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The Role of Mortality Estimation in Project Evaluation: Findings from a Household Survey in Dembo and Beboro Health Zones, Chad

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Abstract

Introduction

In the Mandoul region of Chad, multiple indicators point to an ongoing protracted crisis including high child mortality, food insecurity, and elevated malaria incidence. Since 2018, Médecins Sans Frontières (MSF) has provided seasonal malaria chemoprevention and supported maternal and child health services in Moissala district. In 2023, they conducted a mortality survey to evaluate population health in the supported areas.

Methods

MSF conducted a stratified two-stage cluster survey in Dembo and Beboro health zones. Geospatial sampling was used to select cluster starting points, with three households interviewed per cluster. A sample size of 4,970 people was targeted in each zone. The questionnaire captured household demographics, births, deaths, and migration over an 8-month recall period.

Results

In Dembo, 311 clusters covered 849 households and 5,504 people. In Beboro, 326 clusters covered 895 households and 4,999 people. Dembo had a high crude mortality rate (CMR) of 0.89 (95%CI: 0.70, 1.08) deaths/10,000 people/day and under-five mortality (U5MR) of 1.82 (95%CI: 1.21, 2.41). In Beboro, the CMR was 0.66 (95% CI: 0.48–0.84) and U5MR was 0.84 (95% CI: 0.43–1.25). The under-five male-to-female death ratio was 1.05:1 in Dembo and 4.5:1 in Beboro. Leading reported causes of death were malaria, neonatal complications, chronic disease, and respiratory infections.

Discussion

Dembo’s high mortality rates reflected a population in acute distress with CMR and U5MR more than triple the regional average. In Beboro, marked sex disparities in reporting point to underestimation of the true mortality burden. Elevated mortality in the zones is likely driven by high malaria incidence and poor healthcare access. Following the survey, MSF made a number of adjustments to improve life-saving services. Results underscore the value of mortality estimation as an indicator of population health and a tool to evaluate whether humanitarian programs are meeting population needs.

Key Message

What is already known on this topic: Mortality estimation is a critical but underutilized tool for assessing population health and intervention effectiveness in humanitarian settings.

What this study adds: This survey found elevated mortality in two health zones in Chad where MSF operated, revealing a population in acute crisis despite ongoing support. These findings demonstrate that excess mortality can persist unrecognized even in areas with established services.

How this study might affect research, practice, or policy: Following the study, MSF adjusted program services to better meet population needs. Findings underscore the value of mortality estimation as a key mechanism for evaluating whether humanitarian programs are meeting population needs..

Introduction

Chad ranks ninth on the United Nation's (UN) Least Developed Country list[1], ninth on the fragile state index[2], and 187 of 189 countries on the Human Development Index[3]. The under-five mortality rate (U5MR) ranks as the fourth highest in the world[4]. It is listed 117 of 121 countries in the 2022 Global Hunger Index[5]. Chad also experiences some of the worst gender inequity in the world, measuring 189 of 193 countries in both the Gender Development Index[6] and the Gender Inequality Index[7]. The United Nations Office for the Coordination of Humanitarian Affairs (OCHA) estimates that 39.7% of the Chadian population or 6.9 million people, are in need of humanitarian assistance[8], while in June 2024, just 13% of the UN funding appeal for humanitarian aid had been received[9].

Sub-regional data in Chad are limited, with the last multi-cluster indicator survey (MICS) conducted in 2019[10]. In Mandoul region, the U5MR was 148/1,000 live births, the infant mortality rate (IMR) was 91/1,000, and the neonatal mortality rate (NMR) was 45/1,000. Maternal mortality was not assessed, though past estimates suggest 1 in 16 women die from childbirth-related causes[11]. Moissala district, bordering the Central African Republic, recorded one of Chad's highest malaria incidence rates in 2023 (> 450/1,000/year) [12], over double the Sub Saharan Africa (SSA) average (214/1,000/year) [13]. With elevated child mortality, food insecurity, and disease burden, Moissala reflects the characteristics of a protracted crisis

Dembo and Beboro are rural health zones located outside the district capital of Moissala. Dembo lies across the Ouham River and can only be reached via a frequently malfunctioning ferry, while Beboro is a two-hour journey over poorly maintained dirt roads. Access to both areas is significantly more difficult during the rainy season.

Since 2010, Médecins Sans Frontières (MSF) has provided seasonal malaria chemoprevention (SMC) in Moissala district, targeting children 3–59 months during the rainy season. In 2019, MSF began supporting maternal and child health services at Moissala hospital and in two rural health centers in Dembo and Beboro health zones, where a community-based surveillance (CBS) system was also implemented.

In 2020, MSF conducted a baseline mortality assessment using exhaustive household enumeration, estimating a population of 17,753 in Dembo and 22,870 in Beboro. Crude mortality rates (CMR) were

0.28 (Dembo) and 0.20 (Beboro) deaths/10,000/day; under-five mortality rates (U5MR) were 1.0 and 0.59, respectively. CBS data from 2020–2023 suggested low mortality (CMR 0.026–0.42 in Dembo, 0.14–0.27 in Beboro). In 2023, MSF conducted a follow-up retrospective mortality survey to assess population health after 5 years of support to health service. Results are presented here and were used to inform programmatic decisions.

Methods

Study Design and Period

We conducted a cross-sectional, retrospective, two-stage cluster survey considering Dembo and Beboro health zones as two separate strata. In consultation with local staff, we selected Easter Sunday (April 9, 2023) as the start of the recall period. Data collection took place from November 12–23, 2023, covering an 8-month period that included the lean season (June–November) and malaria season (June–October).

Sample Size

During survey planning, we used a 2023 CBS-derived average U5MR of 0.58 deaths/10,000/day. The average household size was taken from the 2019 MICS (5.9 persons/household). We applied a precision of ± 0.2, a design effect of 1.5, and a 10% non-response rate. These conservative assumptions aimed to ensure sufficient sample size, while the use of mini clusters of 3 households was adopted to improve design efficiency by reducing intra-cluster correlation. The final sample size was 4,970 individuals (or 936 households) per zone. Additional calculations confirmed the sample size was sufficient to power estimates of sex-specific crude mortality as well.

Sampling and Data Collection

In the first stage of sampling, we randomly selected structures using a geospatial database of all building roofs in the health zones. Coordinates of selected buildings served as starting points, with three households interviewed per cluster. Fourteen interviewers completed a 3-day training on the survey protocol, sampling procedures, inclusion/exclusion criteria, key indicators and definitions, interviewer skills, psychological first aid, and informed consent, followed by a one-day pilot.

All households present at the time of visit who provided informed consent were eligible, including permanent residents, displaced persons, refugees from Central African Republic, and nomadic groups. A household was defined as individuals sharing meals and sleeping under the same roof in the past two weeks. Visitors staying fewer than two weeks for events (e.g., weddings, funerals) were excluded. A representative, defined as the head of household or primary caregiver, was interviewed for each household. If the representative was under 18 or lacked decision-making capacity, they were included with assent and consent from a parent/guardian. Emancipated minors (e.g., child-headed households) were treated as adults. Households were excluded if consent was refused, no eligible representative was available, they were confirmed to be away during the survey period, or were absent after two revisits.

Surveys began with an open-ended question on household health challenges, followed by demographic, birth, death, and migration data over the 8-month recall period, including timing and location. For deaths, additional questions addressed cause, care-seeking behavior, and healthcare access. Data were collected on password-protected devices running Open Data Kit Collect, with encrypted forms uploaded daily to a central Kobo server and reviewed daily by staff. The questionnaire was piloted during training and translated/back translated into Mbai, Sar, and southern Chadian Arabic.

Data Cleaning and Analysis

Data were cleaned and analyzed in R (v4.2.2) using RStudio (v2023.06.1 + 524). Survey weights accounted for the complex sampling design, incorporating strata and cluster weights. Strata weights were based on the number of buildings and clusters in each zone, while cluster weights reflected the inverse probability of household selection (three per cluster). Final weights were the product of strata and cluster weights. Categorical variables are presented as proportions with 95% confidence intervals (CIs); continuous variables as means with standard deviations or medians with interquartile ranges, depending on distribution. Age was also grouped for subgroup analyses. Design effects are reported when > 1. Households or individuals with missing data on key variables were excluded from the relevant analysis on a case-by-case basis.

Mortality rates were calculated as total deaths divided by total person-time, incorporating household member births, deaths, arrivals, and departures. Mortality rate ratios (MRRs) compare deaths during malaria and non-malaria seasons. Maternal deaths were defined as deaths related to pregnancy, birth, or within 42 days postpartum. Infant mortality included all deaths under 1 year; neonatal mortality, all deaths before 1 month (rather than 28 days, due to recall limitations). Infant and neonatal mortality rates were calculated per 1,000 live births.

Results

Study Sample

In Dembo, 311 clusters with 849 households were sampled and in Beboro, 326 clusters with 895 households. In Dembo, 11.1% (n = 106) of households were absent and 0.2% (n = 2) refused participation. In Beboro, 7.3% (n = 71) were absent and 0.5% (n = 5) refused. The final sample included 5,221 people in Dembo (mean household size: 5.8, 95%CI: 5.6, 6.0) and 4,790 in Beboro (mean household size: 5.1, 95%CI: 4.9, 5.3).

Vital Events and Population Demographics

During the recall period, Dembo recorded 176 births, 99 deaths, 167 arrivals, and 186 departures (Table 1). Beboro recorded 195 births, 68 deaths, 98 arrivals, and 146 departures. Adjusting for turnover, 5.4% of individuals in Dembo and 3.3% in Beboro moved into or out of a household. The crude birth rate was 60.1 (95%CI: 51.6, 68.5) per 1,000 in Dembo and 72.2 (95%CI: 62.3, 82.0) in Beboro.

In Dembo, 21.3% of the population was under 5 years, 32.4% aged 5–14, and 1.9% aged ≥ 60 (Fig. 1). In Beboro, these figures were 24.0%, 30.6%, and 2.3%, respectively. Females made up a greater share of the population: 53.0% in Dembo and 52.2% in Beboro. Among children under five, sex distribution was roughly equal in Dembo (11.2% female vs. 10.1% male) and Beboro (11.4% female vs. 12.6% male).

Table 1
Registered Vital Events in Dembo and Beboro Health Zones, Chad, Apr-Nov 2023

	Dembo	**Beboro**
	n	**n**
Estimated Population	17,753	22,870
Live Births	176	195
Deaths	99	68
Arrivals	167	98
Departures	186	146
Total People at Start	4,878	4,497
Total People at Midpoint	4,907	4,537
Total People at End	4,936	4,576
Total People Over Recall	5,221	4,790

Mortality Rates

In Dembo, the CMR was 0.89 (95%CI: 0.70, 1.08) deaths/10,000 people/ day (Table 2). The U5MR was 1.82 (95%CI: 1.21, 2.41) deaths/10,000/day. Converted to ratios per 1,000 live births, the U5MR was 229.3 (95% CI: 155.8, 302.7), the maternal mortality ratio (MMR) was 26.8 (95% CI: 0.4, 53.3), the infant mortality ratio (IMR) was 146.3 (95% CI: 90.8, 201.9), and the neonatal mortality ratio (NMR) was 100.0 (95% CI: 53.4, 146.6). The design effect for mortality rates was 1.3.

In Beboro, the CMR was 0.66 (95%CI: 0.48, 0.84). The U5MR was 0.84 (95%CI: 0.43, 1.25). Converted to ratios per 1,000 live births, the under-five mortality ratio per 1,000 live births was 100.7 (95%CI: 52.3, 149.1), IMR was 57.2 (95% CI: 25.4, 89.0), and NMR was 27.5 (95% CI: 6.0, 48.9). The design effect for mortality rates was 1.4.

Table 2
Mortality Rates, Dembo and Beboro Health Zones, Chad, Apr – Nov 2023

	Dembo		Beboro	
	n	**Rate (95%CI)**	**n**	**Rate (95%CI)**
Crude Mortality*	99	0.89 (0.70, 1.08)	68	0.66 (0.48, 0.84)
Under-Five Mortality*	42	1.82 (1.21, 2.41)	19	0.84 (0.43, 1.25)
Male Mortality*	54	1.05 (0.75, 1.35)	41	0.82 (0.55, 1.09)
Female Mortality*	45	0.74 (0.51, 0.98)	27	0.52 (0.30, 0.73)
Infant Mortality Ratio**	27	146.3 (90.8, 201.9)	12	57.2 (25.4, 89.0)
Neonatal Mortality Ratio**	19	100.0 (53.4, 146.6)	6	27.5 (6.0, 48.9)
* per 10,000 per day ** per 1,000 live births				

Mortality Rate Ratios for Malaria and Non-Malaria Seasons

Although no seasonal mortality rate ratios (MRRs) were statistically significant, several trends emerged (Table 3). In Dembo, mortality was consistently higher during the malaria season across all groups. The crude MRR was 1.25 (95% CI: 0.80, 2.96), with higher rates among males (1.54; 95% CI: 0.81, 2.92) than females (0.99; 95% CI: 0.53, 1.87). Under-five mortality also increased during the malaria season, with MRRs of 2.01 (95% CI: 0.59, 6.85) for males and 1.27 (95% CI: 0.50, 3.23) for females. Among infants under one year, malaria season mortality remained elevated for both sexes (1.35; 95% CI: 0.30, 6.04 for males and 1.06; 95% CI: 0.29, 3.91 for females).

In Beboro, overall and male-specific mortality rates were also higher in the malaria season, including crude mortality (1.62; 95% CI: 0.79, 3.30) and under-five mortality (2.38; 95% CI: 0.67, 8.43). In contrast, under-one female mortality was lower in the malaria season compared to the non-malaria season (0.77; 95% CI: 0.07, 8.52). This contributed to lower point estimates for female crude mortality (0.91; 95% CI: 0.42, 1.98) and female under-five mortality (1.42; 95% CI: 0.15, 13.60) relative to males.

Table 3
Mortality Rate Ratios, Malaria vs Non-Malaria Season, Dembo and Beboro Health Zones, Chad Apr – Nov 2023

	Dembo	Beboro
	Rate Ratio (95%CI)	**Rate Ratio (95%CI)**
Crude Mortality		
Total	1.25 (0.80, 2.96)	1.25 (0.74, 2.11)
Male	1.54 (0.81, 2.92)	1.62 (0.79, 3.30)
Female	0.99 (0.53, 1.87)	0.91 (0.42, 1.98)
Under-Five Mortality		
Total	1.56 (0.75, 3.27)	2.13 (0.71, 6.43)
Male	2.01 (0.59, 6.85)	2.38 (0.67, 8.43)
Female	1.27 (0.50, 3.23)	1.42 (0.15, 13.60)
Under-One Mortality		
Total	1.21 (0.46, 3.20)	1.58 (0.34, 7.46)
Male	1.35 (0.30, 6.04)	2.43 (0.29, 20.20)
Female	1.06 (0.29, 3.91)	0.77 (0.07, 8.52)
Mortality Demographics		

Age and sex distributions of reported deaths revealed distinct patterns across the two health zones (Fig. 2). In Dembo, 41.4% (95% CI: 31.8, 51.7) of all deaths occurred in children under five years of age, 10.1% (95% CI: 5.6, 17.7) in children aged 5–14 years, and 11.5% (95% CI: 6.3, 20.0) in adults aged 60 years and older. Among under-five deaths, 25.6% (95% CI: 17.7, 35.4) were in infants under one year. The sex ratio for deaths in children under five was 1.05 males for every 1 female; for infants it was 1.3 and for neonates 0.9.

In Beboro, 28.6% (95% CI: 18.4, 41.4) of deaths were reported in children under five, 13.0% (95% CI: 6.7, 23.7) in children aged 5–14 years, and 14.9% (95% CI: 8.0, 26.2) in adults aged 60 and above. Of under-five deaths, 13.0% (95% CI: 6.0, 26.6) occurred in infants under one year. The sex ratio was markedly skewed: 4.5 male deaths for every 1 female death under five, 3.2 for infants, and 2.0 for neonates.

Household-Reported Causes of Death

Household-reported causes of death mirrored those found across the region. In Dembo, the most common causes of death were malaria (18.9%; 95% CI: 12.1, 28.4), neonatal causes (15.4%; 95% CI: 9.4,

24.2), chronic diseases (10.1%; 95% CI: 5.5, 17.9), diarrhea (10.1%; 95% CI: 4.5, 21.0), respiratory infections (7.5%; 95% CI: 3.5, 15.3), gastritis (5.7%; 95% CI: 2.6, 12.2), and accidents (6.6%; 95% CI: 3.1, 13.5). In Beboro, malaria was also the leading cause of death (29.9%; 95% CI: 19.6, 42.7), followed by chronic diseases (9.1%; 95% CI: 4.2, 18.5), diarrhea (9.7%; 95% CI: 3.7, 23.2), respiratory infections (7.8%; 95% CI: 3.6, 16.0), and gastritis (6.5%; 95% CI: 2.4, 16.4).

Fewer than 5% of deaths in Dembo were reported as maternal deaths (n = 4), skin/dental infections (n = 4), chest pain (n = 3), hernia (n = 3), violence (n = 1), old age (n = 1), and unknown causes (n = 3). In Beboro, fewer than 5% were maternal deaths (n = 3), skin/dental infections (n = 3), chest pain (n = 2), hernia (n = 1), violence (n = 3), old age (n = 3), and unknown causes (n = 3). The “other” category in both zones comprised poisonings, dog bites, surgical complications, and nonspecific complaints.

Among under-five deaths in Dembo, the most common household-reported causes were neonatal (37.2%; 95% CI: 23.0, 54.1) and malaria (31.9%; 95% CI: 18.7–48.8). In Beboro, malaria dominated (59.1%; 95% CI: 36.3, 78.6), followed by neonatal (13.6%; 95% CI: 4.2, 36.4). Other reported causes of under-five deaths in the zones were diarrhea and respiratory infections, each accounting for 9–13%. Chest pain, gastritis, and unknown causes represented less than 4.5% each of deaths in the zones.

Household-Reported Place of Death and Care-Seeking Behavior

Households reported deaths most often occurred at home with 45.8% (95% CI: 36.2, 55.8) in Dembo and 47.4% (95% CI: 35.3, 59.8) in Beboro. The second most reported place of death was Moissala District Hospital (30.8% [95%CI: 21.4, 42.3]and 24.0% [95%CI: 15.6, 35.1], respectively). In Dembo, 15.4% (95% CI: 9.4–24.3) of deaths and in Beboro, 16.9% (95% CI: 9.0, 29.4) occurred at local health centers that lacked the capacity to care for severe cases. Most households reported the deceased had received care before death (80.6% [95%CI: 71.1, 87.5] in Dembo; 85.7% [95%CI: 73.7, 92.8] in Beboro), with just over half seeking care at the health center.

Among those who did not seek care, 61.4% [95%CI: 39.3, 79.6] in Dembo and 100% in Beboro reported that the death occurred too suddenly, most often from neonatal, accidents, or unknown causes. In Dembo, other reasons included having already sought care, perceived lack of severity, cost, inability to travel, or consulting a traditional healer.

Discussion

This study underscores the importance of estimating mortality in humanitarian settings. Mortality estimation allows actors to accurately assess program impact, allocate resources effectively, and target interventions to improve population health, ensuring a comprehensive understanding of a crisis-affected population’s health status. Without accurate mortality estimates, may assume their programs are more effective than they are, missing opportunities to save lives.

In Dembo and Beboro, MSF made concerted efforts to monitor population mortality by establishing CBS in the zones. However, poor data quality and inaccurate population estimates meant rates were underestimated and MSF remained unaware of the true mortality burden within their coverage zones. In Dembo, survey findings indicated a population in acute crisis with high rates across most measures: crude and under-five mortality rates, and infant and neonatal mortality ratios. In Beboro, under-five, infant, and neonatal mortality ratios were lower, suggesting possible underreporting of female deaths in these age groups, which would underestimate overall mortality since these deaths contribute to the crude rate.

In Beboro, the sex ratio of reported deaths was unusually high: 4.5 male deaths per female overall, 3.2 among infants, and 2.0 among neonates. Population data show similar proportions of male and female children in both the under-five and 5–14 age groups, ruling out population imbalance as the driver. Neonatal causes (preterm complications, birth asphyxia and trauma, and congenital anomalies), are the leading cause of death in Chad[14], the region, and the rest of the world.[15] In Dembo, they were the second most common cause of death, but only the sixth in Beboro. The most recent MICS data show only modest male excess mortality, with the largest gap in neonatal deaths (male:female rate ratio of 1.4), far below the ratios observed in Beboro. Ratios as high as those observed in Beboro are highly unlikely in this context. This pattern is consistent with underreporting of female deaths, whether from gender inequity in reporting or misclassification.

Despite probable underreporting of female child deaths in Beboro, Dembo may still have a higher mortality rate. Access to Dembo from Moissala is limited to a ferry or a 12-hour overland route, both more difficult in the rainy season. Moissala serves as the referral hospital for Dembo, but when access is cut off there are few alternatives for care.

Dembo recorded a higher CMR than Beboro (0.89 vs 0.66 deaths/10,000/day). Dembo's U5MR (1.82) was roughly twice its own CMR, consistent with a population under acute stress. If Beboro's under-five deaths had been equally distributed by sex, its CMR and U5MR would rise to 0.75 and 1.27, respectively, still below Dembo's but more than double the regional average and MSF's 2020 baseline. The Sphere and United Nations High Commissioner for Refugees (UNHCR handbooks define a significant public health emergency as a doubling of baseline CMR and U5MR[16,17]. In Dembo, the CMR and U5MR increased by factors of 3.2 and 1.8 and in Beboro, by 3.3 and 1.4.

Questions concerning the reliability of the 2020 assessment prompted comparisons to external benchmarks. As of 2022, the average CMR in SSA is 0.25 deaths/10,000/day[18]. Dembo’s rate was 3.6 times higher, and Beboro’s 2.6 times higher (Table 4). Average U5MR, IMR, and NMR in SSA are 71[4], 49[19], and 27[20] per 1,000 live births, respectively. Chad’s most recent national data come from the 2019 MICS [10] and the 2014–2015 DHS[11]. In Dembo, all child mortality measures surpass these estimates. Beboro demonstrated lower rates, but should be interpreted with likely underreporting in mind. The findings highlight the severity of the crisis in Moissala compared to the Mandoul region, Chad, and the SSA region overall.

Table 4
Comparison of Mortality Rates per 1,000 Live Births, Dembo and Beboro Health Zones, Chad, 2023

Child (< 5 years)	MSF Dembo	MSF Beboro	2019 MICS Mandoul	2019 MICS Chad	2014-15 DHS Mandoul	2014-15 DHS Chad	SSA Average
	229.3	**100.7**	**148**	**122**	**151**	**133**	**71**
Infant (< 1 year)	146.3	57.2	91	79	79	72	49
Neonatal (< 1 month)	100.0	27.5	45	33	39	34	27

Malaria was the leading reported cause of death in both zones, consistent with the district's recently recorded high crude incidence rate[12]. Malaria vs non-malaria mortality rate ratios were not significant, though both zones showed higher point estimates during the malaria season. The shorter non-malaria observation period (2.5 months vs 5.0) likely contributed to the lack of significance.

Consistent with WHO and MoH SMC guidelines for rural and hard-to-reach areas, the MSF program delivered one initial dose by staff and two follow-up doses at home, a model that may increase missed or incorrectly administered doses. Exceptionally high malaria incidence and a long transmission season may also mean SMC alone does not fully offset exposure risk. Despite these challenges, recent internal MSF evaluations show SMC remains effective in reducing malaria incidence and mortality.

As in the rest of the world, neonatal causes of death were reported as a driving factor of premature mortality in Dembo, though less clear in Beboro. While prevention of these deaths is challenging, implementing Basic Emergency Obstetric and Newborn Care and Comprehensive Emergency Obstetric and Newborn Care, alongside assessments of referral pathways and service quality, could greatly improve maternal and newborn health outcomes. Despite MSF-supported preventive and curative services targeting the most vulnerable groups, population mortality was high. The results of the survey provided justification for MSF to adjust project operations to better meet population needs.

Following the dissemination of the study results, the project team initiated several actions aimed at addressing the identified gaps. Focus group discussions were conducted with community members to explore barriers to care and inform service improvements. Meetings were held with the Ministry of Health to review findings and coordinate priority interventions. Supervision of the zonal health centers was increased to strengthen service quality and adherence to protocols. Finally, initial plans were developed to conduct a follow-up mortality survey to evaluate population mortality after project modifications. Even with the best efforts, providing accessible and high-quality healthcare in rural and crisis-affected settings remains challenging and costly. Long-term health system strengthening is needed to address the underlying drivers of population mortality.

The study has several limitations. First, selection bias may have affected the sample, as data collection overlapped with the sesame harvest, a high-value cash crop during which many households sleep in

fields or secondary shelters to guard crops. These households, often absent during visits, may differ systematically from households that were present, potentially introducing bias. Recall bias is inherent to retrospective surveys, as participants may misremember event timing, including events outside the recall period. However, no clustering of reported events at the start of the recall period was observed, suggesting minimal telescoping.

Cause of death data was reported by household representatives, not clinically diagnosed. While verbal autopsy can help identify clinical causes where vital registration is lacking [21,22], they were beyond the scope of this survey. Readers should view cause of death data as indicative, rather than definitive.

Care-seeking behaviors may have been underreported, as participants may have believed MSF was only interested in formal healthcare use, excluding visits to traditional healers commonly sought alongside other care, especially for unresolved conditions. Underreporting may also reflect interviewer error or social desirability bias, as documented in other settings[23].

Better engagement of local actors in the design, implementation, and interpretation of the study would have enhanced data quality and interpretation. Their knowledge of community networks and dynamics may have reduced reporting biases and revealed insights overlooked by external actors, leading to more accurate and actionable findings. Local expertise would additionally have aided in the design of interventions for vulnerable groups and addressed gaps in information and services. A more collaborative approach would have the added benefit of building trust with the community and facilitated implementation of interventions based on study results.

Conclusion

High mortality rates, as observed in Dembo, and possibly Beboro, typically reflect acute crises, such as disease outbreaks, food insecurity, lack of essential healthcare, conflict, forced displacement, or natural disasters, representing both substantial loss of life and systemic failure to meet basic health needs. The high mortality found in Moissala district highlight the critical need for effective health service delivery in neglected and protracted crises.

Mortality in high risk areas should be compared to regional averages, rather than their own previous estimates to ensure equitable distribution of aid directed towards populations in greatest need. These findings validate MSF's decision to target these two health zones in Chad, directing resources toward an area of elevated mortality where they are most needed.

Without this estimation, MSF would remain unaware of the true extent of the crisis in its own intervention areas. Mortality estimation is the ultimate measure of population health and an essential activity for guiding humanitarian programs aimed at saving lives. When neglected, opportunities to improve programs and prevent deaths are missed. This survey underscores the importance of mortality estimation in fragile settings, including its critical role in project evaluation.

Declarations

Ethical Considerations: *Ethical approval was obtained from the Chad National Bioethics Committee (No. 028PT/PM/MESRI/SE/SG/CNBT/SG/2023) and the MSF Ethics Review Board (ID No. 2364). The Johns Hopkins Bloomberg School of Public Health IRB determined the study to be Not Human Subjects Research under public health practice guidelines (No. 24173). Informed consent was obtained at three levels: (1) local government and health authorities, (2) neighborhood and village chiefs, and (3) representatives of selected households.*

Data Sharing

The data generated by this study are not publicly available due their sensitive nature. Requests for data may be submitted to the corresponding author and considered on a case-by-case basis.

Competing Interests:

All authors have no competing interest to declare.

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Author Contribution

JO, PO, FK, and JSH conceived of the study. JO, PO, PS, FK, and JSH contributed to the design. JO, PO, and SA contributed to implementation and data collection. JO, PS, and JSH contributed to the data analysis. All authors contributed to interpretation. JO drafted the initial manuscript . All authors contributed to manuscript revision and approved the final version.

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Data Availability

The data generated by this study are not publicly available due their sensitive nature. Requests for data may be submitted to the corresponding author and considered on a case-by-case basis.

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Figures

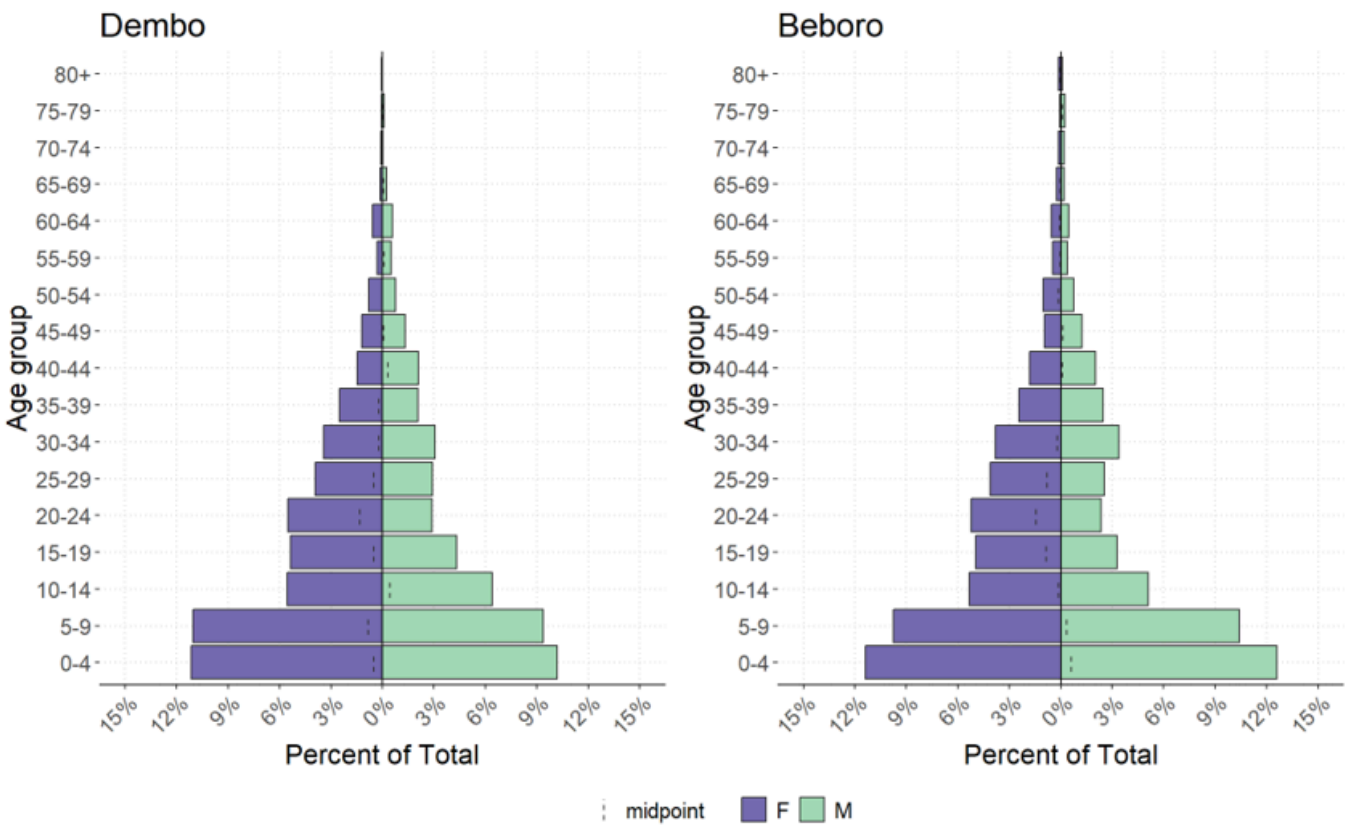

Figure 1

Age and Sex Distribution of Population in Dembo and Beboro Health Zones, Chad, 2023

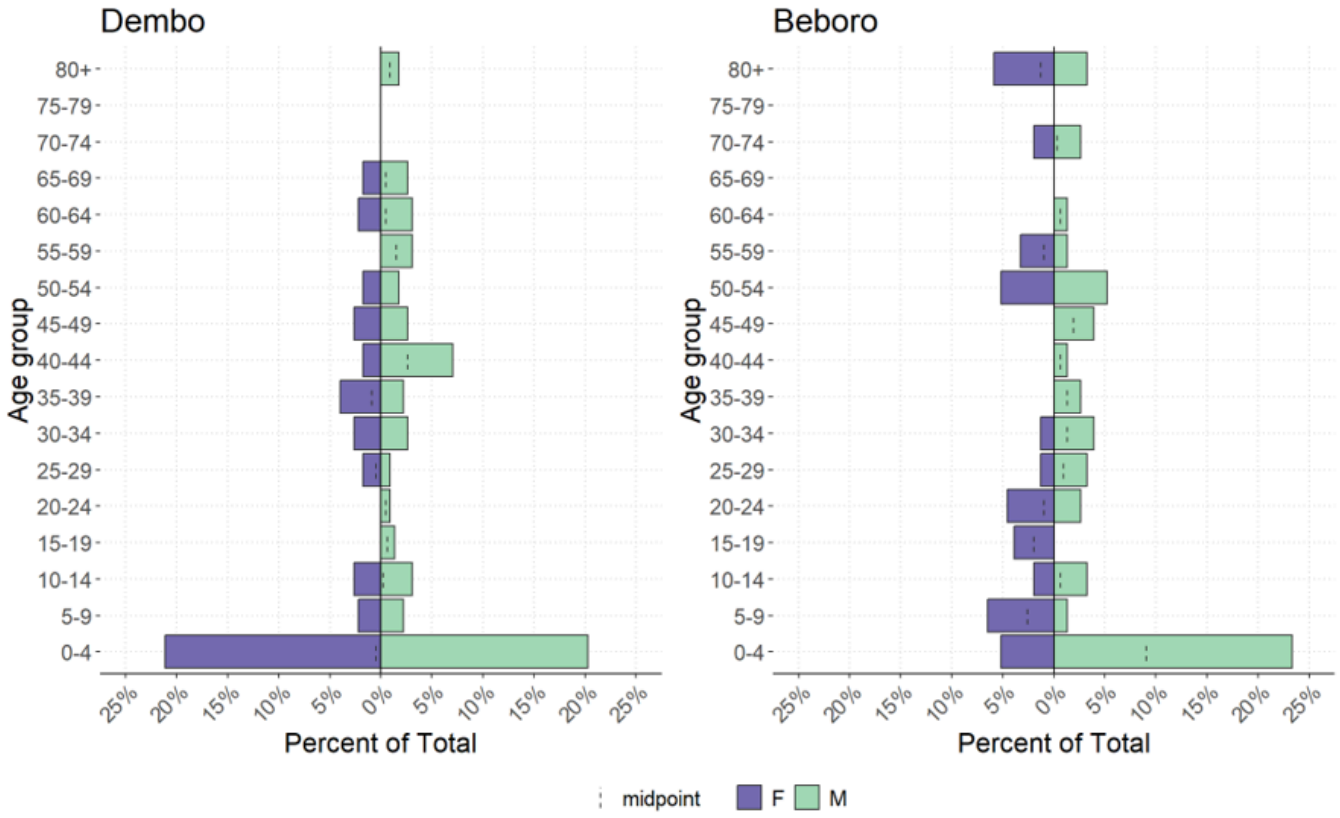

Figure 2

Age and Sex Distribution of Deaths in Dembo and Beboro Health Zones, Chad, Apr-Nov 2023