children had weight-for-length/weight-for-height z-scores ≥ -1. At admission, the median weight was 6.9 kg (IQR, 6.1–7.2 kg) and the median length/height was 72 cm (IQR, 68–76 cm). The median MUAC at admission was 12 cm (IQR, 11–12 cm) (Table 2). Among children who completed the program ($N = 198$), the median weight-for-length and weight-for-height z-scores at admission were ≥ -3 and < -2; at discharge, they were ≥ -1 (Wilcoxon test, $P < 0.001$). At discharge, the median weight was 7.5 kg (IQR, 6.7–7.8 kg), and the median length/height was 72 cm (IQR, 68–76 cm) (Table 2).

Of all the children who underwent the HIV test ($N = 952$), 157 (16.5%) were HIV-positive. Children with HIV had a higher prevalence of severe acute malnutrition: 49% of HIV-positive children and 32% of HIV-negative children had severe acute malnutrition (chi-square test, $P < 0.001$) (Table 3).

Other results. Males had a higher degree of malnutrition than females (Fisher test, $P < 0.001$). The most used supplement was RUFT (Plumpy Nut), which was used by 1,059 (87.8%) of children; however, a blend of corn and soy flour was used for 107 (8.9%) of children. Data were unavailable for 25 children. The median time during which supplements were consumed was 16 days (IQR, 7–28 days). Weight gain was found to be significant after 23 days (Fisher's test, $P = 0.004$).

We retrospectively assessed the accuracy of the diagnosis of the degree of malnutrition performed by health professionals at HCs. We found that it was accurate for 765 (70.5%) children and 391 (67.2%) children at admission and discharge, respectively (Figure 3).

DISCUSSION

During our study, we are able to affirm that in Mozambique, acute malnutrition is a crucial and emerging public health issue. In particular, the rate of severe acute malnutrition is dramatic and probably reflects the unsuitableness of their health services and delays in access to care services despite the malnutrition, child care, and health education programs created by the Mozambique government. These programs include nutritional supplementation interventions, school health and agriculture programs, community prevention campaigns, and nutrition and food security plans.[11]

To obtain the planned results, adherence to the ministerial programs is fundamental. During this study we first assessed adherence to the NRP. Data showed that a high rate of patients, approximately 75%, dropped out of the program before its conclusion. This fact has already been reported in the literature. Takyi et al. confirmed poor adherence to NRPs

TABLE 3
Weight-for-length and weight-for-height z-scores of HIV-positive and HIV-negative children at admission

		Weight-for-length and weight-for-height z-scores at admission				
		≥ -1	≥ -2 and < -1	≥ -3 and < -2	< -3	
HIV status	Negative, n (%)	33 (4)	129 (17)	351 (47)	241 (32)	$P < 0.001$
	Positive, n (%)	2 (1)	16 (12)	54 (38)	70 (49)	(chi-square test)
	No test performed, n (%)	12 (13)	14 (15)	44 (46)	25 (26)	

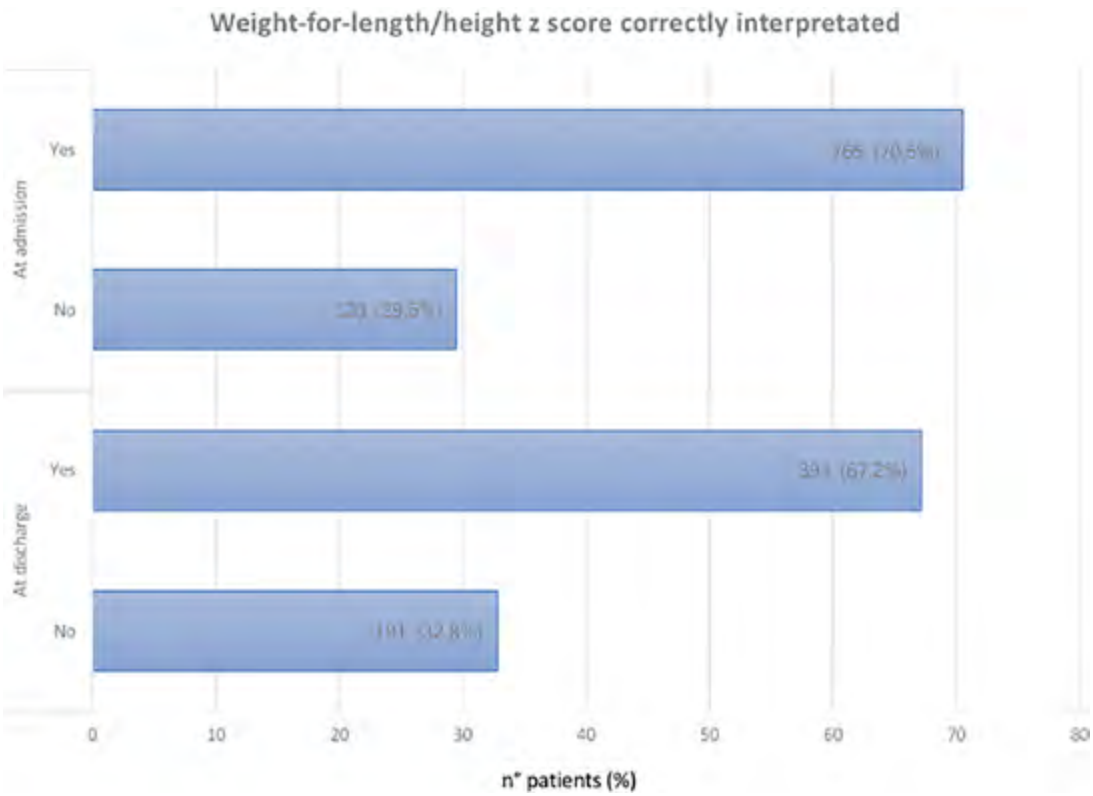


FIGURE 3. Weight-for-length and weight-for-height z-scores correctly interpreted. This figure appears in color at www.ajtmh.org.

for children in Ghana and argued that greater efforts must be made to promote adherence.[12] A study performed in Ethiopia involving HIV-positive adult patients showed poor adherence to nutritional programs and that the only sociodemographic variable with a significant effect on adherence is the educational status.[13] Therefore, further studies are needed to evaluate the factors that negatively affect adherence to health programs for children.

Despite the high level of missing data at discharge and the high number of patients who dropped out, the outcomes of children who completed the NRP indicated that the majority improved their nutritional status. Therefore, the nutritional program seems to work if adhered to; however, there is not yet enough information to evaluate its effectiveness in the long term. The effectiveness of NRPs in developing countries have been confirmed by other studies performed in Ghana and Pakistan.[12,14]

The association between HIV and underweight, stunting, and wasting has been described in the literature.[15–17] Furthermore, it is known that among malnourished children, those living with HIV have a higher rate of severe malnutrition than HIV-negative children.[15,18] Our study results confirmed that HIV-positive children have a higher prevalence of severe malnutrition (nearly 50% of our sample) than HIV-negative children (Table 3). Similar results were described by Poda,[15] who reported that the prevalence rates of severe malnutrition were 31% and 5% among HIV-positive and HIV-negative children. Although the pathophysiological mechanism is not yet clear, the most probable is the correlation between HIV and malnutrition.[16–24] Patients with HIV need to consume a higher amount of calories; however, the state of malnutrition worsens the clinical situation of patients with HIV. Therefore, the nutritional assessment is important for preventing malnutrition in these patients. In 2018, Marotta et al. reported that implementation of task-shifting from clinical officers to maternal and child nurses in the Beira district increased regular nutritional assessments and contributed to improving the global effectiveness of care for HIV-infected children.[25]

Another interesting outcome was that male children are more malnourished than female children.[26,27] The reasons for this are still unknown, but it may be related to bias, the greater biological fragility of males, different food practices, or different cultural factors.

The enteral supplement used most often was RUFT (Plumpy Nut), which is in accordance with the recommendations of the NRP. An innovative and interesting discovery regarding the length of treatment was that the RUFT supplement must be consumed for at least 23 days to ensure a significant increase in weight. This result is in contrast to the results described by studies conducted in Uganda and Nigeria, where the diets

were supplemented with similar RUFT and weight gain was noticed after only 2 weeks.[26,27] However, these results were not comparable with ours because children with severe acute malnutrition were excluded from these trials. Considering these results, the high rate of drop out, and the possible abandonment of the program before completing 3 weeks, it is crucial to guarantee at least 3 weeks of adherence to the program to ensure a high probability of improving the nutritional status of admitted children.

A dramatic discovery was that for approximately one-third of children, both at admission and at discharge, medical staff members incorrectly diagnosed the degree of malnutrition and misinterpreted the anthropometric parameters, thus reflecting that data recording was not performed consistently or properly. The OS department of HCs are managed by one nurse who has to attend to a large number of children every day. This work overload that occurs can result in diagnostic failure. Similarly, sometimes a lack of qualified and adequately paid staff members can affect the data accuracy. Even the use of paper records can facilitate the accumulation of errors in transcriptions or the misinterpretation of written records, which are easily degradable. Therefore, it would be appropriate to introduce both appropriate specific training courses for staff members and programs for monitoring the accuracy and quality of the medical records in the programs.

This study had some limitations. The missing data greatly reduced the sample size, thereby affecting our ability to assess the impact on growth. This reflects the relevant problems associated with data accuracy and data management in developing countries. Another important limitation was the lack of evaluation of the factors that influence the adherence to the NRP by children and caregivers.

Nonetheless, to the best of our knowledge, this is the first study performed in Sofala province and one of few studies performed in Mozambique to assess adherence to nutritional delivery services after the introduction of the NRP and the association between the nutritional status and HIV status of children.

In conclusion, malnutrition, especially in HIV-positive children, is an important problem in Mozambique. This study highlights how the NRP seems to be effective if correctly followed. However, the effectiveness of the NRP is limited by the high abandonment rate and possible difficulties with therapeutic adherence.

Based on these results, it is necessary to establish educational strategies addressing the population and health care professionals to improve the quality and effectiveness of services, encourage better adherence to existing health programs, and ensure proper data collection.

Received April 15, 2020. Accepted for publication June 30, 2021.

Published online September 27, 2021.

Authors' addresses: Serena Calgaro, Cristian Girotto, Liviana Da Dalt, Daniele Trevisanuto, and Giovanna Verlato, Department of Woman's and Child's Health, University of Padova, Padova, Italy, E-mails: serena.calgaro@gmail.com, cristiangir8@gmail.com, liviana.dadalt@unipd.it, daniele.trevisanuto@gmail.com, and verlatogiovanna@gmail.com. Valentina Isidoris, Operational Research Unit, Doctors with Africa CUAMM, Padova, Italy, E-mail: isidoris.valentina@gmail.com. Kajal Chhaganlal, Center for Research in Infectious Diseases, Faculty of Health Sciences, Catholic University of Mozambique, Beira, Mozambique, E-mail: kajalchhaganlal@yahoo.co.uk. Jorge Moiane, Center for Research in Infectious Diseases, Faculty of Health Sciences, Catholic University of Mozambique, Beira, Mozambique, E-mail: jmoiane@ucm.ac.mz. Giovanni Putoto and Damiano Pizzol, Operational Research Unit, Doctors with Africa CUAMM, Padova, Italy, E-mails: g.putoto@cuamm.org and damianopizzol8@gmail.com.

This is an open-access article distributed under the terms of the Creative Commons Attribution (CC-BY) License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.

REFERENCES

1. Organization of United Nations ONU, 2015. *Sustainable Development Goals*. Available at: http://www.un.org/sustainabledevelopment/sustainable-development-goals/. Accessed January 2018.
2. United Nations Children's Fund UNICEF, 2020. *Levels and Trends in Children Malnutrition*. Available at: https://data.unicef.org/media/69816/file/Joint-malnutrition-estimates-2020.pdf. Accessed October 2020.
3. Gonçalves SD, Moultrie TA, 2012. Short preceding birth intervals and child mortality in Mozambique. *Afr J Reprod Health 16:* 29–42.
4. Republic of Mozambique, 2017. *Classificação de Insegurança Alimentar Aguda em Fases – Julho 2016/Fevereiro* 2017. Available at: http://www.ipcinfo.org/fileadmin/user_upload/ipcinfo/docs/IPC_Mozambique_AcuteFI_July16-Feb17.pdf. Accessed January 2018.
5. Marotta C, Di Gennaro F, Pizzol D, Madeira G, Monno L, Saracino A, Putoto G, Casuccio A, Mazzucco V, 2018. The at risk child clinic (ARCC): 3 years of health activities in support of the most vulnerable children in Beira, Mozambique. *Int J Environ Res Public Health 15:* 1350.
6. The Food and Nutrition Technical Assistance III Project [FANTA], 2008. *Mozambique Multiple Indicator Cluster Survey (MICS) 2008.* Available at: https://www.fantaproject.org/node/217. Accessed January 2018.
7. Ministério da Saúde, Departamento de Nutrição, 2010. *Manual de Tratamento e Reabilição Nutricional*, Volume I. Maputo: MISAU.
8. United Nations Programme on HIV/AIDS UNAIDS, 2019. *Global HIV Statistics*. Available at: https://www.unaids.org/sites/default/files/media_asset/UNAIDS_FactSheet_en.pdf. Accessed October, 2020.
9. World Health Organization WHO, 2019. *Mozambique HIV Country Profile 2019.* Available at: http://csf.hivci.org/country-factsheet.html. Accessed October 2020.
10. Pizzol D et al., 2018. Teenage pregnancies in Mozambique: the experience of "Servicios Amigos dos Adolescentes" clinics in Beira. *Afr J AIDS Res 17:* 32–36.
11. Republic of Mozambique, ministry of Health [MISAU], 2020. *Department of Nutrition, Multisectoral Action Plan for the Reduction of Chronic Undernutrition in Mozambique 2011–2015.* Available at: http://extwprlegs1.fao.org/docs/pdf/moz148648.pdf. Accessed January 2018.
12. Takyi A, Tette E, Goka B, Insaidoo G, Alhassan Y, Nyarko MY, Stepniewska K, 2020. Treatment outcomes among children treated for uncomplicated severe acute malnutrition: a retrospective study in Accra, Ghana. *Public Health Nutr* 1–13 (Epub ahead of print). doi: 10.1017/S1368980020002463.
13. Kebede MA, Haidar J, 2014. Factors influencing adherence to the food by prescription program among adult HIV positive patients in Addis Abeba, Ethiopia: a facility-based, cross-sectional study. *Infect Dis Poverty 3:* 20.
14. Aguayo VM, Badgaiyan N, Qadir SS, Bugti AN, Alam MM, Nishtar N, Galvin M, 2018. Community management of acute malnutrition (CMAM) programme in Pakistan effectively treats children with uncomplicated severe wasting. *Matern Child Nutr 14 (Suppl 4):* e12623.
15. Poda GG, Hsu CY, Chao JC, 2017. Malnutrition in associated with HIV infection in children less than 5 years in Bobo-Dioulasso City, Burkina Faso. *Medicine (Baltimore) 96:* e7019.
16. Omoni AO, Ntozini R, Evans C, Prendergast AJ, Moulton LH, Christian PS, Humphrey JH, 2017. Child growth according to

maternal and child HIV status in Zimbabwe. *Pediatr Infect Dis J 36:* 869–876.
17. United Nations Children's Fund UNICEF, 2016. *Malnutrition: Current Status and Progress*. Available at: http://data.unicef.org/nutrition/malnutrition.html. Accessed February 2018.
18. Condo JU, Gage A, Mock N, Rice J, Greiner T, 2015. Sex differences in nutritional status of HIV-exposed children in Rwanda: a longitudinal study. *Trop Med Int Health 20:* 17–23.
19. Duggal S, Chugh TD, Duggal AK, 2012. HIV and malnutrition: effects on immune system. *Clin Dev Immunol 2012:* 784740.
20. Jesson J et al., 2015. Prevalence of malnutrition among HIV-infected children in Central and West-African HIV-care programs supported by the Growing Up Programme in 2011: a cross-sectional study. *BMC Infect Dis 15:* 216.
21. Rose AM, Hall CS, Martinez-Alier N, 2014. Aetiology and management of malnutrition in HIV-positive children. *Arch Dis Child 99:* 546–551.
22. Lodha R, Kabra SK, 2015. Health and nutritional status of HIV infected children. *Indian J Med Res 141:* 10–12.
23. Feucht UD, Van Bruwaene L, Becker PJ, Kruger M, 2016. Growth in HIV-infected children on long-term antiretroviral therapy. *Trop Med Int Health 21:* 619–629.
24. Swetha GK, Hemalatha R, Prasad UV, Murali V, Damayanti K, Bhaskar V, 2015. Health and nutritional status of HIV infected children in Hyderabad, India. *Indian J Med Res 141:* 46–54.
25. Marotta C et al., 2018. Pathways of care for HIV infected children in Beira, Mozambique: pre-post intervention study to assess impact of task shifting. *BMC Public Health 18:* 703.
26. Van der Kam S, Roll S, Swarthout T, Edyegu-Otelu G, Matsumoto A, Kasujja FX, Casademont C, Shanks L, Salse-Ubach N, 2016. Effect of short-term supplementation with ready-to-use therapeutic food or micronutrients for children after illness for prevention of malnutrition: a randomized controlled trial in Uganda. *PLoS Med 13:* e1001951.
27. Van der Kam S, Salse-Ubach N, Roll S, Swarthout T, Gayton-Toyoshima S, Jiya NM, Matsumoto A, Shanks L, 2016. Effect of short-term supplementation with ready-to-use therapeutic food or micronutrients for children after illness for prevention of malnutrition: a randomized controlled trial in Nigeria. *PLoS Med 13:* e1001952.

ACKNOWLEDGEMENTS

1. Abdelghany Shaimaa Abuelnoor Ahmed, Department of Woman's and Child's Health, University of Padua, Italy
2. Abubacar Seni Amir Hussein, Beira Central Hospital, Mozambique
3. Accomando Salvatore, Department of Health Promotion, Mother and Child Care, Internal Medicine and Medical Specialties, University of Palermo, Italy
4. Ademe Tsegaye, Saint Luke Hospital, Wolisso, Ethiopia
5. Ajelli Marco, Department of Epidemiology and Biostatistics, Indiana University School of Public Health, Indiana
6. Aryal Diptesh, Critical Care and Anesthesia, Nepal Mediciti Hospital, Nepal
7. Asnake Tina, Federal Ministry of Health, Addis Ababa, Ethiopia
8. Atzori Andrea, Doctors with Africa CUAMM, Italy
9. Azzimonti Gaetano, Doctors with Africa CUAMM, Tanzania
10. Baracca Giuseppe, Doctors with Africa CUAMM, Italy
11. Barone-Adesi Francesco, Center for Research and Training in Disaster Medicine, Humanitarian Aid, and Global Health (CRIMEDIM), University of Piemonte Orientale, Italy
12. Bavaro Davide Fiore, Clinic of Infectious Diseases, University of Bari, University Hospital Policlinico, Italy
13. Beane Abi, Critical Care Asia Africa Network, Mahidol Oxford Tropical Research Unit, Thailand
14. Beguin Arne, Doctors with Africa CUAMM
15. Benova Lenka, Sexual and Reproductive Health Group, Department of Public Health, Institute of Tropical Medicine, Belgium
16. Bertoncello Chiara, Department of Cardiac Thoracic and Vascular Sciences and Public Health, University of Padua, Italy
17. Bharath Kumar Tirupakuzhi Vijayaraghavan, Indian Registry of IntenSive care, IRIS, India
18. Biggeri Mario, Department of Economics and Management, University of Florence, Italy
19. Bogale Tariki, Children's Investment Fund Foundation, Kenya
20. Bogning Mejiozem Brice Olivier, Centre Hospitalier Universitaire Pédiatrique de Bangui (CHUPB), Central African Republic
21. Bortolani Arianna, Doctors with Africa CUAMM
22. Bortolozzo Marta, Italian Medical Students Association (SISM), Italy
23. Bregani Enrico Rino, Fondazione IRCCS Ca' Granda Ospedale Maggiore Policlinico, Italy
24. Byaruhanga Raymond, National Tuberculosis and Leprosy Control Program (NTLP), Uganda
25. Buson Riccardo, Doctors with Africa CUAMM, Italy
26. Calgaro Serena, Department of Woman's and Child's Health, University of Padua, Italy
27. Cardona – Fox Gabriel, Bologna Institute for Policy Research, Italy
28. Cavagna Chiara, Doctors with Africa CUAMM, Italy
29. Cavaliere Elena, Department of Woman's and Child's Health, University of Padua, Italy
30. Cavallin Francesco, Independent Statistician, Italy
31. Caviglia Marta, Center for Research and Training in Disaster Medicine, Humanitarian Aid, and Global Health (CRIMEDIM), University of Piemonte Orientale, Italy
32. Cebola Bonifacio Rodriguez, Beira Central Hospital, Mozambique
33. Censi Veronica, Doctors with Africa CUAMM
34. Chhaganlal Kajal, Center for Research in Infectious Diseases, Faculty of Health Sciences, Catholic University of Mozambique
35. Ciccarelli Giulia, Doctors with Africa CUAMM, Tanzania
36. Conti Andrea, Center for Research and Training in Disaster Medicine, Humanitarian Aid, and Global Health (CRIMEDIM), University of Piemonte Orientale, Italy
37. Conti Matilde, University of Milano-Bicocca, Italy
38. Conti Simone, Doctors with Africa CUAMM, Tanzania
39. Corsello Giovanni, Department of Health Promotion, Mother and Child Care, Internal Medicine and Medical Specialties, University of Palermo, Italy
40. Costigan Kathleen, Bugisi Health Centre, Shinyanga, Tanzania
41. Da Dalt Liviana, Department of Woman's and Child's Health, University of Padua, Italy
42. Dall'Oglio Immacolata, Continuous Education and Research Service, Bambino Gesù Children's Hospital IRCCS, Rome, Italy
43. Dalla Riva Donata, Doctors with Africa CUAMM, Italy
44. Dalla Zuanna Teresa, Department of Cardiac Thoracic and Vascular Sciences and Public Health, University of Padua, Italy
45. de Dieu Komangoya Kpembi Romuald Belly, Centre Hospitalier Universitaire Pédiatrique de Bangui (CHUPB), Central African Republic
46. de Klerk Josien, Amsterdam Institute for Global Health and Development, Netherlands
47. De Meneghi Giovanna, Doctors with Africa CUAMM, Mozambique
48. de Wit Tobias Rinke, Amsterdam Institute for Global Health and Development, Netherlands
49. Declich Silvia, National Center for Global Health, Istituto Superiore di Sanità, Italy
50. Della Corte Francesco, Center for Research and Training in Disaster Medicine, Humanitarian Aid, and Global Health (CRIMEDIM), University of Piemonte Orientale, Italy
51. Dell'Aringa Marcelo, Center for Research and Training in Disaster Medicine, Humanitarian Aid, and Global Health (CRIMEDIM), University of Piemonte Orientale, Italy
52. Dente Maria Grazia, National Center for Global Health, Istituto Superiore di Sanità, Italy
53. Di Benedetto Chiara, Doctors with Africa CUAMM, Italy
54. Di Gennaro Francesco, Clinic of Infectious Diseases, University of Bari, Italy
55. Djapou Mireille Mande, Centre Hospitalier Universitaire Pédiatrique de Bangui (CHUPB), Central African Republic
56. Dondorp Arjen M., Critical Care Asia Africa Network, Mahidol Oxford Tropical Research Unit, Thailand
57. Elisaria Ester, Ifakara Health Institute, TanzaniaEngoba Moyen, Université Marien Ngouabi, Brazzaville, Congo
58. Erio Tusajigwe, Amsterdam Institute for Global Health and Development, Netherlands
59. Estevez Alba Sardon, Department of Woman's and Child's Health, University of Padua, Italy
60. Falanga Carmine, ANLAIDS Lombarda Section, Italy
61. Fantozzi Pier Lorenzo, Department of Physics, Earth and Environmental Sciences, University of Siena, Italy
62. Festo Charles, Ifakara Health Institute, Tanzania
63. Fogliati Piera, Doctors with Africa CUAMM, Mozambique
64. Fonzo Marco, Department of Cardiac Thoracic and Vascular Sciences and Public Health, University of Padua, Italy
65. Galli Margherita, Center for Health Emergencies, Bruno Kessler Foundation, Trento, Italy
66. Galloni Donata, Centre Hospitalier Universitaire Pédiatrique de Bangui (CHUPB), Central African Republic
67. Genna Giselle Daiana, Department of Woman's and Child's Health, University of Padua, Italy
68. Ghose Aniruddha, Department of Medicine, Chattogram Medical Centre, Bangladesh
69. Girotto Cristian, Department of Woman's and Child's Health, University of Padua, Italy

70. Giuffrè Mario, Department of Health Promotion, Mother and Child Care, Internal Medicine and Medical Specialties, University of Palermo, Italy
71. Gody Jean Chrysostome, Centre Hospitalier Universitaire Pédiatrique de Bangui (CHUPB), Central African Republic
72. Gomez Gabriela B., Department of Global Health and Development London School of Health and Tropical Medicine, United Kingdom
73. Greblo Alessandro, Doctors with Africa CUAMM
74. Gulo Berhanu, Doctors With Africa CUAMM, Ethiopia,
75. Guzzetta Giorgio, Center for Health Emergencies, Bruno Kessler Foundation, Italy
76. Haniffa Rashan, Critical Care Asia Africa Network, Mahidol Oxford Tropical Research Unit, Thailand
77. Hanson Claudia, Karolinska Institutet, Sweden
78. Hashmi Madiha, Department of Critical Care, Ziauddin University, Pakistan
79. Hermans Sabine, Department of Global Health, Amsterdam Institute for Global Health and Development, University of Amsterdam, Netherlands
80. Houndjahoue Ghislain F., Centre Hospitalier Universitaire Pédiatrique de Bangui (CHUPB), Central African Republic
81. Hubloue Ives, Research Group on Emergency and Disaster Medicine, Vrije Universiteit Brussels, Belgium
82. Ictho Jerry, Doctors with Africa, CUAMM, Uganda
83. Imoko Joseph F., Makerere University Lung Institute (MLI), Uganda
84. Isidoris Valentina, Doctors with Africa CUAMM, Italy
85. Itambu Rehema John, Doctors with Africa CUAMM, Tanzania
86. Jambai Amara, Ministry of Health and Sanitation, Government of Sierra Leone, Sierra Leone
87. Kakouguere Evodie Pierrette, Centre Hospitalier Universitaire Pédiatrique de Bangui (CHUPB), Central African Republic
88. Kalyango Joan N., Clinical Epidemiology Unit, Makerere University College of Health Sciences, Uganda
89. Karamagi Charles A., Department of Pediatrics, Makerere University, Uganda
90. Katamba Achilles, Department of Medicine, Makerere University College of Health Sciences, Uganda
91. Katana Elizabeth B., Clinical Epidemiology Unit, Makerere University College of Health Sciences, Uganda
92. Kirenga Bruce, Makerere University Lung Institute (MLI), Uganda
93. Kiteze Nguinzanemou Carine Judith, Centre Hospitalier Universitaire Pédiatrique de Bangui (CHUPB), Central African Republic
94. La Placa Simona, Department of Health Promotion, Mother and Child Care, Internal Medicine and Medical Specialties, University of Palermo, Italy
95. Laforgia Nicole, Doctors with Africa CUAMM, Italy
96. Laforgia Renato, Doctors with Africa CUAMM, Italy
97. Laker Eva A. O., Infectious Disease Institute, Kampala, Uganda
98. Lattanzio Rossana, Clinic of Infectious Diseases, University of Bari, University Hospital Policlinico, Italy
99. Lazzari Marzia, Doctors with Africa CUAMM, Mozambique
100. Leyna Germana, Tanzania Food and Nutrition Centre, Tanzania
101. Lo Caputo Sergio, Infectious Diseases Unit, Department of Clinical and Experimental Medicine, A.O.U. "Policlinico Riuniti", Italy
102. Lochoro Peter, Doctors with Africa, CUAMM, Uganda
103. Lonardi Magda, Doctors with Africa CUAMM, Angola
104. Lorusso Vincenza, Doctors with Africa CUAMM, Tanzania
105. Lupato Alice, Italian Medical Students Association (SISM), Italy
106. Lydie Verleine Danebera, Centre Hospitalier Universitaire Pédiatrique de Bangui (CHUPB), Central African Republic
107. Machibya Clementina, Ngokolo Health Centre, Shynyanga, Tanzania
108. Magige Chacha, Simiyu Regional Medical Officer's Office, Tanzania
109. Makonga Tshikamb Ivo, Missionary Catholic Hospital of Chiulo, Angola
110. Manenti Fabio, Doctors with Africa CUAMM
111. Marotta Claudia, Doctors with Africa CUAMM
112. Martelli Giulia, Doctors with Africa CUAMM
113. Martin Cecilia, King Abdullah University of Science and Technology, Saudi Arabia
114. Marwa Samwel, District Medical Office, Iringa District Council, Tanzania
115. Marziano Valentina, Center for Health Emergencies, Bruno Kessler Foundation, Trento, Italy
116. Mattei Vittoria, Centre Hospitalier Universitaire Pédiatrique de Bangui (CHUPB), Central African Republic
117. Maya Gloria, Doctors with Africa CUAMM, Tanzania
118. Maziku Donald, Tosamaganga Council Designated Hospital, Tanzania
119. Mbode Dusie Lesly Ngoyoli, Centre Hospitalier Universitaire Pédiatrique de Bangui (CHUPB), Central African Republic
120. Melegaro Alessia, Bocconi University, Milan, Italy
121. Merler Stefano, Center for Health Emergencies, Bruno Kessler Foundation, Trento, Italy
122. Meta Judith, Amsterdam Institute for Global Health and Development, Netherlands
123. Miglierina Laura, Doctors With Africa CUAMM, Ethiopia,
124. Minh Yen Lam , Oxford University Clinical Research Unit, Vietnam.
125. Miselli Maria Agata, Doctors with Africa CUAMM, Tanzania
126. Moiane Jorge, Center for Research in Infectious Diseases, Faculty of Health Sciences, Catholic University of Mozambique
127. Moyen George, Université Marien Ngouabi, Brazzaville, Congo
128. Moyer Eileen, Amsterdam Institute for Global Health and Development, Netherlands ID
129. Mrema Jackline, Ifakara Health Institute, Tanzania
130. Mugenyi Levicatus, Makerere University Lung Institute (MLI), Uganda
131. Muhelo Arlindo Rosario, Central Hospital of Beira, Mozambique
132. Mumba Fortihappiness Gabinus, Doctors with Africa CUAMM, Tanzania
133. Musa Elias, Doctors with Africa CUAMM, Tanzania
134. Mutalemwa Katunzi, Doctors with Africa CUAMM, Tanzania
135. Muttamba Winters, Makerere University Lung Institute (MLI), Uganda
136. Nabatanzi Sandra, Clinical Epidemiology Unit, Makerere University College of Health Sciences, Uganda
137. Nacareia Ussene, Department of Woman's and Child's Health, University of Padua, Italy
138. Naniche Denise, Barcelona Institute for Global Health, Spain
139. Nannini Maria, Department of Economics and Management, University of Florence, Italy
140. Ndunguru Bruno, District Medical Office, Iringa District Council, Tanzania
141. Nganda Bangue Marie Collette, Centre Hospitalier Universitaire Pédiatrique de Bangui (CHUPB), Central African Republic
142. Ngegbai Amara S., MoHS, Sierra Leone
143. Nidoi Jaspe, Makerere University Lung Institute (MLI), Uganda
144. Nor Basri, Department of Anaesthesiology and Intensive Care, Kulliyyah (School) of Medicine, International Islamic University Malaysia (IIUM), Malaysia
145. Novara Roberta, Clinic of Infectious Diseases, University of Bari, University Hospital Policlinico, Italy
146. Ntoga Bupe Abel, Tanzania Food and Nutrition Centre, Tanzania

147. Nwanneka Ebelechukwu Okere, Amsterdam Institute for Global Health and Development, University of Amsterdam, Netherlands
148. Occa Edoardo, Doctors with Africa CUAMM, Mozambique
149. Opio Denis, Clinical Epidemiology Unit, Makerere University College of Health Sciences, Uganda
150. Panico Gianfranco Giorgio, Clinic of Infectious Diseases, University of Bari, University Hospital Policlinico, Italy
151. Panunzi Silvia, Department of Diagnostics and Public Health, University of Verona, Italy
152. Papagni Roberta, Clinic of Infectious Diseases, University of Bari, University Hospital Policlinico, Italy
153. Parise Nicoletta, Department of Statistical Sciences, University of Padua, Italy
154. Pembe Andrea B., Department of Obstetrics and Gynecology, Muhimbili University of Helath and Allied Sciences, United Republic of Tanzania
155. Pietravalle Andrea, Doctors with Africa CUAMM, Italy
156. Pini Sara, Doctors with Africa CUAMM, Italy
157. Pisani L., Critical Care Asia Africa Network, Mahidol Oxford Tropical Research Unit, Thailand
158. Pizzol Damiano, Doctors with Africa CUAMM, Italy
159. Poletti Piero, Center for Health Emergencies, Bruno Kessler Foundation, Trento, Italy
160. Poliseno Mariacristina, Infectious Diseases Unit, Department of Clinical and Experimental Medicine, "Policlinico Riuniti", Italy
161. Pozniak Anton, Chelsea and Westminster Hospital NHS Foundation Trust, London, UK
162. Putoto Giovanni, Doctors with Africa CUAMM, Italy
163. Quaglio Gianluca, European Parliamentary Research Services (EPRS), European Parliament, Belgium
164. Radaelli Silvia, Centre Hospitalier Universitaire Pédiatrique de Bangui (CHUPB), Central African Republic
165. Ragazzoni Luca, Center for Research and Training in Disaster Medicine, Humanitarian Aid, and Global Health (CRIMEDIM), University of Piemonte Orientale, Italy
166. Raho Lucia, Doctors with Africa CUAMM, Italy
167. Ramirez Lucy, Doctors with Africa CUAMM, Mozambique
168. Rashan Thalha, Critical Care Asia Africa Network, Mahidol Oxford Tropical Research Unit, Thailand
169. Raviglione Mario C., Centre for Multidisciplinary Research in Health Science, University of Milan, Italy
170. Resti Carlo, Saint Luke Hospital, Wolisso, Ethiopia
171. Rinke de Wit Tobias, Department of Global Health, Amsterdam Institute for Global Health and Development, University of Amsterdam, Netherlands
172. Rizzi Monica, Doctors with Africa CUAMM, Tanzania
173. Robbiati Claudia, Doctors with Africa CUAMM, Angola
174. Rosi Paolo, SUEM 118, Veneto Region
175. Saracino Annalisa, Clinic of Infectious Diseases, University of Bari, University Hospital Policlinico, Italy
176. Schiavone Marcella, Doctors with Africa CUAMM, Italy
177. Scilipoti Martina, Doctors with Africa CUAMM, Angola
178. Segafredo Giulia, Doctors with Africa CUAMM, Tanzania
179. Sekibira Rogers, Makerere University Lung Institute (MLI), Uganda
180. Cornelius Sendagire, Makerere University, Uganda
181. Sendaula Emmanuel, Clinical Epidemiology Unit, Makerere University College of Health Sciences, Uganda
182. Shamal Maryam, NICS-MORU collaboration, Crit Care Asia Afghanistan team, Afghanistan
183. Simbwa Brenda Nakafeero, Clinical Epidemiology Unit, Makerere University College of Health Sciences, Uganda
184. Smekens Tom, Department of Public Health, Institute of Tropical Medicine, Belgium
185. Sperotto Milena, Department of Cardiac Thoracic and Vascular Sciences and Public Health, University of Padua, Italy
186. Straneo Manuela, Athena Institute, VU Amsterdam, The Netherlands
187. Taddei Stefano, Department of Internal Medicine, University of Pisa, Italy
188. Tognon Francesca, Doctors with Africa CUAMM, Italy
189. Torelli Giovanni Fernando, Doctors with Africa CUAMM, Tanzania
190. Totaro Valentina, Clinic of Infectious Diseases, University of Bari, University Hospital Policlinico, Italy
191. Trentini Filippo, Center for Health Emergencies, Bruno Kessler Foundation, Trento, Italy
192. Trevisanuto Daniele, Department of Woman's and Child's Health, University of Padua, Italy
193. Tripathy Swagata, Anaesthesia and Intensive Care Medicine, All India Institute of Medical Sciences, India
194. Tripoli Federica Maria, Department of Health Promotion, Mother and Child Care, Internal Medicine and Medical Specialties, University of Palermo, Italy
195. Tsegaye Ademe, Doctors with Africa CUAMM, Ethiopia
196. Turyahabwe Stavia, National Tuberculosis and Leprosy Control Program (NTLP), Uganda
197. Vandy Matthew Jusu, Ministry of Health and Sanitation, Government of Sierra Leone, Sierra Leone
198. Valcarenghi Caterina, University of Milan, Italy
199. van Breevoort Dorothee, Doctors with Africa CUAMM, Sierra Leone
200. van den Akker Thomas, Athena Institute, VU Amsterdam, Netherlands
201. van den Broek Ankie, Department of Global Health, Royal Tropical Institute (KIT), Amsterdam, The Netherlands
202. Verlato Giovanna, Department of Woman's and Child's Health, University of Padua, Italy
203. Villa Simone, Centre for Multidisciplinary Research in Health Science, University of Milan, Italy
204. Volpe Alessandro, Clinic of Infectious Diseases, University of Bari, University Hospital Policlinico, Italy
205. Walusimbi Simon, Makerere University Lung Institute (MLI), Uganda
206. Waraka Petula, Centre Hospitalier Universitaire Pédiatrique de Bangui (CHUPB), Central African Republic
207. Waweru-Siika Wangari, Department of Anaesthesia, Aga Khan University, Nairobi, Kenya
208. Wilunda Calistus, Maternal and Child Wellbeing Unit, African Population and Health Research Center, Kenya
209. Worku Nigussa Gamshie, Doctors with Africa CUAMM, Ethiopia
210. Worodria William, Department of Medicine, Makerere University College of Health Sciences, Uganda
211. Youkee Daniel, School of Population Health and Environmental Sciences, King's College London, UK
212. Zardini Agnese, Center for Health Emergencies, Bruno Kessler Foundation, Trento, Italy

It is fundamental to conduct operational research while providing humanitarian assistance, in order to generate critical know-how that allows us to better understand what does and does not work in emergency interventions.
This, too, is part of our mandate.

La realizzazione di ricerche operative realizzata dentro e accanto all'assistenza umanitaria può fornire elementi fondamentali a comprendere meglio cosa funziona negli interventi d'emergenza. Anche questo fa parte del nostro mandato e su questo ci impegneremo ulteriormente nel prossimo futuro.