

## SOCIAL SCIENCE

# Death in Darfur

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The crisis of death and displacement in western Sudan began in February of 2003 and soon engulfed all three states of North, West, and South Darfur. To begin to comprehend the tragedy of the conflict and the extent of the genocide (1, 2), it is necessary to have an accurate estimate of the number of deaths that occurred. Yet current estimates differ by more than an order of magnitude.

This uncertainty results from difficulties inherent in surveying a war-torn region in Africa, as well as assumptions made by agencies trying to generate estimates. There is no way, as might happen in a natural disaster, to get an accurate body count; estimates must rely on interviews. Surveys from displacement camp samples must be substituted for unavailable population-based census data; extrapolating from limited samples to an entire population at risk is problematic. A quarter-century of famine and war has reconfigured nuclear families, making sampling units in surveys problematic. Current surveys also vary in recall periods and coverage. Finally, past estimates of Darfur mortality have been based on the dubious assumption of constant numbers of deaths per month.

The initial World Health Organization (WHO) study, conducted with cooperation of the Sudanese Ministry of Health, presented crude mortality rates (CMRs) developed from sample surveys conducted in “internally displaced person” (IDP) camps (3). The CMRs were calculated for 2 months when respondents were mostly in the camps and past the risk of violent attacks that led to their displacement (4). In fall 2004, WHO based a projection that 70,000 had died in 7 months (5) on extrapolation of the earlier, 2-month data, under the assumption of a constant death rate. This assumption is doubtful and the underestimation of precamp violent deaths was emphasized in a British parliamentary committee report (4).

Early in 2005, a United Nations (U.N.) humanitarian coordinator reported that 180,000

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Analysis of factors confounding previous estimates leads to the conclusion that hundreds of thousand of people rather than tens of thousands have died as a result of the conflict in Darfur.



Disruption of family structures and loss of kinship boundaries make counting the dead more difficult. Refugees in an IDP camp school, Nyala, South Darfur, Sudan.

died over 18 months (6)—on the basis of extrapolation from the WHO estimate (7). Other estimates doubled the 180,000 figure (8–10), and Kofi Annan suggested there were 300,000 deaths (11). Then in spring of 2005, U. S. Deputy Secretary of State Robert Zoellick reported a lower estimate of 63,000 to 146,000 “excess” deaths (12). Following the State Department estimate, the press largely reverted to reporting a Darfur death toll in the tens of thousands and underestimated hundreds of thousands of lost lives (13, 14).

The State Department estimate remedied the assumption of constant monthly mortality, but introduced new issues (15, 16). It drew on health surveys that were not fully identified and for which primary sources are uncertain. Monthly CMRs and risk populations were not specified. It focused on camp health problems rather than precamp violence.

The State Department estimate draws a further distinction between “excess” and “normal” or “expected” mortality under a hypothetical situation without the conflict. This generates opportunities for additional errors. The Darfur conflict has lasted more than 3 years, and in an actuarial sense, some deaths would be expected. Yet there are legal and moral difficulties in equating deaths expected in a settled population with deaths in “displacement” camps.

To address these issues, we have built an estimate from the best of the primary surveys from the West Darfur camps. All use systematic sampling, report age-specific mortality rates, and provide some information on violence. We first focus on the 19-month period when we could combine the wide coverage of the surveys by WHO in 43 West Darfur camp sites with the more detailed information gathered by Médecins Sans Frontières (MSF) in five West Darfur camps (17). The MSF Surveys detailed pre- and in-camp mortality. They could only ask explicit questions about precamp violence in five camps. The WHO surveys focused on in-camp mortality with limited representation of precamp violence, but with coverage of the entire state of West Darfur (3, 18).

The U.N. generates humanitarian profiles of people counted in the camps and people surrounding the camps who together constitute conflict-affected people who are also in need of assistance. These counts are important to the United Nations as the basis of planning and support. The United Nations does not ask specific questions about violence, but the numbers generated are essential in calculating the population at risk, which we used to estimate the actual numbers of deaths in West Darfur. West Darfur refugees in Chad are not included in these profiles. We used a State

Department survey and U.N. refugee camp counts to complete the estimate of the West Darfur population at risk (1).

We used the WHO and MSF surveys to obtain direct and indirect monthly estimates of CMRs, which respectively over- and underestimate mortality and thus are best used in combination (19). (Methodological details are presented in the supporting online material.) The direct method is based on CMRs calculated for all age groups in the surveys. These rates are likely upwardly biased by reports of deaths of extended, as well as nuclear family, members, because kinship boundaries often expand and become more inclusive in response to war. The indirect method counters this by relying on under-age-5 mortality rates (M5) reported in the surveys. These rates are likely downwardly biased by missing children whose entire unrepresented families have died. The indirect method uses Coale-Demeny North life tables for sub-Saharan Africa to estimate the full age distribution of mortality in the absence of wartime violence. Violence is reincorporated on the basis of the proportion of violence reported in the surveys, but the overrepresentation of young adults with low mortality outside of war is also a downward bias in the indirect method.

The figure below displays (on the left side) the upper and lower 95% bound CMRs for the direct and indirect estimates (19). The right side displays the upper and lower bound and midpoint number of deaths associated with these methods. The peak in the death estimates occurs later than the peak CMRs side because of the ongoing growth of the conflict-affected population associated with the expanding conflict.

We conservatively estimate 19 months of mortality in West Darfur as 49,288 (with a range from 40,850 to 67,598) by summing the means for estimated deaths between the high and low monthly figures in the right side of the figure. When the right tail of this distribution is extended to May 2006 (18), the total number of deaths is 65,296 in West Darfur alone, with a range from 57,506 to 85,346. This estimate covers 31 months of conflict that, as of August 2006, has been under way for 43 months. If the further 12 months of conflict were well estimated, and/or if all or most missing or disappeared persons were presumed dead, the death estimate would be much higher.

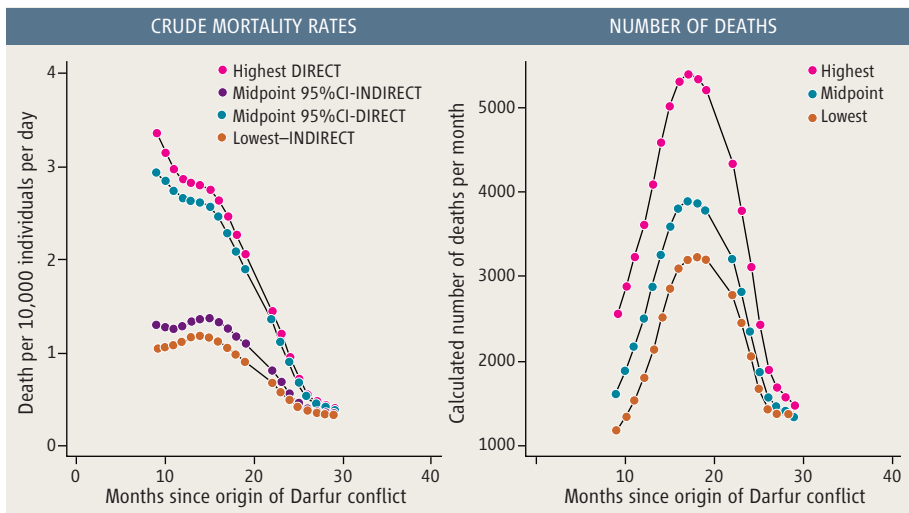
Largely as a result of this killing, more than one million individuals are now displaced or affected in West Darfur (20). About one million people are similarly displaced in each of the adjoining Sudanese states of North and South Darfur. If the same ratio of death to displacement applies across states, this implies that close to 200,000 deaths have occurred over 31 months in Greater Darfur. This calculation divides the difference between potential upward and downward biases of direct and indirect methods. If the high direct and low indirect bands of estimates are extended across the three Darfur states for 31 months, the range is between ~170,000 and ~255,000 estimated deaths. It is likely that the number of deaths for this conflict in Greater Darfur is higher than 200,000 individuals, and it is possible that the death toll is much higher.

Our awareness of the humanitarian catastrophe in Darfur and others like it would be

much improved by regular systematic surveys in IDP camps of age-specific, pre- and in-camp mortality. Nongovernmental organizations have had great difficulty undertaking this survey work because of the conflict conditions in Darfur. Although we cannot overcome the limitations in the basic information, on the basis of the surveys available, we conclude that the death toll in Darfur is conservatively estimated to be in the hundreds of thousands rather than tens of thousands of people.

#### References and Notes

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**Estimated deaths during Darfur conflict.** Estimated ranges for CMR and number of deaths. Direct estimates of CMR were derived from the survey material; indirect estimates were based on child mortality rates. It is likely that direct estimates of CMR are overestimates, whereas indirect estimates are underestimates; they were used in combination to produce upper and lower bounds. Numbers of deaths were calculated from the CMRs and estimates of the affected populations. For details, see text and SOM.

#### Supporting Online Material

[www.sciencemag.org/cgi/content/full/313/5793/1578/DC1](http://www.sciencemag.org/cgi/content/full/313/5793/1578/DC1)

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