

# Maternal health planning and prioritization in Chad: developing a supportive tool

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## Abstract

The Republic of Chad has one of the highest rates of maternal mortality in the world. With scarce resources to respond to competing demands, pragmatic evidence-based planning tools are needed to aid planning and support priority setting. This action research aimed to develop a tool to support maternal health (MH) planning and prioritization decisions and identify priority regions/provinces for intervention in Chad based on aggregate MH coverage gap scores (Target-Coverage = Coverage Gap). A rapid review was conducted to identify key indicators and relevant national targets. The 2019 Multiple Indicator Cluster Survey and other national surveys were the data sources for selected indicators at the provincial level. Aggregate MH coverage gaps were calculated and displayed using geographic information system software to visualize variations by province. Eleven key informant interviews (KIIs) and six focus group discussions (FGDs) were conducted with clinicians and administrators to understand existing MH planning, prioritization, and maternal mortality risks in Chad. Wide provincial variation in aggregate MH coverage gaps was identified (mean score 374.3, SD: 77.4). Indicators contributing the most to coverage gaps include emergency obstetric care, adolescent births, tetanus vaccination, and delivery by skilled health personnel. Two weighting scenarios for the coverage gap scores are also considered. KIIs and FGDs revealed that existing MH planning in Chad differs provincially and by health system level, with no clear prioritization processes identified. Main themes regarding MH risks reported by stakeholders included challenges relating to the health system, policy landscape, country and population-specific factors, along with specific MH threats. Current centralized planning approaches may benefit from greater consideration of provincial differences to support more efficient and equitable resource distribution. This multi-indicator assessment offers an adaptable approach for evidence-based MH resource allocation to prioritize subnational areas with worst health indicators in resource-limited settings, although further research is needed to test its impact.

**Keywords:** Chad; action research; decision-making; qualitative research; geographic information system; strategic planning; health planning; local authority; maternal health; priorities; prioritization

## Introduction

The risk of death during pregnancy, childbirth, and the puerperium in the Republic of Chad is among the highest in the world. In 2020, the World Health Organization (WHO) reported a maternal mortality ratio (MMR) of 1063 maternal deaths per 100 000 live births (uncertainty interval: 772–1586) (WHO, 2023). Reductions in maternal mortality over the past two decades in Chad have been modest, particularly when compared to the aggregate MMR of low-income countries (LICs), which has almost halved during the same period to 409 maternal deaths per 100 000 in 2020 (World Bank, 2020).

A comprehensive response to improving maternal health (MH) in Chad is hindered by inadequate resources including

limited national health financing, weak health infrastructure, an insufficient and inequitably distributed health workforce, lack of coordination in the health system, and underreporting of maternal deaths (Tchad 2010, Azétsop and Ochieng 2015, Kouanda et al. 2022). Healthcare spending is \$29 USD per capita, or 21.6% less than other LICs (Micah 2020). Skilled health personnel are also scarce with 79.1% fewer physicians and 84.3% fewer nurses/midwives when compared to other African nations (WHO 2021). Moreover, nearly half of Chad's skilled health workforce is in the capital of N'Djamena, which serves <10% of the country's population (Ministère de la Santé Publique, 2015). In the past two national health surveys, important regional disparities in coverage for key MH interventions across antepartum, intrapartum, and

### Key messages

- The Republic of Chad has one of the highest rates of maternal mortality globally and limited resources with which to address the many pressing health needs.
- Progress to reduce maternal mortality over the past 20 years in Chad has been modest, especially when compared to other low-income countries, suggesting a need for pragmatic and evidence-based planning and prioritization solutions.
- In the absence of definitive and validated maternal health (MH) priority-setting tools in Chad or other low-resource settings, we developed a simple data-driven tool that combines aggregate MH coverage gap profiles for key indicators at a regional/provincial level with geographic information systems to improve understandings of regional disparities in coverage.
- By identifying areas of greatest need and gaps in coverage, health planners can develop more equitable frameworks and allocate their resources in ways that have a greater impact.

postpartum stages have been identified ([Institut National de la Statistique des Études Économiques et Démographiques—INSEED/TCHAD, 2016](#), [UNICEF 2016](#), [National Institute of Statistics, EADSC, UNICEF, 2019](#), [Ngaba and Kamga 2021](#)). These inequalities in resource distribution, service coverage, and weak maternal mortality reporting suggest a need for improved planning and prioritization in the country.

The Ending Preventable Maternal Mortality (EPMM) initiative identified a need for strategic and country-specific planning and prioritization tools that reinforce national ownership and leadership to address the multifactorial causes of maternal mortality, including care inequities ([WHO, 2015](#)). Health system planning and resource allocation are challenging and inextricably political, particularly when key resources such as personnel, financing, and up-to-date data are limited ([Youngkong et al. 2009](#), [Henriksson et al. 2019](#)). Prioritization decisions can be difficult when coverage is heterogeneous by district or region, and multiple maternal and other health indicators are not achieving coverage targets. Typically, these health indicators are not necessarily ranked by urgency or importance ([Rudan et al. 2010](#), [Wigley et al. 2020](#), [UNICEF 2021](#)). A definitive methodology or validated tool for MH priority-setting in low- and middle-income countries (LMICs) or Chad specifically is lacking in the literature ([Youngkong et al. 2009](#), [Rudan et al. 2010](#), [Henriksson et al. 2019](#)).

The use of geographic information systems (GIS) may enable a more comprehensive understanding of the significant regional disparities and variation in MH service coverage to support health planning and prioritization decisions, although GIS has infrequently been used by ministries in the global south for these purposes ([Rudan et al. 2010](#), [Musa et al. 2013](#), [Makanga et al. 2016](#)). We suggest an approach to optimize the targeting of limited resources for MH in Chad, at a regional level (termed provincial in Chad), by combining key MH indicator coverage gaps tailored to national targets and GIS to support MH decision-making and accelerate action against maternal mortality in Chad.

The overall aim of this study was to identify regions/provinces in Chad for priority intervention based on relatively higher aggregate MH coverage gaps of key indicators. The research objectives were to (I) develop a pragmatic tool specific to Chad's national MH targets and aggregates of key available data using GIS to visualize variations in coverage gaps by province and (ii) gather key stakeholder perspectives and insights about current MH planning in Chad and perceived MH risks nationally and provincially, which may not be reported in the literature.

## Materials and methods

This action research used a mixed-methods approach and involved the steps detailed further.

### Indicator selection and weighting

Key MH indicators included in this analysis were selected based on a rapid review of the literature. Between June and November 2021, major causes of maternal death, associated risk factors, and key interventions that have been shown to contribute to major reductions in maternal mortality in low-resource settings were searched in two databases: PubMed and Google Scholar. Any study design was included along with international guideline documents and national reports identified using governmental websites. Causes of maternal death that were considered can be grouped into three main categories: (I) infections (sepsis, tetanus, human immunodeficiency virus (HIV), malaria, and unsafe abortions), (ii) MH status (anaemia, malnutrition, short stature associated with adolescent pregnancy, and noncommunicable diseases), and (III) peripartum causes (delivery complications: hypertensive disorders of pregnancy, haemorrhage, and obstructed labour leading to infection or haemorrhage), which are generally poorly managed by less-skilled personnel ([Boerma et al. 2023](#)). Notable MH documents informing our indicator selection included the Lancet Maternal Health Series, EPMM, and a World Bank analysis identifying drivers and enablers for the substantial (65%) maternal mortality reductions achieved in South Asia between 1990 and 2013 ([Bauserman et al. 2015](#), [GBD 2015 Maternal Mortality Collaborators 2016](#), [WHO 2015](#), [Campbell et al. 2016](#), [El-Saharty et al. 2017](#)). Key MH indicators included interventions seeking to address each of the main causes of maternal death [e.g. intermittent preventive treatment of malaria in pregnancy (IPTp) and insecticide-treated net (ITN) use were interventions addressing malaria as a cause of maternal death], interventions or critical drivers of maternal mortality reductions in South Asia, known risk factors for maternal death (e.g. anaemia prevalence or socioeconomic factors including poverty rates), and based on provincial data availability in Chad as national-level estimates do not provide sufficient detail to know where interventions are needed and were therefore considered less actionable.

As each indicator or condition does not equally contribute to maternal mortality, a weighting of indicators was done ([Table 1](#)). Since data on maternal causes of death in Chad are limited, the Global Burden of Disease (GBD) distribution of causes of maternal death between 1990 and 2015 in 2015 for LICs was used ([Kouanda et al. 2022](#), [Boerma et al. 2023](#)). Since the infection category was responsible for 5% of deaths, the smallest category, it was assigned a weight of 1 and

**Table 1.** Weighting of indicators based on GBD and WHO cause-of-death data

Grouped causes of maternal death (Boerma et al. 2023)	Weighting based on GBD distribution in LIC <sup>b</sup>	GBD distribution of causes of maternal death in LICs in 2015 <sup>a</sup> (%)	Weighting based on WHO distribution in SSA <sup>b</sup>	WHO distribution of causes of maternal death in SSA in 2014 <sup>a</sup> (%)
Sepsis/infectious causes of maternal death	1	5	1	10
Obstetric causes of death	14	70	5.2	52
Indirect/HIV/late causes of death	3.4	17	2.9	29

<sup>a</sup>Abortion data excluded due to a lack of data availability in Chad.

<sup>b</sup>Weight of 1 assigned to the smallest grouped causes of death for each scenario, GBD, and WHO. Other categories are divided by 5 or 10 depending on the scenario.

the other category percentages were also divided by 5. Thus, obstetric causes of death indicators were assigned a weight of 14, sepsis/infection indicators were assigned a weight of 1, and indirect/HIV/late causes of death were assigned a weight of 3.4 (Boerma et al. 2023). A second weighting scenario using the 2014 WHO estimates of the distribution of causes of maternal death in sub-Saharan Africa was also done. Here, the infection category was responsible for an estimated 10% of deaths, the smallest category, so it was also assigned a weight of 1, with the other category percentages also divided by 10 (Boerma et al. 2023). Thus, obstetric causes of death indicators were assigned a weight of 5.2, and indirect/HIV/late causes of death were assigned a weight of 2.9 (Boerma et al. 2023).

### Secondary indicator and national target data identification

Secondary data were used to ascertain provincial indicator coverage throughout the country. The 2019 Multiple Indicator Cluster Survey (MICS), a large-scale nationally representative survey, offered the most up-to-date data for nearly all indicators (INSEED & UNICEF 2021). If a specific indicator was not available from the 2019 MICS, the next most recent survey data that provided indicator coverage at a provincial level were used. The oldest indicator data included in this analysis were from 2019 and in total three secondary data sources were used (Tchad 2019, République du Tchad 2020, UNICEF 2021).

National targets for selected indicators were sourced from publicly available national health policy and strategy documents (Supplementary Table S1). The most recent national target was used. Key health policy documents included the Politique Nationale de Santé 2016–30, Plan de Suivi Évaluation de Plan National de Développement Sanitaire 2018–21, Plan National de Développement Sanitaire 2018–21, Plan Nationale de Développement 2013–15, and Project D'Éducation des Filles et d'Alphabétisation des Femmes (Ministère de l'Économie, 2013, Publique 2016, Tchad 2018a, 2018b, Groupe de la Banque Africaine de Développement and RDGC/AHHD 2020). If a national indicator target was not identified, an international target was used. In the absence of national or international targets for the adolescent birth rate (ABR), the current regional coverage in sub-Saharan Africa was used as a proxy 'target', since the ABR in most provinces of Chad exceeded the sub-Saharan African ABR.

### Building aggregate coverage gap scores

For each selected indicator, a coverage gap score was determined by calculating the difference between the provincial

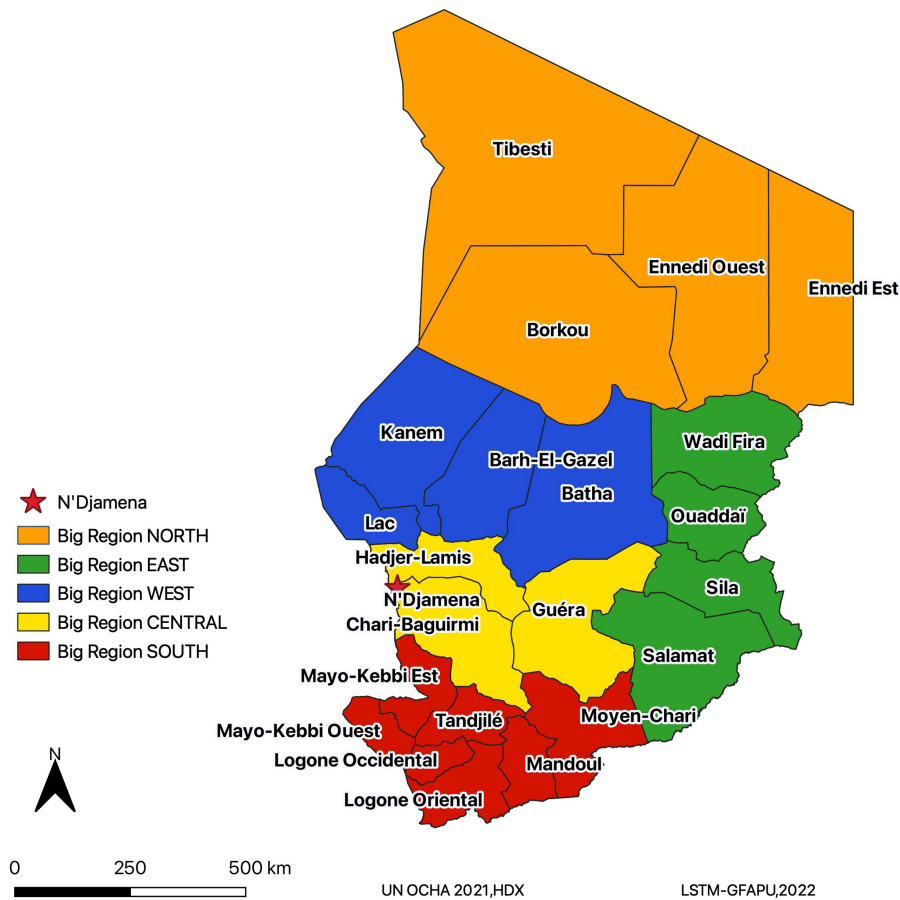
indicator coverage and the national or international target (Target-Coverage = Coverage Gap). The provincial aggregate coverage gap for MH was then determined by adding each individual indicator gap together. Most indicators were protective (e.g. skilled attendant at birth), with higher indicator coverage being beneficial for MH. However, several indicators were harmful (e.g. poverty) with national targets aiming for a lower coverage. In these cases, the coverage gap for harmful indicators was the indicator coverage minus the indicator target.

### Mapping aggregate coverage gap scores

Existing geospatial files containing national and subnational administrative boundaries for Chad were downloaded from the Humanitarian Data Exchange (UNOCHA 2017). Indicator coverage and coverage gap score data were merged with these files to build coverage gap maps using Quantum GIS (QGIS) software (version 3.16) (Quantum GIS Development Team 2020). This allowed both coverage and gap score maps to be built for each indicator in addition to the aggregate coverage gap maps.

### Interviews and focus group discussions

Due to the limited literature on current MH planning and prioritization action in Chad, key informant interviews (KIIs) and focus group discussions (FGDs) were conducted to explore the views and experiences of health administrators and clinicians (e.g. physicians and nurses/midwives) working in the MH sector in Chad and provide a deeper understanding of how MH planning is carried out. In addition, as cause-specific maternal mortality data are limited in Chad, we were also interested in local views of perceived risks to MH in different provinces, particularly as our main analysis used secondary data from 2019 (Kouanda et al. 2022). Purposive sampling of clinicians and administrators, with a diverse range of training and experience in the MH field, was used to capture a wide range of perspectives among the target group. As it was not logistically feasible to recruit participants from all provinces, six 'big regions' (north, south, east, west, central, and N'Djamena) based on geography and in line with a previous MH study (Fig. 1) made up our sampling frame (Ngaba and Kamga 2021). Recruitment focused on participants attending affiliated prescheduled trainings on quality improvement, and antenatal and postnatal care in N'Djamena for a larger research project, as well as those attending a Ministry of Health COVID workshop or contacted by phone. Our target sample was a total of 30 participants, with 12 interview and 18 discussion participants, and the unit of analysis was the six big regions. FGDs were conducted with clinicians



**Figure 1.** The six 'big regions' (north, south, east, west, central, and N'Djamena) interview and FGD sampling frame aligned with Ngaba and Kamga (2021).

or lower-level administrator groups, as it was assumed that discussions would differ both in content and as power differentials, or concern for disciplinary action, might affect disclosure of information if these participant groups were mixed. Interviews were conducted with higher-level administrators. The KIIs and FGDs were conducted in French between October and December 2021 by two local researchers, one facilitating the discussion and the other taking notes. The semistructured KII and FGD guides were developed in collaboration with local partners to ensure that they were both relevant to each group and culturally appropriate for the target audience. All participants were made aware that their participation was voluntary with the option to withdraw at any time without consequence during the consent process. Audio recordings were transcribed and securely stored shortly after each KII/FGD. Interview and FGD transcripts were managed in French using NVivo12 software (version 12.6.1) (QSR International Pty Ltd, 2018) by the main study author and reviewed by all authors. KII and FGD data were analysed using an inductive thematic analysis (Guest et al. 2012) to identify any perceived or potential risks to MH in Chad, by province, and any health planning successes and challenges using open coding. These themes were not defined a priori and were summarized and compared with those identified from the literature review and secondary data.

## Results

### MH coverage gap scores and mapping

Eleven MH indicators were included as a result of the literature review and data availability (Table 2): ABR, delivery by skilled health personnel, tetanus vaccination coverage, contraceptive coverage, postnatal consultation coverage, ITN use, IPTp, poverty, education, anaemia, and emergency obstetric care (EmOC). Many key interventions are covered by EmOC, but data on individual interventions in Chad were seldom available.

The raw aggregate MH coverage gap score map (Fig. 2) and corresponding table in the figure indicate variation in calculated scores by quintiles. A higher score (darker red colour) indicates a greater aggregate gap between coverage and targets of key MH indicators, identifying higher priority provinces for intervention (e.g. provinces in darkest red in Fig. 2 are the highest priority). Provinces have been divided into quintiles to assist with health planning by differentiating degrees of aggregate MH coverage gaps and grouping provinces according to need for intervention. The calculated raw aggregate MH coverage gap scores ranged from 154.3 to 491.4, with an average provincial score of 374.3 (SD: 77.5). The capital province of N'Djamena had the lowest MH aggregate coverage gap score (154.3) followed by Moyen-Chari (238.6) and Mayo-Kebbi Ouest (285.4), whereas the provinces with

**Table 2.** Summary of selected MH indicators and their corresponding national targets

Indicators	Targets
Adolescent birth rate (per 1000 women aged 15–19 years)	<u>100.5</u>
Delivery by skilled health personnel	%
Tetanus vaccination coverage (fully immunized)	90%
Contraceptive coverage (any method)	15%
Postnatal consultation coverage	50%
ITN use by pregnant women	80%
IPT for malaria (three doses)	50%
Poverty (poorest quintile)	27.5%
Education (literacy in women aged 15–49 years)	17%
Anaemia in pregnant women <sup>a</sup>	<30%
EmOC	100% (available and operational capacity) ≥5 BEmOC/500 000 population ≥1 CEmOC/500 000 population

Indicator inclusion required available indicator data. Targets: regular font = national target, bold font = international target, underlined font = coverage in sub-Saharan Africa. BEmOC = Basic EmOC; CEmOC = Comprehensive EmOC. <sup>a</sup>Nonpregnant women sampled for anaemia data (Republique du Tchad 2020).

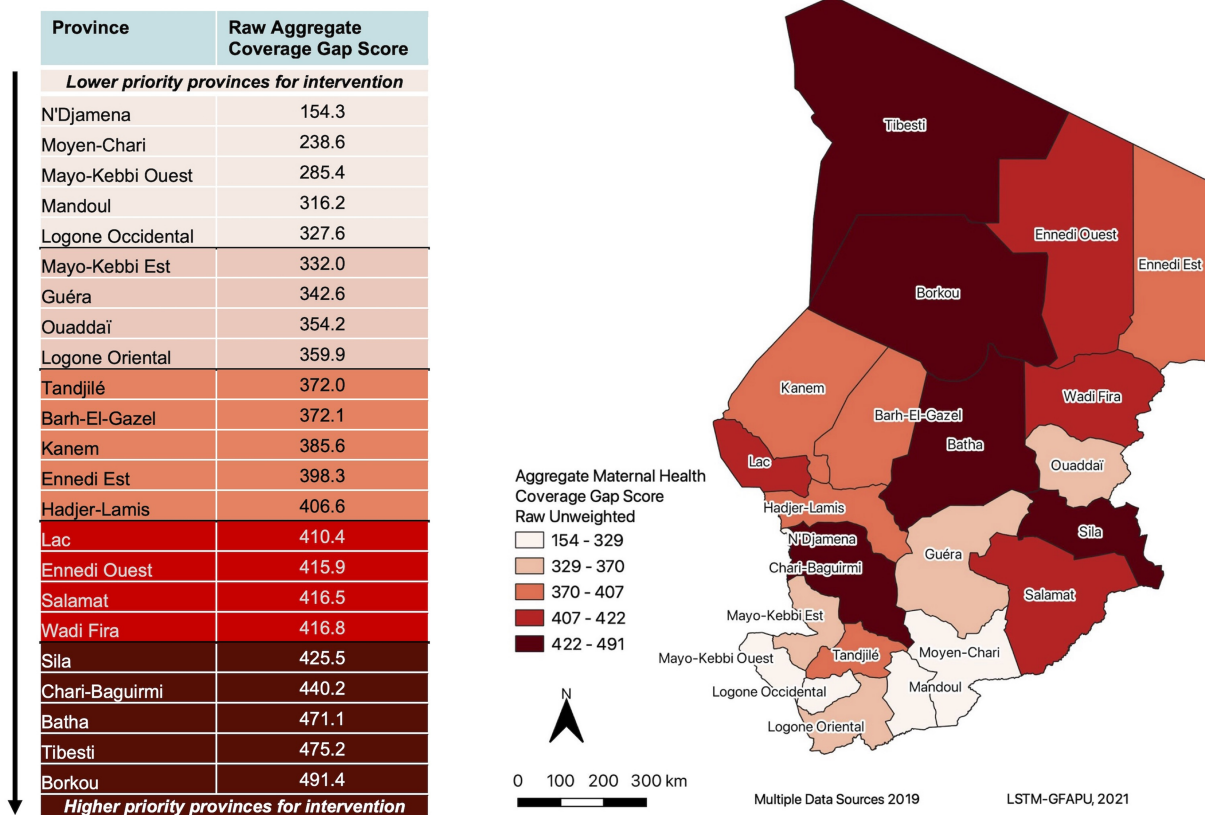
the greatest calculated aggregate coverage gap were Borkou (491.4), Tibesti (475.2), and Batha (471.1). The greatest individual indicator coverage gaps were from EmOC (basic

and comprehensive), ABR, tetanus vaccination, and delivery by skilled health personnel (Supplementary Figs S1–S5).

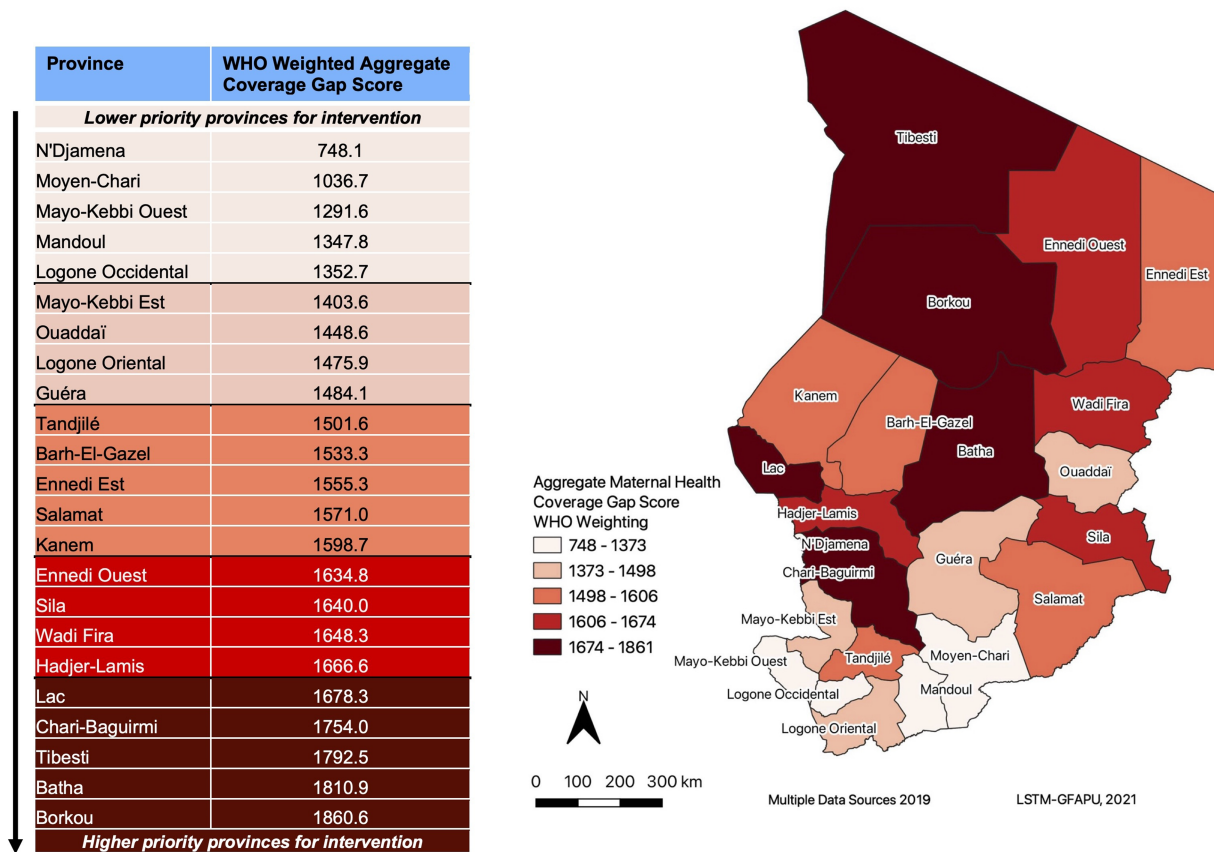
For the weighting, (I) obstetric causes of death indicators included EmOC, delivery by skilled health personnel, and postnatal consultation, (II) sepsis/infection indicators included tetanus vaccination, ITN use, and IPTp, and (III) indirect/HIV/late causes of death included contraceptive coverage, poverty, education, anaemia, and ABR. The calculated WHO weighted aggregate MH coverage gap scores ranged from 748.1 to 1860.6, with an average provincial score of 1514.6 (SD: 251.5) (Fig. 3). The capital province of N’Djamena had the lowest MH-weighted aggregate coverage gap score (748.1) followed by Moyen-Chari (1036.7) and Mayo-Kebbi Ouest (1291.6), whereas the provinces with the greatest calculated aggregate coverage gap were Borkou (1860.6), Batha (1810.9), and Tibesti (1792.5). The calculated GBD-weighted aggregate MH coverage gap scores ranged from 2114.3 to 2215.2, with an average provincial score of 3659.4 (SD: 537.1) (Fig. 4). The capital province of N’Djamena had the lowest MH-weighted aggregate coverage gap score (2114.3) followed by Moyen-Chari (2610.9) and Logone Occidental (3182.9), whereas the provinces with the greatest calculated aggregate coverage gap were Borkou (4416.2), Tibesti (4263.1), and Batha (4173.6). The weighting did change the order of provinces by the coverage gap score as indicated in Table 3.

**Interviews and FGDs**

In total, 27 respondents across 11 KIIs and 6 FGDs were recruited, representing all six big regions and 15 provinces.



**Figure 2.** Raw aggregate MH coverage gap map of Chad (right) and corresponding calculated gap scores (left). A higher score/darker colour indicates a greater gap in coverage and thus should be considered for priority intervention. Provinces have been divided into quintiles to assist with health planning by differentiating the degree of coverage gap.



**Figure 3.** WHO weighting aggregate MH coverage gap map of Chad (right) and corresponding calculated weighted gap scores (left). A higher score/darker colour indicates a greater gap in coverage and thus should be considered for priority intervention. Provinces have been divided into quintiles to assist with health planning by differentiating the degree of coverage gap. See 'Materials and methods' section.

There were three fewer interview participants than our target sample due to participant unavailability during the study period or refusal. Respondents reported having between less than a year and up to 37 years of work experience in Chad's health sector (mean 13.1 years, SD 9.7). Administrator respondents held positions of provincial health delegates (délégués provinciaux à la santé -DSP), Médecin Chef de District, or Chef de Zone, and clinician respondents were largely physicians. On average, respondents had worked in at least three different provinces and reported strong convictions to work in the health field, particularly in MH. The main themes and subthemes of reported MH risks are listed in Table 4 with the former including health system challenges, population-related challenges, specific MH threats, country challenges, and policy challenges:

My first motivation is suffering. Mother, women, and wives who suffer enormously because the majority do not have access to care, there are multiple causes for health coverage, lack of means, lack of decision-making power, lack of infrastructure to act .... (Interview participant)

KII and FGD respondents also described a variety of established, data driven and participatory health planning processes for MH at the facility, district, provincial, and national levels. Reported challenges included the use of multiple different planning tools from various nongovernmental partners or health system strata, with tool revision being

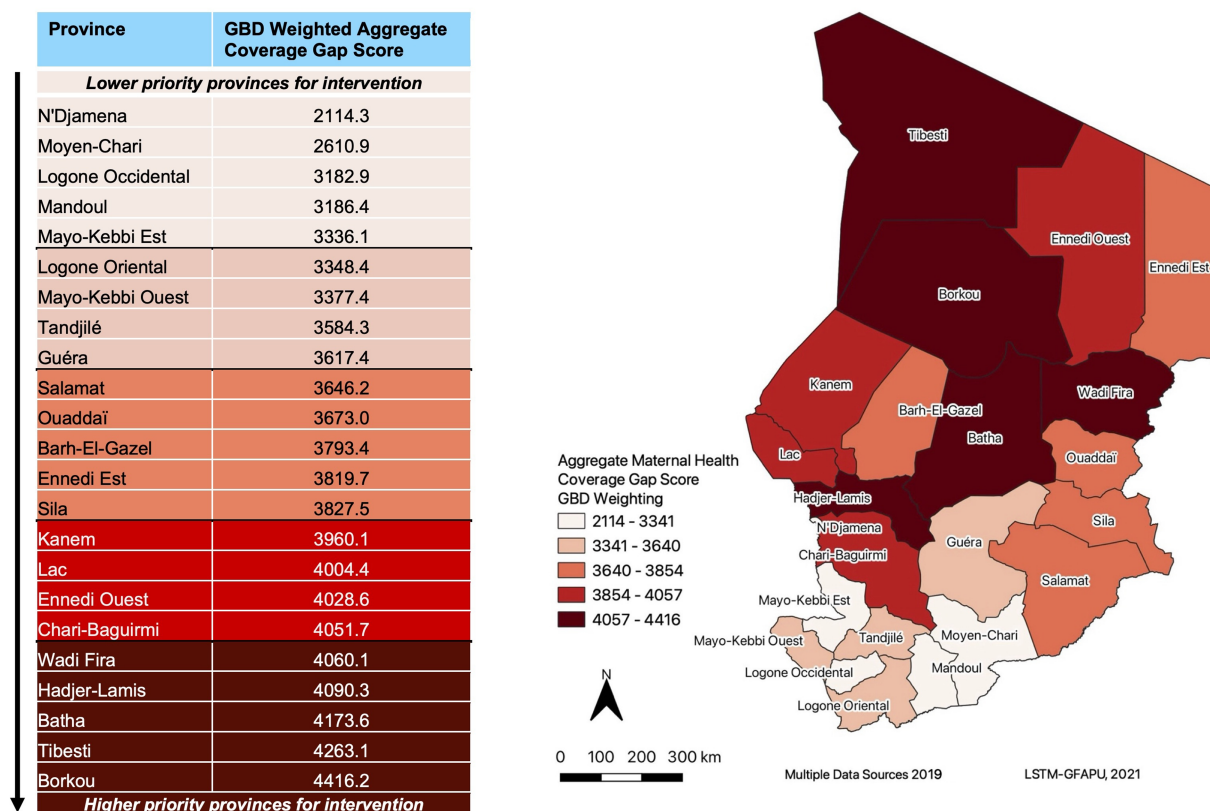
conducted on variable bases. Further reported challenges included centralized policy or planning that does not consider provincial differences or realities on the ground. This contributed to erratic implementation of health planning, which is largely undermined by inadequate resources and the reliance on international partners who often have different priorities. Notably, no clear prioritization process was identified by participants during the qualitative data collection:

On the planning, we have no difficulties. There are outlines that are there, but the problem is the implementation of the plan .... (Interview participant)

Funding is much more centralized, but the realities are not the same for each locality. We develop a standard plan that takes all areas into consideration, but our realities are not the same and application on the ground is problematic. (Interview participant)

There are partners who finance their part and the partners each have their own priority which is not necessarily our priority. They see our action plan and take what interests them... (Interview participant)

There is a personnel problem: you go to certain health centres, a single agent manages the entire minimum package of activities and this person manages both the children, the mothers there and therefore certain adults. It is a daily



**Figure 4.** GBD weighting aggregate MH coverage gap map of Chad (right) and corresponding calculated weighted gap scores (left). A higher score/darker colour indicates a greater gap in coverage and thus should be considered for priority intervention. Provinces have been divided into quintiles to assist with health planning by differentiating the degree of coverage gap. See 'Materials and methods' section.

management that is sometimes very difficult.” (Interview participant)

For the most part, participants concurred that provincial variations in MH risks existed both within and between provinces. Among participants working in more rural and remote areas, insufficient or adequately trained health personnel was identified as a main challenge, along with unique service delivery challenges for provinces with a greater number of nomadic tribes. Participants in better resourced settings felt that the risks were universal and that everyone was ill-equipped to provide an appropriate level of MH care. Both perspectives were somewhat corroborated by participants with experience in multiple provinces, who reported greater access to services in provinces with higher population densities, but that risks relating to an overall fragile health system, including inadequate personnel, health financing, and medical supply issues, were universal. Other identified issues impacting MH coverage included discomfort with male providers, especially as physicians providing emergency services tended to be male, and delays seeking postnatal care due to cultural expectations that a woman remains home for 42 days following birth.

In addition, many participants also highlighted progress against maternal mortality that had been achieved in their province. Some of this progress was innovative strategies such as mobile outreach teams to improve access to care for nomadic populations, while others were improved awareness of MH risks resulting in improved care-seeking

behaviours, or simply steady improvements to overall MH indicators.

## Discussion

Our study sought to develop a pragmatic tool to support MH prioritization and decision-making in Chad that addressed multiple drivers of maternal mortality and considered national goals for MH. We identified provinces in Chad that should be considered for priority intervention based on calculated aggregate coverage gap scores for key MH indicators from secondary MICS data. Greater aggregate MH coverage gaps may represent an increased risk for maternal mortality, and these provinces should be considered for additional resource allocation as appropriate and feasible. However, it should be noted that any decisions about interventions should also consider important contextual factors, including safety, feasibility, appropriateness, and acceptability. Both the secondary analysis and primary qualitative data revealed wide variation in aggregate MH coverage gap scores throughout Chad's 23 provinces (Figs 2–4) and across different indicators (Supplementary Figs S1–S5). Two weighting scenarios were trialled which adjusted the order of provinces by aggregate coverage gaps. Notably, the three provinces with the greatest coverage gaps, and thus likely candidates for priority intervention, remained consistent in each scenario. Analogously, the six provinces with the smallest coverage gaps were similar suggesting that the identified highest and lowest priority provinces for intervention may be more reliable

**Table 3.** Raw and weighted aggregate MH coverage gaps from smallest to largest and relative to the raw ordering for each province in Chad for the two weighting scenarios

Province	Raw aggregate coverage gap order (smallest to largest)	GBD-weighted aggregate coverage gap order	WHO-weighted aggregate coverage gap order
N'Djamena	1	1	1
Moyen-Chari	2	2	2
Mayo-Kebbi Ouest	3	7↓	3
Mandoul	4	4	4
Logone	5	3↑	5
Occidental Mayo-Kebbi Est	6	5↑	6
Guéra	7	9↓	9↓
Ouaddaï	8	11↓	7↑
Logone Oriental	9	6↑	8↑
Tandjilé	10	8↑	10
Barh-El-Gazel	11	12↓	11
Kanem	12	15↓	14↓
Ennedi Est	13	13	12↑
Hadjer-Lamis	14	20↓	18↓
Lac	15	16↓	19↓
Ennedi Ouest	16	17↓	15↑
Salamat	17	10↑	13↑
Wadi Fira	18	19↓	17↑
Sila	19	14↑	16↑
Chari-Baguirmi	20	18↑	20
Batha	21	21	22↓
Tibesti	22	22	21↑
Borkou	23	23	23

Down Arrow (↓): the province coverage gap is now larger relative to the raw ordering.

Up Arrow (↑): the province coverage gap is now smaller relative to the raw ordering.

No Arrow: order unchanged relative to the raw ordering.

WHO, weighting based on WHO distribution of causes of maternal death as described in the 'Materials and methods' section.

GBD, weighting based on GBD distribution of causes of maternal death as described in the 'Materials and methods' section.

than those with more moderate coverage gaps. However, both weighting scenarios have limitations as neither one is specific to Chad (LIC versus sub-Saharan Africa), and both are based on sparse cause-of-death data from LMICs and may over- or underestimate the role of obstetric causes of death in the country.

Primary data revealed that existing MH planning is typically more centralized and might benefit from a more in-depth understanding of provincial variations in key MH indicators. Including a prioritization tool in decision-making may be advantageous in Chad as no clear prioritization process for MH planning was identified, resources are scarce, and large coverage gaps exist for multiple indicators. By combining MH indicators of greatest import with GIS, our proposed tool can help health planners differentiate between the many needs in a more strategic manner and identify priority provinces for intervention.

This coverage gap scoring tool offers several advantages to MH planning in Chad and could be replicated in other challenging and lower resource contexts. First, this tool may help facilitate decisions around health resource distribution and the identification of priority provinces according to national

**Table 4.** Summary of challenges to maternal and child health in Chad as identified by clinician and health administrator respondents

Main themes	Sub-themes
Health system challenges	<ul style="list-style-type: none"> <li>• Insufficient health personnel</li> <li>• Inadequately trained health personnel</li> <li>• Inequitable distribution of resources</li> <li>• Medical supply issues</li> <li>• Constraints on the Ministry of Health</li> <li>• Lack of protocols</li> <li>• Overwhelmed hospitals in N'Djamena</li> <li>• Insufficient/ill-equipped BEmONC/CEmONC services</li> <li>• Traditional birth attendants (TBA)</li> <li>• Insufficient blood donation services</li> <li>• Weak supervision</li> <li>• Weak referral system</li> <li>• Disorganized services</li> <li>• Inequitable access to health services</li> <li>• Infrastructure issues</li> <li>• Quality of care issues</li> </ul>
Population-related challenges	<ul style="list-style-type: none"> <li>• Nomadic population challenges</li> <li>• Low attendance: ANC, PNC, delivery, nonmaternal care, etc.</li> <li>• Delayed care-seeking behaviours</li> <li>• Patient expectations</li> <li>• Low knowledge of MCH risks</li> <li>• Low literacy/education</li> <li>• Cultural beliefs</li> <li>• Poverty/low socioeconomic status</li> </ul>
Specific maternal and child health threats	<ul style="list-style-type: none"> <li>• Anaemia</li> <li>• Children's safety</li> <li>• Communicable diseases: malaria, HIV, human African trypanosomiasis, sexually transmitted infections, and other infections</li> <li>• Malnutrition</li> <li>• Low vaccination coverage</li> <li>• Street drugs</li> <li>• Mental health</li> <li>• Low access to contraception</li> <li>• Gender-based violence</li> <li>• Low contraception uptake</li> <li>• Poor water, sanitation, and hygiene</li> <li>• Mental health</li> </ul>
Country challenges	<ul style="list-style-type: none"> <li>• Climate: rainy season and climate change</li> <li>• Corruption</li> <li>• Insecurity</li> <li>• Urban versus rural differences</li> <li>• Nongovernmental organization-related issues</li> <li>• Infrastructure issues</li> </ul>
Policy challenges	<ul style="list-style-type: none"> <li>• Free healthcare (Gratuité de Soins) policy</li> <li>• Lack of/weak protocols</li> <li>• TBA</li> <li>• Political will</li> <li>• Weak health information systems/health data</li> <li>• Illicit sale of medications</li> </ul>

BEmONC: basic emergency obstetric and neonatal care, CEmONC: comprehensive emergency obstetric and neonatal care, ANC: antenatal care, PNC: postnatal care, MCH: maternal child health, HIV: human immunodeficiency virus.

targets, which may also support greater local ownership and coordination with partners. Second, the tool suggests a data-driven approach to health planning and prioritization in Chad using existing and preferred national data sources for MH monitoring. Third, it emphasizes key aggregate MH coverage gaps and interventions to reduce maternal mortality in LMICs based on data availability in Chad. Fourth, the proposed coverage gap score calculations are quite simple and



can be easily and quickly reproduced without any equipment or software purchase. Ultimately, these elements support a more data-driven and equitable approach to MH planning and prioritization in lower resource settings, in line with the EPMM goals (WHO 2015).

Our tool also offers several advantages compared to existing action-oriented and accountability tools, such as the Reproductive, Maternal, Newborn, Child, and Adolescent Health scorecards (Hub 2021, Gullo et al. 2018). While designed with a similar aim of supporting ministries of health, our approach uses validated national household survey data to consider coverage gaps at national or regional/provincial levels. The scorecards offer a more granular assessment by using district-level Health Management and Information System (HMIS) data, although this approach excludes persons not accessing health services which may be concerning based on known underreporting of maternal deaths in Chad, especially at the community level (Mowafi et al. 2019, Moukéné et al. 2021, Kouanda et al. 2022). The survey data used in our tool may also be more relevant in Chad where HMIS data inaccuracy is a known issue (Mowafi et al. 2019, Moukéné et al. 2021). Our approach also considers an aggregate score of key MH indicators instead of assessing indicators individually. This more comprehensive scoring tool may be useful in challenging contexts such as Chad with large gaps between many indicator targets and a need to perhaps focus on the groups of indicators with greatest import.

However, there are limitations with this tool. First, once a priority province is identified, the tool does not advise which interventions to then prioritize in that province. However, existing tools such as The Lives Saved Tool (LiST) already do this estimating how the coverage change will impact mortality (Walker et al. 2013). By combining our tool with LiST, health planners may be able to prioritize specific interventions in priority provinces. Second, morbidity or variations in disease severity are not considered. Third, provincial data for some indicators of import were not available in Chad, including abortions, adolescent births before the age of 15 years, antenatal care, noncommunicable diseases, HIV prevalence, and antiretroviral use. These indicators would add to the current aggregate coverage gap scoring and may alter decisions around priority provinces for intervention. Fourth, for a couple of indicators, national targets lacked specificity, including not differentiating between basic and comprehensive EmOC despite health facilities reporting the two levels. A further limitation is that the weighting approaches used may not accurately reflect the different effects of these indicators on maternal mortality and are based on international estimates that may differ for Chad. The lack of applicable odds or risk ratios for all of the selected indicators also limited any weighting using an alternate and likely more accurate approach. For the qualitative data collection, our sampling included the recruitment of participants who were already traveling to N'Djamena for prescheduled trainings in antenatal care, postnatal care, and quality improvement. This may have affected the responses provided, with a greater emphasis on certain issues, particularly around quality improvement. Some bias is also anticipated in these results due to all participants being voluntary. The qualitative findings likely have limited generalizability outside Chad and for non-MH planning and prioritization in the country. The analysis presented here is based on survey data gathered in 2019 or earlier. In light of

the COVID-19 global pandemic and 2021 appointment of a transitional military council in Chad, it is possible that pressures on the health system and health planning decisions may have changed.

If this tool were to be implemented, topics of further research could include an evaluation of the impact or performance of this tool on priority setting at a national level. The tool could also be adapted to include additional criteria including cost-effectiveness/economic efficiency, morbidity/severity of disease, political circumstances, culturally relevant criteria, facility accessibility, and/or district-level health data. It could also be adapted for other health conditions or priorities in Chad and other LMICs.

## Conclusion

We proposed a simple data-driven tool to support MH planning and prioritization in Chad that can easily be adapted to other challenging and lower resource settings. By combining GIS with aggregate MH coverage gap profiles for key indicators at a regional/provincial level, our tool seeks to support local health officials with health system planning, prioritization, and resource distribution decisions. By identifying areas with greater need or gaps in coverage, health planners can develop more equitable frameworks and allocate limited resources so that they have a bigger impact. Further research is needed to test this tool and its impact on MH planning in Chad and other LMICs.

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## Supplementary data

Supplementary data is available at *Health Policy and Planning* online.

## Author contributions

Ana Krause (Conceptualization [co-lead], Project administration [lead], Investigation [co-lead], Methodology [co-lead], Formal analysis [supporting], Visualization [lead], Writing—original draft [lead]), Alexandre Quach (Conceptualization [co-lead], Project administration [supporting], Methodology [co-lead], Formal analysis [supporting], Writing—original draft [supporting]), Yamingue Betinbaye (Conceptualization [supporting], Investigation [co-lead], Data curation [lead], Writing—review & editing [supporting]), Mindekem Rolande (Conceptualization [supporting], Project administration [supporting], Investigation [supporting], Writing—review & editing [supporting]), Florence Mgawadere (Conceptualization

[supporting], Validation [supporting], Writing—review & editing [supporting]), and Charles A. Ameh (Conceptualization [supporting], Validation [supporting], Writing—review & editing [supporting], Supervision [lead]).

## Reflexivity Statement

A.K. has a clinical background in emergency nursing and triage, which influenced her approach to the project conception when considering the health sector challenges in Chad. Her prior experience supporting household health surveys in humanitarian settings also served as a foundation for applying a data-driven approach to health system planning and decision-making around resource allocation. As an outsider, lacking a nuanced understanding of Chad's health system and sociopolitical context, she had no preconceived assumptions as to the potential results of a proposed regional/provincial risk assessment and greatly appreciated the expertise, collaboration, and support from in-country partners.

Y.B. is a Chadian researcher accustomed to qualitative studies at the country level. He has a good knowledge of Chad and a good understanding of the national sociopolitical context and the Chadian health system. He was influenced by his prior knowledge of the field when conducting KIIs and FGDs. He also considered that the initial questions on seniority in the health system and the personal motivation(s) underlying career choices were very relevant because they served as a doorway to encourage respondents to be as objective as possible when participating in KIIs and FGDs. He, however, mostly considered inclusivity and balance in dimensions such as gender, seniority, and provincial location in carrying out the research.

A.Q. was influenced by the fact that we wanted to align with the larger programme's schedule (see below) and the wishes of the Chad Ministry of Public Health. Suggesting the inclusion of delegates and Médecins Chef de Districts helped to meet our objectives, while also responding to the partner's suggestion to include provincial and district authorities in the overall programme, and fit within our budget limitations.

This study was part of a larger quality improvement programme in antenatal and postnatal care in Chad, supported by the Global Fund and the Liverpool School of Tropical Medicine. This operational research project was developed in collaboration with local partners from the Centre de Support en Santé Internationale—Centre de Recherche en Anthropologie et Sciences Humaines (CSSI-CRASH) Consortium and the Ministry of Public Health, in particular the General Technical Directorate for Reproductive Health, Vaccination and Nutrition (DGTSRVN) and the Maternal Neonatal Child Adolescent Reproductive Health and Nutrition Platform (SRMNIA-N). This study sought to support and strengthen overall MCH planning and prioritization in the Republic of Chad, a challenging context with many pressing health needs and limited resources with which to respond. In addition to their involvement in the research design, all primary qualitative data collection was conducted by nationally based coresearchers Dr Yamingue Betinbaye and Ali Koitigam from CRASH with coordination support from Dr Mindekem Rolande in Chad. Engaging local partners in the study design, field work, and analysis was important to obtain input from researchers with

deeper insight into the challenges in-country and make the study more relevant and useful. The health survey data that were used were previously collected as part of national household health surveys led in partnership between the National Institute of Statistics, Economic and Demographic Studies (INSEED) and international partners. Funding supported the local research team by providing indemnities and funding costs associated with data collection. This equipment could be used by the team for future studies. Broader programme funding also supported a dissemination and networking workshop in December 2021 where preliminary research findings were presented to key stakeholders in the maternal and child health sector in Chad from various administrative levels. The research findings were subsequently presented at a national maternal and child health summit in March of 2022. All international and national research team members involved in the study have been acknowledged in the initial research proposal, final report, and were invited to be authors. All team members have access to the full study report and more detailed findings, which have been made available in both English and French. Of the full research team, including the lead researcher and main field coordinator, five are male and six are female. The first author is an early career researcher, who has contributed to the study design and data analysis, and led the writing. Safeguarding procedures were in place in Chad and the UK, and all team members and qualitative research participants were made aware of both sets of procedures through information sheets and verbal presentations prior to their participation in the study.

## Ethical approval

Approval for the study methodology was obtained from the Liverpool School of Tropical Medicine Research Ethics Committee (21-070) and Comité National de Bioéthique—CNBT, Tchad (No. 009/CMT/PC/PM/MESRSI/SE//SG/CNBT/SG/2021).

## Conflict of interest

None declared.

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## Data availability

The primary data underlying this article are available in the Liverpool School of Tropical Medicine's online digital archive upon publication at <https://archive.lstmed.ac.uk/>, and the secondary data underlying this article are available publicly through the United Nations Children's Fund (UNICEF)-MICS at <https://mics.unicef.org/surveys>.

## References

- Azétso J, Ochieng M. The right to health, health systems development and public health policy challenges in Chad. *Philos Ethics Humanit Med* 2015;10:1–14.
- Bauserman M, Lokangaka A, Thorsten V *et al.* Risk factors for maternal death and trends in maternal mortality in low- and middle-income countries: a prospective longitudinal cohort analysis. *Reproductive Health* 2015;12:55.
- Boerma T, Campbell R, Amouzou A *et al.* Maternal mortality, stillbirths, and neonatal mortality: a transition model based on analyses of 151 countries. *Lancet Glob Health* 2023;11:e1024–31.
- Campbell OMR, Graham W, Althabe F *et al.* Maternal health: an executive summary for The Lancet's Series. *Lancet* 2016. <https://www.thelancet.com/pb/assets/raw/Lancet/stories/series/maternal-health-2016/mathealth2016-exec-sum.pdf>.
- El-Saharty S, Chowdhury S, Ohno N *et al.* *Improving Maternal and Reproductive Health in South Asia: Drivers and Enablers*. World Bank Studies. Washington, DC: World Bank, 2017.
- GBD 2015 Maternal Mortality Collaborators. Global, regional, and national levels of maternal mortality, 1990–2015: a systematic analysis for the Global Burden of Disease Study 2015. *Lancet* 2016;388:1775–812.
- Groupe de la Banque Africaine de Développement and RDGC/AHHD, D. Projet d'Éducation des Filles et d'Alphabétisation des Femmes (PEFAF): République du Tchad. *Rapport d'Évaluation*. N'Djamena, Tchad: Groupe de la Banque Africaine de Développement, 2020.
- Guest G, Macqueen KM, Namey EE. *Applied Thematic Analysis*. Thousand Oaks, CA: SAGE Publications, 2012.
- Gullo S, Gkuhlmann AS, Galavotti C *et al.* Creating spaces for dialogue: a cluster-randomized evaluation of CARE's Community Score Card on health governance outcomes. *BMC Health Serv Res* 2018;18:1–12.
- Henriksson DK, Peterson SS, Waiswa P *et al.* Decision-making in district health planning in Uganda: does use of district-specific evidence matter? *Health Res Policy Sys* 2019;17:1.
- Hub AS. Kenya RMNCAH scorecard. ALMA Scorecard Hub. 2021.
- IHME. *Chad*. Seattle: University of Washington, 2020. <http://www.healthdata.org/chad> (21 June 2021, date last accessed).
- INSEED, and UNICEF. MICS6-Tchad, Enquête Par Grappes À Indicateurs Multiples 2019: Rapport Des Résultats de L'enquête. N'Djamena, Tchad: MICS, 2021. [https://mics.unicef.org/sites/mics/files/Chad%202019%20MICS%20Survey%20Findings%20Report\\_French.pdf](https://mics.unicef.org/sites/mics/files/Chad%202019%20MICS%20Survey%20Findings%20Report_French.pdf)
- Institut National de la Statistique, des Études Économiques et Démographiques (INSEED), Ministère de la Santé Publique (MSP) et ICF International. Enquête Démographique et de Santé et à Indicateurs Multiples (EDS-MICS 2014-2015). In: M. D. L. S. P.-M. T. E. I. (ed.), *International*. Chad ed. Rockville, MD: INSEED, MSP et ICF International, 2016; FR317.
- Kouanda S, Ouedraogo OMA, Tchoufiene PP *et al.* Analysis of the implementation of maternal death surveillance and response in Chad. *Int J Gynecol Obstet* 2022;158:67–73.
- Makanga PT, Schuurman N, Von Dadelszen P *et al.* A scoping review of geographic information systems in maternal health. *Int J Gynecol Obstet* 2016;134:13–17.
- Micah AE, Su Y, Bachmeier SD *et al.* Health sector spending and spending on HIV/AIDS, tuberculosis, and malaria, and development assistance for health: progress towards Sustainable Development Goal 3. *The Lancet* 2020;396:693–724.
- Ministère de la Santé Publique. Plan Stratégique de Santé Communautaire 2015-2018. In: PUBLIQUE MDLS (ed.). N'Djamena, Chad: République du Tchad, 2015.
- Ministère de l'Économie, DPEDLCI. Plan National de Développement 2013-2015. In: Ministère De L'économie DPEDLCI (ed.). N'Djamena, Tchad: République du Tchad, 2013.
- Moukéné A, De Cola MA, Ward C *et al.* Health management information system (HMIS) data quality and associated factors in Massaguet district, Chad. *BMC Med Inf Decis Making* 2021;21:1–10.
- Mowafi H, Ngaruiya C, O'reilly G *et al.* Emergency care surveillance and emergency care registries in low-income and middle-income countries: conceptual challenges and future directions for research. *BMJ Global Health* 2019;4:e001442.
- Musa GJ, Chiang P, Sylk T *et al.* Use of GIS mapping as a public health tool—from cholera to cancer. *Health Serv Insights* 2013;6:HIS-S10471.
- National Institute of Statistics, EADSC, UNICEF. Multiple Indicator Cluster Survey 6-Chad. UNICEF (ed.), 6 ed. UNICEF, 2019.
- Ngaba EA, Kamga BF. Inequalities in effective access to obstetric care in Chad. *Afr J Econ Rev* 2021;9:1–20.
- Nvivo Software. QSR International Pty Ltd. Nvivo. 2018.
- Publique MDLS. Politique Nationale de Santé 2016-2030. In: PUBLIQUE MDLS (ed.). N'Djamena, Tchad: République du Tchad, 2016.
- Quantum GIS Development Team. QGIS Geographic Informations System—Hannover. QGIS.org: Open Source Geospatial Foundation Project, 2020.
- Republique du Tchad. Enquete Nationale de Nutrition—Rapport Final. In: NATIONALE MDLSPEDLS (ed.). Chad, 2020.
- Rudan I, Kapiriri L, Tomlinson M *et al.* Evidence-based priority setting for health care and research: tools to support policy in maternal, neonatal, and child health in Africa. *PLoS Med* 2010;7:e1000308.
- Tchad M. Carte Sanitaire du Tchad 2019-2023. PUBLIQUE MDLS (ed.). N'Djamena, Tchad: INSEED, 2019.
- Tchad MDLSPA. Plan de Suivi Évaluation de Plan Nationale de Développement Sanitaire 2018-2021. In: Publique MDLS (ed.). N'Djamena, Tchad: Ministère de la Santé Publique au Tchad, 2018a.
- Tchad MDLSPA. Plan National de Développement Sanitaire (PNDS3: 2018-2021). PUBLIQUE MDLS (ed.). N'Djamena, Chad: Ministère de la Santé Publique au Tchad, 2018b.
- Tchad RD. Plan Stratégique de Développement Des Ressources Humaines Pour la Santé Au Tchad 2011-2020. In: PUBLIQUE MDLS (ed.). Global Health Workforce Alliance: WHO, 2010.
- UNICEF. Maternal and Newborn Health Disparities Chad. *Maternal and Newborn Health Disparities Country Profiles*. UNICEF, 2016.
- UNICEF. MICS6 TOOLS. Multiple Indicator Cluster Surveys (MICS): UNICEF. 2021. <https://mics.unicef.org/tools?round=mics6> (28 June 2021, date last accessed)
- UNOCHA. *Chad - Subnational Administrative Boundaries*. Humanitarian Data Exchange (HDX): UNOCHA. 2017. <https://data.humdata.org/dataset/cod-ab-tcd> (13 November 2021, date last accessed).
- Walker N, Tam Y, Friberg IK. Overview of the Lives Saved Tool (LiST). *BMC Public Health* 2013;13:1–6.
- WHO. *Strategies toward Ending Preventable Maternal Mortality (EPMM)*. Geneva: World Health Organization, 2015.
- WHO. *The 2021 update, Global Health Workforce Statistics*. Geneva: World Health Organization. 2021. <https://www.who.int/data/gho/data/themes/topics/health-workforce> (28 June 2021, date last accessed).
- WHO. Trends in maternal mortality 2000 to 2020: estimates by WHO, UNICEF, UNFPA, World Bank Group and UNDESA/Population Division. In: WHO, UNICEF, UNFPA, World Bank Group and UNDESA/Population Division (eds). Geneva: World Health Organization, 2023.
- Wigley AS, Tejedor-Garavito N, Alegana V *et al.* Measuring the availability and geographical accessibility of maternal health services across sub-Saharan Africa. *BMC Med* 2020;18:1–10.
- World Bank. *Maternal Mortality Ratio (per 100,000 Live Births)*. www.worldbank.org. 2020. [https://liveprod.worldbank.org/en/indicator/sh-sta-mmrt?view=trend&geos=WLD\\_TCD\\_LIC](https://liveprod.worldbank.org/en/indicator/sh-sta-mmrt?view=trend&geos=WLD_TCD_LIC) (10 June 2024, date last accessed).
- Youngkong S, Kapiriri L, Baltussen R. Setting priorities for health interventions in developing countries: a review of empirical studies. *Trop Med Int Health* 2009;14:930–39.

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