



## Estimating Excess Mortality in Post-Invasion Iraq

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There is no set formula for accurately tallying deaths from humanitarian crises. When a population becomes destabilized, estimation of mortality is likely to be severely challenged. In the case

of a sudden traumatic event, such as a natural disaster affecting an otherwise stable population, health and human service agencies, though compromised, may well be able to facilitate an accurate assessment of deaths through the use of prospective registries of vital events.

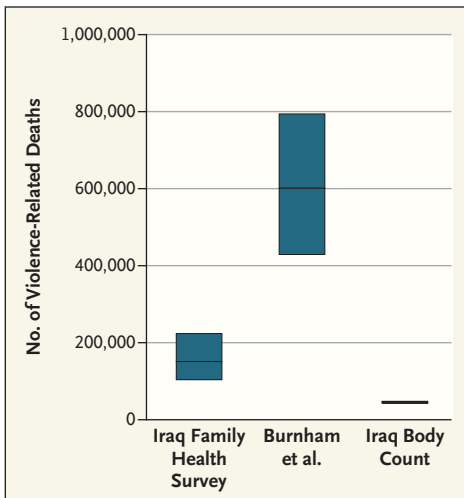
In the event of a military invasion and ongoing war, however, the likelihood of obtaining good demographic data plummets. A death registry is unlikely to be developed or maintained, and as conditions deteriorate, it may become increasingly unlikely that bodies can be counted at all. In Iraq, there is also a strong cultural imperative that bodies be

put to rest quickly, which may affect the ability to arrive at accurate estimates. Although sentinel populations are commonly monitored to rapidly estimate mortality in developing countries when a registry is not available, the impossibility of finding reliably representative populations in countries engaged in armed conflict and the absence of an accurate population count make it difficult to extrapolate from the rates at sentinel sites to produce reliable national estimates.

A more accurate option, but one that is more dangerous for researchers, is the household survey.<sup>1</sup> Even in nonemergency situations, the study design of the

survey may be subject to underreporting and may not accurately reflect rates of migration and fertility. Complex computations are required to account for variation among regions and subpopulations. During conflicts, an estimation of the death rate is further complicated by the difficulties involved in creating a valid sampling frame, the problem of reporting bias, and obstacles to accurate ascertainment of causes of death. Researchers often must risk their lives if they wish their estimates to accurately represent the population, and they must spend as much time in dangerous areas as in less dangerous ones to minimize bias.

In this issue of the *Journal* (pages 484–493), the Iraq Family Health Survey (IFHS) study group reports the results of a household survey conducted in Iraq in 2006 and 2007 for the purpose of es-



The ranges in studies by the Iraq Family Health Survey and by Burnham et al. represent 95% confidence intervals; data from the Iraq Body Count represent absolute minimum and maximum counts.

estimating mortality between January 2002 and June 2006. The researchers divided the country into 56 mutually exclusive sampling strata and surveyed 9345 households in total (see map). Information on all deaths within a household was sought, in an effort to estimate overall and cause-specific rates of death. The group obtained an estimate of 151,000 violent deaths, with a purported 95% confidence interval of 104,000 to 223,000 — a massive death toll — since the 2003 invasion. Violence was found to be the leading cause of death among Iraqi men between the ages of 15 and 59 years and a leading cause of death among Iraqi adults in general.

The results of this survey are most striking in comparison with those in two other reports: the Iraq Body Count Project<sup>2</sup> and a 2006 study by Burnham et al.<sup>3</sup> The IFHS authors note that their estimate is much lower than that reported in the study by Burnham et al., which yielded a point estimate of 601,027 violent deaths

between 2003 and 2006. Since the latter tally was much publicized, the first response to the IFHS results may be disbelief; some will no doubt suggest that the findings are flawed. However, the Iraq Body Count arrived at an even lower total — 47,668 (see graph).

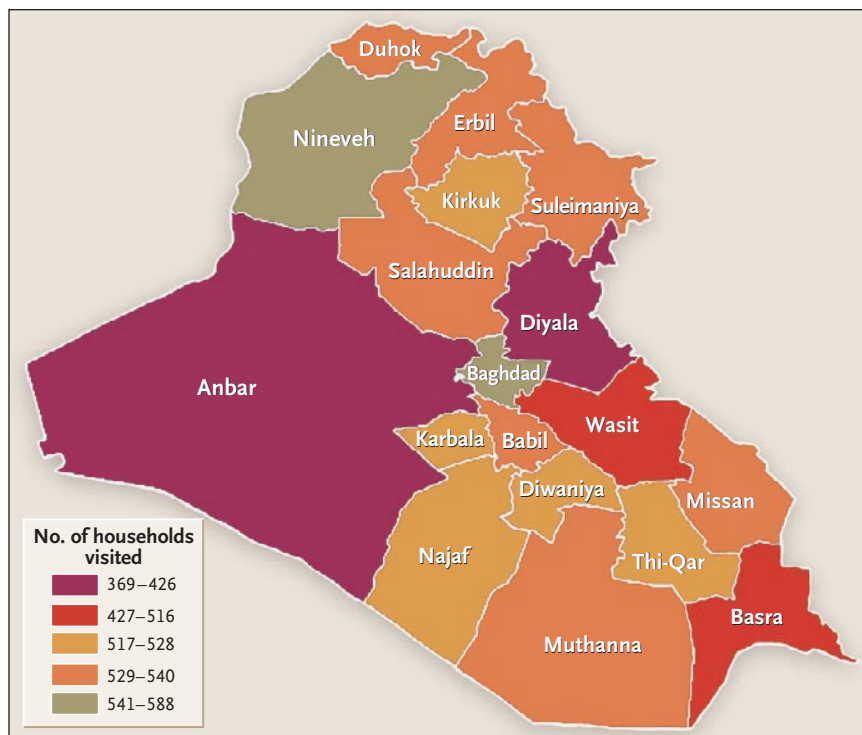
How is it that these numbers vary so widely, given that there can be only one true answer? The IFHS study group does not directly address this question, but it deserves speculation. The probable cause is that the techniques used to obtain the estimates differ radically from one another. The Iraq Body Count collects details from every available distinct report for all identified incidents in which civilians were killed. Deaths are included if they appear in a minimum of two independent data sources, and they are cross-checked with media reports and with the records of hospitals, morgues, and nongovernmental organizations, as well as with official figures, to produce a credible record of known deaths and incidents (though as of December 21, 2007, credible single-source reports will now be recorded).<sup>2</sup> The Iraq Body Count doesn't include deaths of combatants — only those of civilians. Nor does it cover all possible non-English-language media outlets or incidents that are not covered by news reports. In other words, the Iraq Body Count's tally represents an undercount based on surveillance, not a survey, and should be treated as a reliable lower bound.

Meanwhile, there is ongoing discussion<sup>4</sup> about the validity of the study by Burnham et al. The survey methods have been scrutinized, and observers have put forward convincing arguments

both that it does and that it does not overestimate mortality. One of the issues under debate is whether the clusters that were surveyed were nonrandomly distributed owing to “main-street bias” (an oversampling of highly trafficked areas). What cannot be debated is that it was a much smaller study (1849 households in 47 clusters) than that conducted by the IFHS (9345 households in 1086 clusters).

Though the IFHS study group should be commended for its attempt to capture the highest-quality results, uncertainties remain. The survey design, in particular, is certainly open to criticism, and the authors honestly admit the shortcomings of their analysis. For example, sometimes it was problematic or too dangerous to enter a cluster of households, which might well result in an undercount; data from the Iraq Body Count on the distribution of deaths among provinces were used to calculate estimates in these instances. If the clustering of violent deaths wasn't accurately captured, that could also increase uncertainty.

The sampling frame was based on a 2004 count, but the population has been changing rapidly and dramatically because of sectarian violence, the flight of refugees, and overall population migration. Another source of bias in household surveys is underreporting due to the dissolution of some households after a death, so that no one remains to tell the former inhabitants' story. Mortality estimates that are derived from surveying deaths of siblings were also calculated, but this method may also be subject to such underreporting. However, the IFHS group's overall estimate of



**Numbers of Households Visited in Each Governorate of Iraq for the Iraq Family Health Survey.**

Map is from the Central Organization for Statistics and Information Technology of Iraq.

mortality does reflect uncertainty in the level of underreporting (20 to 50%) and the instability of the projected population during the post-invasion period (1 million to 2 million).

Under the current conditions in Iraq, it is difficult to envision a study that would not have substantial limitations. The circumstances that are required to produce high-quality public health statistics contrast starkly with those under which the IFHS study group worked. Indeed, it must be mentioned that one of the authors

of the survey was shot and killed on his way to work.

We cannot begin to explore all the political implications of this work, which will no doubt shape international public opinion regarding the war in Iraq. What we can discuss, however, are the implications of this work for mortality-estimation research in areas in which violent conflict persists. The addition of this study and comparisons between it and others will permit a better understanding of the relationship between study tech-

niques and mortality estimation that can, in turn, provide a basis for improved guidelines to decrease bias in future studies. When alternative data sources become available, the IFHS and the other surveys conducted to date will be verified or refuted, along with their survey techniques. The goal should be to ensure that decisions regarding epidemiologic methods for estimating mortality in high-risk populations are based on the best possible evidence; these estimates are critical for the effective implementation of humanitarian relief efforts.

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1. Working Group for Mortality Estimation in Emergencies. Wanted: studies on mortality estimation methods for humanitarian emergencies, suggestions for future research. *Emerg Themes Epidemiol* 2007;4:9.
2. The Iraq Body Count Project. (Accessed January 2, 2008, at <http://www.iraqbodycount.org>.)
3. Burnham G, Lafta R, Doocy S, Roberts L. Mortality after the 2003 invasion of Iraq: a cross-sectional cluster sample survey. *Lancet* 2006;368:1421-8.
4. Giles J. Death toll in Iraq: survey team takes on its critics. *Nature* 2007;446:6-7.

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