Violence and mortality in West Darfur, Sudan (2003–04): epidemiological evidence from four surveys

Evelyn Depoortere, Francesco Checchi, France Broillet, Sibylle Gerstl, Andrea Minetti, Olivia Gayraud, Virginie Briet, Jennifer Pahl, Isabelle Defourny, Mercedes Tatay, Vincent Brown

Lancet 2004; 364: 1315–20

Published online October 1, 2004 http://image.thelancet.com/extras/04art9087web.pdf

See Comment page 1290

Epicentre, Paris, France (E Depoortere MD, F Checchi MHS, F Broillet MPH, S Gerstl PhD, V Brown MD); **and Médecins Sans Frontières, Paris, France** (A Minetti MD, O Gayraud RN, J Pahl MSN, V Briet RN, I Defourny MD, M Tatay MD)

Correspondence to: Dr Evelyn Depoortere **evelyn.depoortere@brussels.msf.org**

Summary

Background **Violence in Darfur, Sudan, has rendered more than one million people internally displaced. An epidemiological study of the effect of armed incursions on mortality in Darfur was needed to provide a basis for appropriate assistance to internally displaced people.**

Methods **Between April and June, 2004, we did retrospective cluster surveys among 215 400 internally displaced people in four sites of West Darfur (Zalingei, Murnei, Niertiti, El Geneina). Mortality recall periods covered both the pre-displacement and post-displacement periods in Zalingei, Murnei, and Niertiti, but not in El Geneina. Heads of households provided dates, causes, and places of deaths, and described the family structure.**

Findings **Before arrival at displacement sites, mortality rates (expressed as deaths per 10 000 per day), were 5·9 (95% CI 2·2–14·9) in Zalingei, 9·5 (6·4–14·0) in Murnei, and 7·3 (3·2–15·7) in Niertiti. Violence caused 68–93% of these deaths. People who were killed were mostly adult men (relative risk 29·1–117·9 compared with children younger than 15 years), but included women and children. Most households fled because of direct village attacks. In camps, mortality rates fell but remained above the emergency benchmark, with a peak of 5·6 in El Geneina. Violence persisted even after displacement. Age and sex pyramids of surviving populations were skewed, with a deficit in men.**

Interpretation **This study, which was done in a difficult setting, provides epidemiological evidence of this conflict's effect on civilians, confirming the serious nature of the crisis, and reinforcing findings from other war contexts.**

Introduction

The situation in Darfur, Sudan has drawn increasing international political and media attention.[1] Although much interest is justifiably directed at relief needs, the violent events that brought about the humanitarian crisis have also come under scrutiny.

The present conflict in Darfur began in earnest in February, 2003, with the emergence of two anti-government rebel groups (the Sudan Liberation Army and the Justice and Equality Movement). The ensuing anti-rebel offensive, led by pro-government *Janjaweed* militia and Sudanese army units, resulted in the displacement of more than one million people within Darfur itself, and the flight of about 188 000 to neighbouring Chad up until August, 2004.[2,3] Militia attacks in particular were blamed by refugees and internally displaced people for indiscriminate killings, rape, abductions, cattle and property looting, and razing of villages.[4]

Available evidence on the extent of violence in Darfur largely relied on testimonies from refugees in Chad, or mostly non-quantitative assessments done when access was possible in selected sites within Darfur itself.[5] Estimates of the number of people killed increased progressively from 3000 in January[6] to 10 000 in April,[7] reaching 30 000 to 50 000 in July, 2004.[8] To our knowledge, however, these figures did not represent systematically gathered epidemiological evidence, mainly because of the dire absence of international relief organisations working on the ground within Darfur. Factors accounting for this lack of assistance included ongoing insecurity, severe governmental restrictions on the entry of international aid staff and material to Darfur, and low institutional donor interest.

Médecins Sans Frontières (MSF) was one of the first non-governmental relief organisations to obtain an authorisation to work in Darfur. Beginning in December, 2003, the French section of MSF gradually implemented nutritional, medical, and water and sanitation programmes in several sites for internally displaced people in West Darfur state. As part of comprehensive, site-specific assessments of the health and nutritional status of these populations, we retrospectively measured the extent and causes of mortality both before and after displacement to these sites. We also investigated the effect of the events on demographic structure.

Methods

We did two-stage, household-based cluster surveys in four sites of West Darfur (Zalingei, Murnei, Niertiti, and El Geneina) after estimating numbers of internally displaced people through a combination of community health worker censuses, shelter counts, and area mapping (details not shown).[9]

Internally displaced people lived either in clearly identifiable camps (consisting mostly of minuscule thatch or cardboard structures crowded together without any evident spatial planning), or had mixed with the resident population. In Niertiti town, which was attacked by

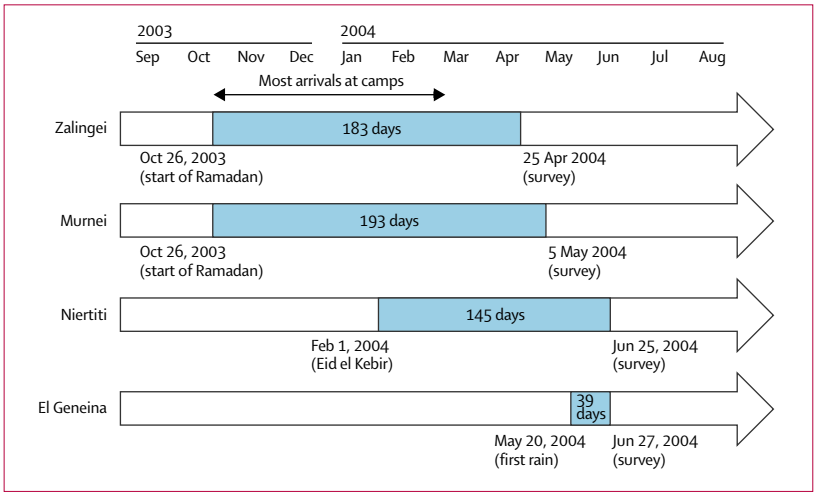

Figure 1: **Recall periods by survey site**

militia, residents were considered by aid agencies to be as vulnerable as the displaced people; therefore, we decided to survey both groups.

In Murnei, Niertiti, and El Geneina, we chose to sample 900 households (30 clusters of 30 households), or 4500 people (assuming a mean household size of five); this sample size would have been sufficient to estimate a crude mortality rate of 2·0 per 10 000 persons per day with 95% CI 1·0–3·0, with a minimum mortality recall period of 1 month and a hypothetical design effect (loss of variance due to intra-cluster homogeneity) of two. Precision would have improved with a longer recall period. In Zalingei, because the available window of time was small, we limited our sample to 450 households (30 clusters of 15).

We selected households (defined as groups of persons sleeping and/or eating together) on the basis of the standard WHO/Expanded Programme on Immunisation method.[10] At the first stage of sampling, we allocated numbers of clusters to camps (or pre-defined sectors of camps) proportionally to the population size of the camp or sector. At the second stage, we selected households within each cluster by walking in a random direction from the centre to the edge of the camp (or sector), counting the number (n) of households found along the way. Among these, we selected the first household in the cluster as the one corresponding to a randomly drawn number between 1 and n. We selected subsequent households by proximity, until completion of the cluster. We re-visited empty (but not abandoned) households later in the day, and asked for the help of neighbours to trace absentees.

Survey questionnaires were standardised initially, but were simplified at each site to fit local security, human resources, and time constraints. We recorded data about deaths that occurred during pre-defined mortality recall periods (figure 1). In all sites except El Geneina, mortality recall periods included all or part of the main wave of attacks.

In all sites we asked heads of households, who gave oral consent, about deaths that occurred within the recall period; for each death, we noted the age in years of the person who died (as reported by the respondent), the Islamic calendar month during which the death occurred, and the location where it had occurred (in the village, in flight, or in the camp), and coded the reported cause as violence, medical reasons, or other. We used a calendar of locally important events to facilitate recall of dates and Islamic months. In Zalingei and Murnei we also inquired about people who had left the household more than 2 weeks ago: we regarded such people as absent or disappeared, dependent on whether the household knew the person's whereabouts.

Respondents in Zalingei, Murnei, and Niertiti also provided the month of arrival in the camp of household members, and, in Zalingei and Murnei, the reason for departure from the village of origin (coded into pre-defined categories). We also asked respondents for the age and sex of living household members, so that we could create a population pyramid (in El Geneina, the sole age distinction was between people younger and older than 5 years).

Local, highly literate, but not medically trained surveyors, complemented by translators, recorded

***Panel:* Equations**

Equation 1

$$\frac{\text{n deaths in period}}{\sum \left[\text{population at end of month}_i + 0{\cdot}5\,(\text{n deaths during month}_i)\right]/\text{n months in period}} \times \frac{10000}{\text{n days in period}}$$

Equation 2

$$\frac{\text{n deaths before/after arrival in camps}}{\text{person-days before/after arrival}} \times 10000$$

	Zalingei	Murnei	Niertiti	El Geneina
Estimated IDP population	34 600	74 900	25 600*	80 300
Households sampled (clusters)	460 (15)	912 (30)	903 (30)	900 (30)
Population sampled (present on survey date)	2386	4754	5188†	5191
Children younger than 5 years	467 (19·6%)	1025 (21·6%)	1060 (20·4%)	936 (17·6%)
Male-to-female ratio	0·82 (1074 to1312)	0·79 (2097 to 2657)	0·96 (2535 to 2653)	0·94 (2520 to 2671)
Mean household size	5·2	5·2	5·7	5·8
Deaths	100	322	116	115
Disappeared people	21	79	Not recorded	Not recorded
Absent people	253	458	Not recorded	Not recorded

IDP=internally displaced people. *Includes 10 200 residents. †Includes 1426 residents.

Table 1: **Survey profiles**

information in Arabic on standardised, back-translated, pre-piloted questionnaire forms, checked daily for accuracy. We entered data on EpiData version 3.0 (the EpiData Association, Odense, Denmark) and analysed them with EpiInfo version 6.04 (Centers for Disease Control and Prevention, Atlanta, USA). For each point estimate, design effect was estimated in CSample (EpiInfo) to obtain 95% CIs.

We expressed crude mortality rate, mortality rate in children younger than 5 years, and violence-specific mortality rate as deaths per 10 000 persons per day, using as denominator the average of populations at the mid-point of each month in the recall period, as in equation 1 (panel).

In the main analysis, we did not include absent or disappeared persons in this denominator, because we wished to compare rates among all sites and data were only available for Zalingei and Murnei.

We also calculated mortality during the "village or flight" and "camp" (post-displacement) periods by dividing deaths that occurred in these periods by the total person-time spent by the surveyed population in each period (giving deaths per 10 000 person-days, which is equivalent to deaths per 10 000 per day), as in equation 2 (panel).

Person-time spent by each individual in either period was delimited by the start and end dates of the overall recall period, and varied according to month of arrival in the camp, or, if applicable, month of death (thus, an individual who died before his or her household was displaced to the camp counted for zero person-days in the "camp" period). To convert time from months to days, we assumed that all arrivals and deaths had occurred exactly at the mid-point of the month.

Role of the funding source

MSF was involved, through co-authors and other members of the Paris headquarters of the organisation, in planning, design, and implementation of the survey. Epicentre assessed data and MSF participated in the interpretation of findings. MSF supported the decision to publish this paper, and participated through co-authors in its drafting.

Results

Surveys took place on 24–27 April (Zalingei), 3–8 May (Murnei), 22–26 June (Niertiti), and 26–29 June (El Geneina), 2004. No refusals to take part in the survey were reported. The main characteristics of surveyed populations are shown in table 1. Among people present on the survey date, the proportions of people younger than 5 years were as expected for sub-Saharan Africa, but the overall male-to-female ratio showed a deficit in male people (table 1). Age/sex pyramids were skewed (figure 2), with a male-to-female ratio in the age group 15 years and older of 0·61 (880 to 1435) in Murnei, 0·61 (422 to 690) in Zalingei, and 0·83 (1072 to 1287) in Niertiti. Conversely, the male-to-female ratios among dead, disappeared, and absent people were 1·33 (57 to 43), 2·50 (15 to 6), and 2·89 (188 to 65),

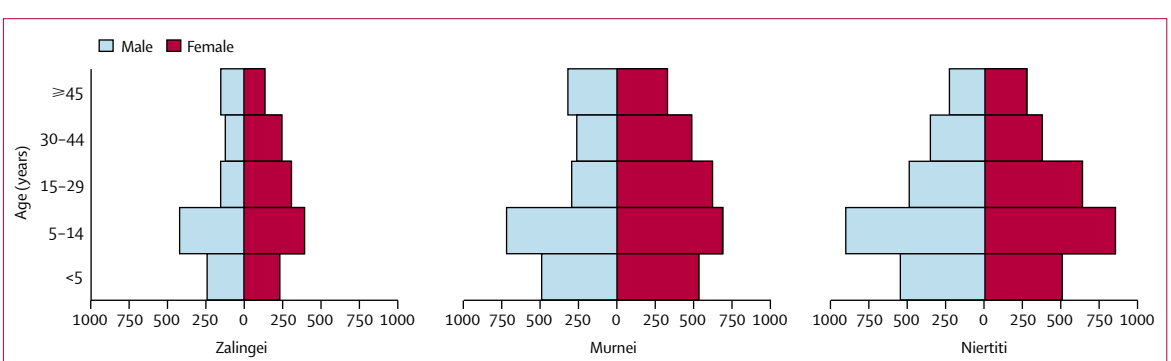

Figure 2: **Age and sex distribution of surviving household members**

	Zalingei	Murnei	Niertiti	El Geneina
Number of deaths				
Village and flight period				
Crude (all ages, causes)	55	238	25	..
Under 5 years	5	11	1	..
Cause: violence	46	222	17	..
Camp period				
Crude	45	84	91	115
Under 5 years	11	21	32	50
Cause: violence	3	18	13	11
Overall				
Crude	100	322	116	115
Under 5 years	16	32	33	50
Cause: violence	49	240	30	11
Mortality rates				
Village and flight period				
Crude (all ages, causes)	5·9 (2·2–14·9)	9·5 (6·4–14·0)	7·3 (3·2–15·7)	..
Under 5 years	2·8 (0·9–7·8)	2·1 (1·0–4·2)	1·5 (0·1–10·3)	..
Cause: violence	5·0 (1·5–14·4)	8·9 (5·9–13·4)	5·0 (1·4–14·7)	..
Camp period				
Crude	1·3 (0·9–1·8)	1·2 (1·0·1·5)	1·3 (1·0–1·6)	5·6 (4·1–7·6)
Under 5 years	1·6 (0·7–3·4)	1·4 (0·7·2·7)	2·1 (1·5–3·0)	14·1 (9·7–20·1)
Cause: violence	0·1 (0·0–0·3)	0·3 (0·2·0·5)	0·2 (0·1–0·4)	0·5 (0·1–1·8)
Overall				
Crude	2·3 (1·4–3·7)	3·4 (2·6–4·6)	1·5 (1·2–1·9)	5·6 (4·1–7·6)
Under 5 years	1·9 (1·0–3·3)	1·6 (1·0–2·6)	2·1 (1·5–3·0)	14·1 (9·7–20·1)
Cause: violence	1·1 (0·4–3·0)	2·6 (1·7–3·7)	0·4 (0·2–0·8)	0·5 (0·1–1·8)

Mortality rates expressed as deaths per 10 000 per day (95% CI). Under 5 years=in children younger than 5 years. No person-time was spent in the village and flight period in El Geneina.

Table 2: **Absolute numbers of deaths and crude mortality rates, overall and by period**

respectively in Zalingei, and 2·98 (241 to 81), 1·32 (45 to 34), and 2·59 (329 to 127) in Murnei. The male-to-female ratio among dead people in Niertiti was 1·15 (62 to 54) and in El Geneina was 1·45 (68 to 47; no data for absent or disappeared people were recorded).

In Zalingei, 2340 of 2431 (96·3%) internally displaced people arrived between 26 Oct, 2003, and 22 Jan, 2004 (these dates correspond to three Islamic months known locally as Ramadan, Fatur, and Faturein); here, 427 of 460 (92·8%) of respondents mentioned a "direct attack on the village" as the reason for moving to the camp. In Murnei, 4385 of 4843 (90·5%) arrived between Oct 26, 2003, and Feb 20, 2004 (the above 3 Islamic months plus Dahia), and direct attack was cited as the reason by 888 of 912 (97·4%) respondents. In Niertiti, 3421 of 3821 (89·5%) arrivals occurred in the same period.

	Zalingei	Murnei	Niertiti	El Geneina
Violent deaths (% of all-cause deaths)				
Children younger than 15 years	1 of 20 (5·0%)	15 of 42 (35·4%)	0 of 40	0 of 57
Women	5 of 30 (16·7%)	32 of 68 (47·1%)	4 of 38 (10·5%)	0 of 27
Men	43 of 50 (86·0%)	193 of 212 (91·0%)	26 of 38 (68·4%)	11 of 31 (35·5%)
Relative risk of violent death (95% CI)				
Children younger than 15 years	reference	reference	..	..
Women	9·0 (1·4–57·6)	3·6 (1·8–7·3)	..	..
Men	117·9 (16·0–869·7)	29·1 (15·4–55·3)	..	..

Relative risks cannot be calculated for Niertiti and El Geneina because of zero values.

Table 3: **Proportionate mortality due to violence, and relative risk of violent death, according to population group**

At all study sites, the crude mortality rate for the entire recall period was much greater than the benchmark of 1, indicating an emergency (or "very serious") situation (table 2),[11] and three to ten times the expected rate in non-emergency sub-Saharan populations (0·5).[12] In Niertiti, crude mortality rates were similar among internally displaced people and residents (1·5 for both). If all disappeared people (table 1) were assumed to have died, crude mortality rates increased to 2·7 (95% CI 1·7–4·2) in Zalingei and 4·2 (95% CI 3·3–5·3) in Murnei.

Crude mortality rates everywhere were extremely high in the "village and flight" period. Violence-specific mortality rates accounted for most mortality during this period (table 2).

In the "camp" period, crude mortality rate decreased five-fold to eight-fold, but remained greater than the emergency benchmark. Here, medical causes of death were dominant, but violence still accounted for 6·7% of deaths in Zalingei, 21·4% in Murnei, 14·3% in Niertiti, and 9·6% in El Geneina (table 2). All these killings were ascribed to *Janjaweed* militia surrounding the camps. When violence was excluded as a cause of death, mortality rates due to non-violent causes in the camp and during the "village and flight" period, respectively, were 1·0 (95% CI 0·3–3·1) and 1·2 (0·8–1·7) in Zalingei, 0·6 (0·4–1·2) and 1·0 (0·7–1·3) in Murnei, and 2·3 (1·1–4·9) and 1·1 (0·9–1·3) in Niertiti. In-camp mortality was far higher in El Geneina than in the other sites, where 50 of 104 (48·1%) non-violent deaths were children younger than 5 years.

Interestingly, design effects for all-cause mortality were far greater than the expected value (2·0) in the "village and flight" period (11·3 in Zalingei, 8·6 in Murnei, and 3·5 in Niertiti), and even higher for violence-related MRs. Conversely, they were uniformly below 2·0 among children younger than 5 years in all periods, and in the "camp" period (where violent deaths were less frequent) for all ages and causes.

Deaths due to violence occurred in all population groups, notably in Murnei (table 3). However, men aged 15 years or older were disproportionately affected; they were far more likely to be killed than were children. In Zalingei 2·0% (95% CI 0·6–5·3) and in Murnei 4·7% (3·2–6·8) of the total population of internally displaced people were killed during the recall period (which in these two sites includes the main attacks and displacement wave). Based on these percentages, and assuming that population numbers are correct (table 1), we estimate that 700 (95% CI 200–1900) people were killed, both before and after displacement, among internally displaced people who sought refuge in Zalingei, and 3700 (95% CI 2500–5500) among those currently in Murnei. For Niertiti and El Geneina, the start dates of the recall periods were after the main waves of displacement and arrival; therefore, information on the pre-displacement events was unavailable.

Discussion

The four surveys we present, which were done in difficult and insecure field conditions, are representative of about 215 400 internally displaced people—43% of the total estimated population of 500 800 internally displaced people in West Darfur in July, 2004.[2] These findings provide data on demographic events affecting a large Darfurian population of internally displaced people in the periods before and after displacement, and clarify the contribution of violence to mortality in this population.

We believe that clear trends emerge from our findings. Most people in the populations we surveyed fled as a result of attacks on their villages. While in the village or in flight, mortality was extremely high, overwhelmingly because of violence. Although men were at far higher risk of being killed, women and children were also targeted. Separations and disappearances were also common, mostly affecting men. Adding these absentees to men who were killed during the recall period largely explains the skewed nature of the age/sex pyramids. Surveys done among refugees in Chad also showed raised mortality (again, in great part violence-related), although mortality rates were lower than in Darfur, possibly due to the fact that these groups fled to safety in the early stage of the conflict.[13]

Among internally displaced people settled in camps, violence continued to cause a substantial proportion of deaths. Although we did not systematically record information on the circumstances of these killings, data from MSF health centres suggest a high incidence of shootings, beatings, and rapes (unpublished). Even when violent causes were excluded, mortality remained unacceptably high after arrival in the camps, with alarming peaks in El Geneina, where little humanitarian aid, apart from irregular food distributions, was dispensed before June, 2004, and where we found a 50% weekly attack rate of diarrhoea among children (data not shown). Generally, existence was precarious in these hard-to-access, poorly serviced camps; people there were under constant threat from malnutrition and epidemics, and were deprived of most coping mechanisms (farming in particular).[2] The onset of heavy rains in July, 2004, was expected to hamper transport, interrupting vital food supplies, worsen sanitary conditions, and expose vulnerable populations to seasonal malaria and water-borne diseases. A further increase in mortality rates therefore seemed likely, and was, indeed, shown by a region-wide WHO survey targeting a 3-month post-displacement period.[14]

Surveys such as these have important and well-described limitations.[15] When mortality rates are high, entire households may disappear (survival bias): their experience is thus not reflected in the sampled population, and mortality rate is underestimated. Recall bias is difficult to measure, but when retrospective periods are long, as in our Murnei and Zalingei surveys, less recent deaths might be under-reported, leading to an underestimate of mortality rate. On the other hand, households might recall traumatic events as having occurred more recently than they actually did, leading to an overestimate of recent mortality. In our surveys, however, we were able to cross-check months of death with place of death and time of arrival, which probably reduced bias related to date recall. Incorrect reporting of age could have caused a misrepresentation of the age/sex distribution; however, the all-age/sex ratio does suggest an overall imbalance. Systematic or non-systematic errors might also have resulted from linguistic barriers, since we do not speak Arabic. The WHO/Expanded Programme on Immunisation cluster design has not been fully validated as a tool to measure mortality, although no alternative methods have been clearly established for settings, such as ours, where systematic sampling is unfeasible due to the absence of an individual household sampling frame. In particular, design effects were higher than expected because of clustering of violent deaths. Surveys such as ours should plan for design effects of greater than two when measuring causes of death that, like violence, are likely to be very clustered.

Our findings do not in themselves substantiate claims that events in Darfur amount to genocide,[16] not least because this would require demonstration of such an intent on the part of the perpetrators,[17] which is clearly beyond the scope of an epidemiological survey. Nevertheless, we believe that, in the four sites we surveyed, high mortality and family separations amount to a demographic catastrophe. While our data reflect the striking extent of killings, systematic accounts of other crimes, such as mass rape, have been put forward.[18] Satellite maps have also suggested widespread village destruction.[19] Together, these findings strongly suggest that between 2003 and 2004, populations in West Darfur experienced massive attacks against life and property. One of the most serious and long-lasting consequences of such attacks may be widespread mental trauma among survivors and witnesses. Although we did not survey this issue, we believe that it is largely overlooked in the present Darfur relief context.

The Darfur crisis resembles most armed conflicts, small and great, that have affected the world—in particular Africa—in recent years.[20] The victims are mostly civilian.[21,22] Women and children are not spared,[23,24] although in West Darfur the risk of being killed was far higher for men. Displacement also results in excess mortality and loss of livelihoods, creating chronic dependence on aid.[25] Aid itself is insufficient and late, often due to a deadly combination of international neglect and warring parties who do not grant humanitarian access to the affected populations when they need it most.[26] West Darfur's case seems exceptional because of the overwhelming contribution of violence to mortality, resulting in crude mortality rates

that were actually higher than mortality rates among children younger than 5 years, contrary to what is commonly observed.

In humanitarian emergencies, field epidemiology can, in addition to helping to orient and evaluate aid programmes, provide key scientific testimony about past events.[27] Overwhelming epidemiological evidence on the consequences of armed conflicts, including that provided here, should be a tool to advocate respect for international humanitarian law.

Contributors

E Depoortere and F Checchi co-wrote this paper, with input from all other investigators. All investigators designed, coordinated, and analysed surveys on site (E Depoortere, S Gerstl, A Minetti, and V Brown in Murnei; E Depoortere, S Gerstl, and O Gayraud in Zalingei; F Broillet and V Briet in Niertiti; F Checchi and J Pahl in El Geneina), with the exception of I Defourny and M Tatay, who contributed to design, oversight, and data interpretation. F Checchi did additional analysis under the supervision of V Brown.

Conflict of interest statement

We declare that we have no conflict of interest.

Acknowledgments

We thank all the field teams of Médecins Sans Frontières who contributed to this effort, and our very dedicated teams of Sudanese translators and surveyors. Many thanks to Sally Hargreaves (MSF-UK) for reviewing the data and manuscript. The study was financed by Médecins Sans Frontières.

References

1 Singh JA. Genocide: burden of proof and inaction is costing lives in Sudan. *Lancet* 2004; **364:** 230–31.

2 Office of UN Humanitarian Resident and Coordinator for the Sudan. Darfur Humanitarian Profile no. 5 (1 August 2004). Khartoum: United Nations, 2004.

3 United Nations High Commissioner for Refugees. Darfur: IDP evaluation; Chad: security agreement with government. Aug 31, 2004. http://www.unhcr.ch/cgi-bin/texis/vtx/country?iso=tcd (accessed Aug 31, 2004).

4 Office of the United Nations High Commissioner for Human Rights. Report of the United Nations High Commissioner for Human Rights and follow-up to the world conference on human rights: situation of human rights in the Darfur region of the Sudan (3 May 2004). Geneva: United Nations, 2004.

5 Human Rights Watch. Darfur destroyed: ethnic cleansing by government and militia forces in Western Sudan. May, 2004. http://hrw.org/reports/2004/sudan0504 (accessed Aug 31, 2004).

6 Amnesty International. Press release—Sudan: killings, abductions of children and arbitrary detention in Darfur. Jan 7, 2004. http://web.amnesty.org/library/Index (accessed Aug 31, 2004).

7 Agence France-Presse. Sudan's Darfur calm because 'no more villages to burn', UN official says. May 12, 2004. http://wwww.reliefweb.int/w/rwb.nsf/3a81e21068ec1871c1256633003c1c6f/f95a9a9c26c3a71949256e93000d2cc6?OpenDocument (accessed Aug 31, 2004).

8 Agence France-Presse. Sudan plays down death toll from Darfur conflict. Aug 9, 2004. http://www.reliefweb.int/w/rwb.nsf/480fa8736b88bbc3c12564f6004c8ad5/934a65df81213b84c1256eeb004e7953?OpenDocument (accessed Aug 31, 2004).

9 Brown V, Jacquier G, Coulombier D, Balandine S, Belanger F, Legros D. Rapid assessment of population size by area sampling in disaster situations. *Disasters* 2001; **25:** 164–71.

10 Henderson RH, Sundaresan T. Cluster sampling to assess immunization coverage: a review of experience with a simplified sampling method. *Bull World Health Organ* 1982; **60:** 253–60.

11 United Nations High Commissioner for Refugees. Handbook for emergencies. Geneva: UNHCR, 1999.

12 Centers for Disease Control and Prevention. Famine-affected, refugee, and displaced populations: recommendations for public health issues. *MMWR Recomm Rep* 1992; **41:** 1–76.

13 Tomczyk B, Dunne E, Chang M, Fedele S, Talley L, Blanton C. Emergency nutrition and mortality surveys conducted among Sudanese refugees and Chadian villagers, northeast Chad, June 2004. UNHCR/WFP/UNICEF/Ministry of Health—Chad/Centers for Disease Control and Prevention technical report.

14 WHO. Retrospective mortality survey among the internally displaced population, Greater Darfur, Sudan, August 2004. Sept 13, 2004. http://www.who.int/disasters/repo/14652.pdf (accessed Sept 15, 2004).

15 Woodruff BA. Measuring mortality rates in cross-sectional surveys: a commentary. *Field Exchange* 2002; **17:** 16.

16 BBC News. US House calls Darfur 'genocide'. July 23, 2004. http://news.bbc.co.uk/2/hi/africa/3918765.stm (accessed Aug 3, 2004).

17 United Nations General Assembly. Convention on the prevention and punishment of the crime of genocide. Dec 9, 1948. http://www.hrweb.org/legal/genocide.html (accessed Aug 31, 2004).

18 Amnesty International. Sudan, Darfur–rape as a weapon of war. July 19, 2004. http://web.amnesty.org/library/eng-sdn/reports (accessed Aug 31, 2004).

19 United States Agency for International Development. Sudan (Darfur)/Chad border region—confirmed damaged and destroyed villages—August 2. Aug 2, 2004. http://www.usaid.gov/locations/sub-saharan_africa/sudan/images/Darfur_Aug_2_villages.pdf (accessed Aug 31, 2004).

20 Murray CJL, King G, Lopez AD, Tomijima N, Krug EG. Armed conflict as a public health problem. *BMJ* 2002; **324:** 346–49.

21 Brown V, Caron P, Ford N, Cabrol JC, Tremblay JP, Lepec R. Violence in southern Sudan. *Lancet* 2002; **359:** 161.

22 Spiegel PB, Salama P. War and mortality in Kosovo, 1998–99: an epidemiological testimony. *Lancet* 2000; **355:** 2204–09.

23 Nathan N, Tatay M, Piola P, Lake S, Brown V. High mortality in displaced populations of northern Uganda. *Lancet* 2004; **363:** 1402.

24 Salignon P, Cabrol JC, Liu J, Legros D, Brown V, Ford N. Health and war in Congo-Brazzaville. *Lancet* 2000; **356:** 1762.

25 Roberts L, Despines M. Mortality in the Democratic Republic of the Congo. *Lancet* 1999; **353:** 2249–50.

26 Grein T, Checchi F, Escriba JM, et al. Mortality among displaced former UNITA members and their families in Angola: a retrospective cluster survey. *BMJ* 2003; **327:** 650–54.

27 Legros D, Brown V. Documenting violence against refugees. *Lancet* 2001; **357:** 1429.