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Violence-Related Mortality in Iraq from 2002 to 2006

Iraq Family Health Survey Study Group

ABSTRACT

Background Estimates of the death toll in Iraq from the time of the U.S.-led invasion in March 2003 until June 2006 have ranged from 47,668 (from the Iraq Body Count) to 601,027 (from a national survey). Results from the Iraq Family Health Survey (IFHS), which was conducted in 2006 and 2007, provide new evidence on mortality in Iraq.

Methods The IFHS is a nationally representative survey of 9345 households that collected information on deaths in the household since June 2001. We used multiple methods for estimating the level of underreporting and compared reported rates of death with those from other sources.

Results Interviewers visited 89.4% of 1086 household clusters during the study period; the household response rate was 96.2%. From January 2002 through June 2006, there were 1325 reported deaths. After adjustment for missing clusters, the overall rate of death per 1000 person-years was 5.31 (95% confidence interval [CI], 4.89 to 5.77); the estimated rate of violence-related death was 1.09 (95% CI, 0.81 to 1.50). When underreporting was taken into account, the rate of violence-related death was estimated to be 1.67 (95% uncertainty range, 1.24 to 2.30). This rate translates into an estimated number of violent deaths of 151,000 (95% uncertainty range, 104,000 to 223,000) from March 2003 through June 2006.

Conclusions Violence is a leading cause of death for Iraqi adults and was the main cause of death in men between the ages of 15 and 59 years during the first 3 years after the 2003 invasion. Although the estimated range is substantially lower than a recent survey-based estimate, it nonetheless points to a massive death toll, only one of the many health and human consequences of an ongoing humanitarian crisis.

Without reliable death-registration systems, the estimation of mortality relies mostly on household surveys, which are subject to many biases, even in peacetime.[1,2] In conflict situations, the estimation of the rate of death either from violence or from indirect causes has another level of complexity: since data collection is difficult, events may be clustered in small areas, and traditional models of adjustment do not apply.[3]

The death toll in Iraq after the U.S.-led invasion in March 2003 has been the subject of much discussion, with numbers differing by as much as a factor of 10. A national survey of a sample of population clusters that was conducted in mid-2006 estimated that an additional 654,965 persons had died during the 40 months since the U.S.-led invasion, as compared with prewar numbers. This number included 601,027 excess deaths due to violence.[4] The Iraq Body Count, a project that is based on a continuous count of screened and validated press reports of casualties, registered 47,668 violent deaths among civilians from March 2003 through June 2006.[5]

In 2006 and 2007, the Iraq Family Health Survey (IFHS), a cross-sectional, nationally representative survey of 9345 households, was conducted by relevant federal and regional ministries in Iraq in collaboration with the World Health Organization (WHO). We present the results on rates and causes of death, compare the results with other data sources, and provide new plausible estimates of violence-related mortality for the 3-year period after the 2003 invasion (March 2003 through June 2006).

Methods

Data Sources

The IFHS is a two-stage, stratified survey of households, with an original target sample size of 10,080 households. The originally allocated sample sizes for the Baghdad–Karkh domain and for Anbar and Nineveh provinces were increased by the addition of census enumeration areas or clusters before the survey fieldwork was undertaken: 6 areas for the Baghdad–Karkh region (a 33.3% increase), 54 areas for Anbar (a 100% increase), and 18 areas for Nineveh (a 33.3% increase). The addition of the census enumeration areas was done to compensate for the expected difficulties in accessing some of the selected clusters because of security problems. The additional enumeration areas increased the target sample size to 10,860 households located in 1086 clusters.

Because of different selection probabilities of households in the sample, design weights were calculated on the basis of projected population numbers according

to province and stratum and were further adjusted for nonresponses at both the cluster and household levels. The sampling frame that was used in the southern and central provinces was derived from the 1997 census, which had been updated for the Iraq Living Conditions Survey 2004[6]; the frame that was used in Kurdistan was based on information provided by the Statistical Offices in the region. Population estimates for Iraq for the survey period were projected by the Central Organization for Statistics and Information Technology. (For details on the survey design and implementation, see the Supplementary Appendix, available with the full text of this article at www.nejm.org.)

All deaths that occurred in the selected households from June 2001 to the time of the survey were ascertained. The respondents were first asked whether anyone in the household had died during this period. For each death, data were recorded on sex, age at the time of death, the time and place of death, whether medical attention had been sought before the death, and the main cause of death according to the respondent. The interviewers coded the responses with the use of a list of 23 probable causes of death. (Additional details regarding the IFHS report are available at www.emro.who.int/iraq/ifhs.htm.)

Rates of Death

The rates of overall and cause-specific death were calculated with the use of information on the age and sex of household residents at the time of the survey, as well as the age, sex, and time of death of the deceased and the cause of death that was reported in the household questionnaire. Exposure times to the risk of death for both living and dead persons during the analysis period (January 2002 through June 2006) were calculated to the nearest month. The analysis period was divided into a pre-invasion period (January 2002 through February 2003) and a post-invasion period (March 2003 through June 2006). June was selected as the end month to allow comparison of the results with those of a previous survey that was conducted in mid-2006.[4]

Assessment of Mortality Data

Of the 1086 originally selected clusters, 115 (10.6%) were not visited because of problems with security. These clusters were located in Anbar (61.7% of the unvisited clusters), Baghdad (26.9%), Nineveh (10.4%), and Wasit (0.8%). Since past mortality is likely to be higher in these clusters than in those that were visited during the IFHS, we imputed mortality figures for the missing clusters in Anbar and Baghdad with the use of information from the Iraq Body Count on the distribution of deaths among provinces to estimate the ratio of rates of death in these areas to those in other provinces with high death rates. Data from the Iraq Body Count were used to compute ratios for death rates in Anbar and Baghdad, as compared with the three provinces that contributed more than 4% each to the total number of deaths reported for the period from March 2003 through June 2006.

For instance, we compared the ratio of the rate of death in Baghdad relative to the rate in three high-mortality provinces reported by the Iraq Body Count (3.08) with the rate ratio reported by the IFHS for the same provinces (1.56). To obtain the same ratio, overall mortality in Baghdad would need to have been 1.97 times as high as that in the three other provinces on the basis of the visited clusters only. This corresponds to a rate of death in the missing clusters that is 4.0 times as high as that in the visited clusters; the corresponding numbers for Anbar were 1.43 and 1.70, respectively (Table 1 of the Supplementary Appendix). This adjustment involves some uncertainty, since it assumes that completeness of reporting for the Iraq Body Count is similar for Baghdad and other high-mortality provinces. Since the Iraq Body Count did not collect information on age and sex for all deaths, the adjustment factors were not stratified according to these factors.

Adjustment for Reporting Bias

In general, the underreporting of deaths is likely to be common in household surveys. The most serious concern is household dissolution after the death of a household member. Several demographic assessments have suggested that there has been an underreporting of deaths in the IFHS. The application of the growth balance method,[7] with the use of the age distribution of deaths in the population obtained from the household roster, indicates that the level of completeness in the reporting of death was 62%. However, this estimation needs to be interpreted with caution, since a basic assumption of the method — a stable population — is violated in Iraq. Furthermore, the comparison is not made to a rate of death derived from two successive censuses, as is usually done, but from the age distribution of the households in the IFHS.

Analysis of Sibling Data

The IFHS also asked female respondents between the ages of 15 and 49 years for the sex and survival status of all siblings with the use of the sibling history module developed by the Demographic and Health Surveys.[8,9] For surviving siblings, respondents were asked for the current age; for siblings who were reported to have died, respondents were asked for the age at the time of death and the time period. These data were used to make separate estimates of rates of death that were specific to age and sex for the pre-invasion and post-invasion periods for comparison with the death rates estimated from the questions on deaths reported in households. The analysis of death rates among siblings was not used in the preparation of the final estimate of post-invasion deaths. Methods proposed by Gakidou and King[10] were adapted to adjust for two forms of bias in the estimation of death rates from data regarding the survival of siblings. (For more information on the adjustment, see the Supplementary Appendix.)

For comparison, rates of death were also estimated with the use of microdata from the Iraq Body Count[5] and from the 2006 study by Burnham and colleagues.[4] These data were provided to the WHO by the principal investigators of each study. We used projected midyear population numbers that were adjusted for net migration to convert the rates of death into numbers of violent deaths (Table 2 of the Supplementary Appendix).

Response Rates

Table 1 shows the results of the household questionnaires and reasons for nonresponse, according to geographic region. Of the 9710 households that were

visited, successful interviews were conducted in 9345 households, which represented a national response rate of 96.2% percent, including 95.8% for southern and central regions. Of the households that did not respond, 0.7% were absent for an extended period of time, and 1.1% of households were vacant dwellings. Only 0.4% of households declined to complete the questionnaire. Analysis of the level of nonresponse did not show significant differences according to the rate of reported household mortality.

View this table: **Table 1.** Final Disposition of Household Questionnaires, According to Region.
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Statistical Analysis

Rates of death from any cause and from violent causes were calculated. Robust confidence intervals were estimated with the use of the jackknife procedure,[11] and all results were weighted with the use of survey normalized weights.

To estimate the most probable rate of violent deaths after the invasion and the range of uncertainty, we performed Monte Carlo simulations that took into account the survey sampling errors that were estimated with the use of the jackknife procedure and uncertainty regarding the missing cluster-adjustment factors, the level of underreporting, and the projected population numbers. We assumed that the level of underreporting was 35% (95% uncertainty range, 20 to 50), and its uncertainty was normally distributed. Uncertainty in the projected population for the post-invasion period reflected uncertainty in the total migration of 1.49 million persons (95% uncertainty range, 1.00 to 2.00), with an assumption of normal distribution. Uncertainty in the missing cluster-adjustment factors was difficult to quantify, since we assumed that the excess risk of mortality in missing clusters in Baghdad and Anbar was normally distributed, with standard deviations of 0.2 and 0.1, respectively. All analyses were performed with the use of Stata statistical software, version 9. All P values are two-sided.

Results

IFHS

At the time of the survey, 61,636 persons were living in the sampled households, with 13.1% of the respondents living in Kurdistan. The male:female ratio in the households was 1.02, the average household size was 6.4 persons, and two-thirds of household members were between the ages of 15 and 59 years. (Detailed analyses are available at www.emro.who.int/iraq/ifhs.htm.)

Table 2 shows the distribution of 1325 reported deaths according to major cause for the periods relative to the 2003 invasion among children under the age of 15 years, men and women between the ages of 15 and 59 years, and persons over the age of 60 years. (Cause-specific data are available in Table 3 of the Supplementary Appendix.) Overall, the proportion of deaths from injuries increased from 10.5% before the invasion to 23.2% after the invasion. The increase was most dramatic among men between the ages of 15 and 59 years, among whom deaths from injuries increased from 31.2% before the invasion to 63.5% after the invasion and became the leading cause of death in this age group.

View this table: **Table 2.** Distribution of Main Causes of Death Reported from January 2002 through June 2006, According to Sex and Age.
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Table 3 shows the crude rates of death per 1000 person-years for the period from January 2002 through June 2006, according to region, time period, sex, and age, after adjustment for missing clusters in Anbar and Baghdad. The adjustment increased the post-invasion rate of death from any cause by nearly 5%, from 5.73 to 6.01 per 1000 person-years; it also increased the rate of violence-related death by 36%, from 0.80 to 1.09 per 1000 person-years. (For additional details, see Table 4 of the Supplementary Appendix.)

View this table: **Table 3.** Rates of Death per 1000 Person-Years before and after the Invasion, According to Age, Sex, and Region.
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Death from any cause per 1000 person-years was 5.31 (95% confidence interval [CI], 4.89 to 5.77). The rate was higher in the southern and central regions of Iraq than in Kurdistan and higher among men than women. In Kurdistan, a nonsignificant increase in the rate of death was observed. In southern and central Iraq, the adjusted rate of death per 1000 person-years increased significantly, from 3.19 (95% CI, 2.67 to 3.82) to 6.36 (95% CI, 5.78 to 7.02); the increases were seen in all age groups but were most prominent in men between the ages of 15 and 59 years. Mortality from nonviolent causes was significantly higher per 1000 person-years in the post-invasion period (4.92; 95% CI, 4.49 to 5.41) than in the pre-invasion period (3.07; 95% CI, 2.61 to 3.63) (Table 4 of the Supplementary

Appendix).

The independent estimate of mortality of persons between the ages of 15 and 59 years that was derived from data on sibling survival showed reasonable consistency with the above-mentioned estimates (Table 5 of the Supplementary Appendix). On the basis of household data, for the period 5 to 15 years before the survey date, death rates per 1000 person-years for persons between the ages of 15 and 59 years were 2.2 for men and 1.2 for women, as compared with 2.0 and 0.8, respectively, for the 2-year period before the invasion. In this age group, death rates for the period from 2003 to 2006 were 3.2 for men and 1.2 for women, as compared with 5.9 and 2.0, respectively, for the post-invasion period on the basis of household data. The estimates that were based on reported sibling survival may be subject to similar or higher levels of underreporting than were estimates based on household data. Completeness of the reporting of sibling deaths might well be lower than that of households if siblings had been out of recent contact.[2]

Comparison with Other Sources

Our comparison between the results of the study by Burnham et al. and that of the Iraq Body Count focused on the distribution of violent deaths according to the region of the country, time trends, and rates. Figure 1A shows the proportional distribution of deaths for four groups of provinces: Kurdistan, Baghdad, high-mortality provinces (in which each province accounted for ≥3.5% of total mortality reported by the Iraq Body Count, including Anbar, Babylon, Basra, Diyala, Nineveh, and Salahuddin), and low-mortality provinces (<3.5% of total mortality reported by the Iraq Body Count) for the post-invasion period. All three sources agreed on the low mortality in Kurdistan. Of all the violent deaths occurring in Iraq, the proportion in Baghdad was 54% in the IFHS, 60% in the Iraq Body Count, and only 26% in the study by Burnham et al. The Iraq Body Count probably overestimated this proportion, since press coverage is probably better in Baghdad than it is elsewhere in the country. It should also be noted that the rate of death in Baghdad was adjusted with the use of data from the Iraq Body Count, as reported above. The Iraq Body Count does not include combatant deaths among Iraqis, which would have been picked up by the household surveys. The most striking difference in rates of death was between those in the study by Burnham et al. and those in the two other data sources for the six high-mortality provinces, which accounted for 64% of all deaths in the study by Burnham et al.

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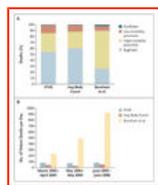
Figure 1. Percent Distribution of Violent Deaths among Provinces and the Number of Violent Deaths per Day from March 2003 to June 2006, According to Three Data Sources.

Panel A shows the proportions of violent deaths among provinces in Iraq according to three data sources: the Iraq Family Health Survey (IFHS), the Iraq Body Count, and a study by Burnham et al.[4] Panel B shows the number of violent deaths per day according to the year and data source.

The rates and time trends of violent deaths differed considerably among the three sources (Table 4). On the basis of population estimates shown in Table 2 of the Supplementary Appendix, the IFHS data indicate that every day 128 persons died from violence from March 2003 through April 2004, 115 from May 2004 through May 2005, and 126 from June 2005 through June 2006. The Iraq Body Count numbers were 43, 32, and 55 civilian deaths per day for the same periods. In the study by Burnham et al., there was a much higher rate of death from violence and a sharp increase during the 3-year period, with 231, 491, and 925 deaths per day, respectively (Figure 1B). There was greater agreement regarding mortality from nonviolent causes between the IFHS study (372 deaths per day) and the study by Burnham et al. (416 deaths per day) (Table 2 of the Supplementary Appendix).

View this table: **Table 4.** Violence-Related Deaths after the Invasion, According to Time Period and Data Source.
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The pre-invasion rates of adult mortality from any cause per 1000 person-years were 2.0 for men and 0.8 for women in the IFHS, with a relatively small proportion of deaths attributed to violent causes. In a regional comparison for 2002, a study by the WHO[12] estimated that in Syria and Jordan, the rates of death for adults were 4.2 for men and 2.8 for women. In Iran, the rates were 4.7 and 2.9, respectively. If we assume that the rate of death in Iraq would have been at similar levels without the invasion, underreporting of adult deaths in the IFHS would be as much as 55% for men and 70% for women for reported deaths occurring in 2001 and 2002. The underreporting of deaths was expected to be lower for more recent years.

A comparison of the results of the IFHS and those of the Multiple Cluster Indicator Survey (MICS) 2006,[13] conducted by the United Nations Children's Fund (UNICEF), provides some insight into the consistency of child-mortality estimates. Both surveys included questions regarding all children who were ever born and those who were still alive to estimate child-mortality trends, which could be used to estimate the rate of death for children under the age of 5 years with the use of model life tables.[7] The estimates per 1000 live births were 54 deaths in the IFHS and 49 deaths in the MICS for the period from 2002 through 2006. On

the basis of the simulation that took into account the sampling errors and the uncertainty in factors for missing clusters, the level of underreporting, and the projected population numbers, we estimated that there were 151,000 violent deaths in Iraq (95% uncertainty range, 104,000 to 223,000) during the post-invasion period from March 2003 through June 2006.

Discussion

The IFHS 2006 was a large health survey that included the collection of data regarding rates of death. In spite of the difficult circumstances in Iraq, the experienced survey coordinating teams managed to visit 89% of the 1086 selected clusters, and household response rates were high throughout the country.

Recall of deaths in household surveys with very few exceptions suffer from underreporting of deaths. None of the methods to assess the level of underreporting provide a clear indication of the numbers of deaths missed in the IFHS. All methods presented here have shortcomings and can suggest only that as many as 50% of violent deaths may have gone unreported. Household migration affects not only the reporting of deaths but also the accuracy of sampling and computation of national rates of death.

The IFHS results for trends and distribution of deaths according to province are consistent with what has been reported from the scanning of press reports for civilian casualties through the Iraq Body Count project. The estimated number of deaths in the IFHS is about three times as high as that reported by the Iraq Body Count. Both sources indicate that the 2006 study by Burnham et al. considerably overestimated the number of violent deaths. For instance, to reach the 925 violent deaths per day reported by Burnham et al. for June 2005 through June 2006, as many as 87% of violent deaths would have been missed in the IFHS and more than 90% in the Iraq Body Count. This level of underreporting is highly improbable, given the internal and external consistency of the data and the much larger sample size and quality-control measures taken in the implementation of the IFHS.

At present, there are no better methods available to provide more accurate estimates of the death toll due to the humanitarian conflict in Iraq in the wake of the 2003 invasion. Rapid small-scale surveys of households are likely to yield unreliable estimates. Surveys of a large number of respondents with carefully prepared household interviews and multiple methods for collecting data on mortality still run into reporting problems because of the insecurity, instability, and migration associated with the conflict situation. The clustering of violent deaths may further affect uncertainty related to sampling,[14] even though more than 1000 clusters were selected for the IFHS. It is unlikely that more accurate estimates of the death toll during the post-invasion period can be obtained by conducting more household surveys with recall questions on mortality. On the basis of press reports, the Iraq Body Count is also affected by considerable underreporting but is likely to be a valuable way to monitor trends over time. Further investment in such mechanisms is justified, especially if ways can be found to assess the level of underreporting and the consistency of the reporting mechanisms over time. Other methods, such as systematic reporting by mortuaries and hospitals and the strengthening of vital registrations with the use of sentinel sites, will also need to be explored.

On the basis of direct reporting of deaths by households respondents that were adjusted for missing clusters, it was estimated that the violence-related rate of death from March 2003 through June 2006 was 1.09 per 1000 person-years (95% CI, 0.81 to 1.50). About half of the violent deaths were estimated to have occurred in Baghdad, and virtually all such deaths occurred in the southern and central regions.

Overall mortality from nonviolent causes was about 60% as high in the post-invasion period as in the pre-invasion period. Although recall bias may contribute to the increase, since deaths before 2003 were less likely to be reported than more recent deaths, this finding warrants further analysis.

During the same period, the Iraq Body Count registered 47,668 civilian deaths from violence. A much smaller mortality survey (1849 households in 47 clusters) by Burnham et al. came up with a best estimate of 601,027 violent deaths. The best estimate on the number of deaths from March 2003 through June 2006 based on the IFHS data analysis and comparisons with other sources is three times as high as that reported by the Iraq Body Count but only one fourth of that reported by Burnham et al. On the basis of simulations that took into account survey sampling errors and estimated probable uncertainty in the adjustment factors for missing clusters, in the level of underreporting, and in projected population figures, we estimated that there were 151,000 violent deaths in Iraq during this period (95% uncertainty range, 104,000 to 223,000). Although this number is substantially lower than that estimated by Burnham et al., it nonetheless points to a massive death toll in the wake of the 2003 invasion — and represents only one of the many health and human consequences of an ongoing humanitarian crisis.

Source Information

The members of the writing committee (Amir H. Alkhuzai, M.D., Ihsan J. Ahmad, M.D., Mohammed J. Hweel, M.D., Thakir W. Ismail, M.D., Hanan H. Hasan, M.D., Abdul Rahman Younis, M.D., Osman Shawani, M.B., Ch.B., Vian M. Al-Jaf, M.D., Mahdi M. Al-Alak, Ph.D., Louay H. Rasheed, M.Sc. (deceased), Suham M. Hamid, M.B., Ch.B., Naeema Al-Gasseer, Ph.D., Fazia A. Majeed, M.D., Naira A. Al Awqati, M.D., Mohamed M. Ali, Ph.D., J. Ties Boerma, Ph.D., and Colin Mathers, Ph.D.) assume responsibility for the overall content and integrity of the article.

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Appendix

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