Mortality after the 2003 invasion of Iraq: a cross-sectional cluster sample survey

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Summary

Background **An excess mortality of nearly 100 000 deaths was reported in Iraq for the period March, 2003–September, 2004, attributed to the invasion of Iraq. Our aim was to update this estimate.**

Methods **Between May and July, 2006, we did a national cross-sectional cluster sample survey of mortality in Iraq. 50 clusters were randomly selected from 16 Governorates, with every cluster consisting of 40 households. Information on deaths from these households was gathered.**

Findings **Three misattributed clusters were excluded from the final analysis; data from 1849 households that contained 12 801 individuals in 47 clusters was gathered. 1474 births and 629 deaths were reported during the observation period. Pre-invasion mortality rates were 5·5 per 1000 people per year (95% CI 4·3–7·1), compared with 13·3 per 1000 people per year (10·9–16·1) in the 40 months post-invasion. We estimate that as of July, 2006, there have been 654 965 (392 979–942 636) excess Iraqi deaths as a consequence of the war, which corresponds to 2·5% of the population in the study area. Of post-invasion deaths, 601 027 (426 369–793 663) were due to violence, the most common cause being gunfire.**

Interpretation **The number of people dying in Iraq has continued to escalate. The proportion of deaths ascribed to coalition forces has diminished in 2006, although the actual numbers have increased every year. Gunfire remains the most common cause of death, although deaths from car bombing have increased.**

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Introduction

There has been widespread concern over the scale of Iraqi deaths after the invasion by the US-led coalition in March, 2003. Various methods have been used to count violent deaths, including hospital death data from the Ministry of Health, mortuary tallies, and media reports.[1,2] The best known is the Iraq Body Count, which estimated that, up to September 26, 2006, between 43 491 and 48 283 Iraqis have been killed since the invasion.[1] Estimates from the Iraqi Ministry of the Interior were 75% higher than those based on the Iraq Body Count from the same period.[2] An Iraqi non-governmental organisation, Iraqiyun, estimated 128 000 deaths from the time of the invasion until July, 2005, by use of various sources, including household interviews.[3]

The US Department of Defence keeps some records of Iraqi deaths, despite initially denying that they did.[4] Recently, Iraqi casualty data from the Multi-National Corps-Iraq (MNC-I) Significant Activities database were released.[5] These data estimated the civilian casuality rate at 117 deaths per day between May, 2005, and June, 2006, on the basis of deaths that occurred in events to which the coalition responded. There also have been several surveys that assessed the burden of conflict on the population.[6–8] These surveys have predictably produced substantially higher estimates than the passive surveillance reports.

Aside from violence, insufficient water supplies, non-functional sewerage, and restricted electricity supply also create health hazards.[9,10] A deteriorating health service with insecure access, and the flight of health professionals adds further risks. People displaced by the on-going sectarian violence add to the number of vulnerable individuals. In many conflicts, these indirect causes have accounted for most civilian deaths.[11,12]

In 2004, we did a survey of 33 randomly selected clusters of 30 households with a mean of eight residents throughout Iraq to determine the excess mortality during the 17·8 months after the 2003 invasion.[8] The survey estimated excess mortality of at least 98 000 (95% CI 8000–194 000) after excluding, as an outlier, the high mortality reported in the Falluja cluster. Over half of excess deaths recorded in the 2004 study were from violent causes, and about half of the violent deaths occurred in Falluja.

To determine how on-going events in Iraq have affected mortality rates subsequently, we repeated a national household survey between May and July, 2006. We measured deaths from January, 2002, to July, 2006, which included the period of the 2004 survey.

Methods

Participants and procedures

To measure mortality we did a national cross-sectional cohort study of deaths from January, 2002, through July, 2006. Household information was gathered about deaths that occurred between January 1, 2002, and the invasion of March 18, 2003, in all households and these data were compared with deaths that occurred from the time of the invasion through to the date of survey. A sample size of 12 000 was calculated to be adequate to identify a doubling of an estimated pre-invasion crude mortality

rate of 5·0 per 1000 people per year with 95% confidence and a power of 80%, and was chosen to balance the need for robust data with the level of risk acceptable to field teams. Sampling followed the same approach used in 2004,[8] except that selection of survey sites was by random numbers applied to streets or blocks rather than with global positioning units (GPS), since surveyors felt that being seen with a GPS unit could put their lives at risk. The use of GPS units might be seen as targeting an area for air strikes, or that the unit was in reality a remote detonation control. By confining the survey to a cluster of houses close to one another it was felt the benign purpose of the survey would spread quickly by word of mouth among households, thus lessening risk to interviewers.

As a first stage of sampling, 50 clusters were selected systematically by Governorate with a population proportional to size approach, on the basis of the 2004 UNDP/Iraqi Ministry of Planning population estimates (table 1). At the second stage of sampling, the Governorate's constituent administrative units were listed by population or estimated population, and location(s) were selected randomly proportionate to population size. The third stage consisted of random selection of a main street within the administrative unit from a list of all main streets. A residential street was then randomly selected from a list of residential streets crossing the main street. On the residential street, houses were numbered and a start household was randomly selected. From this start household, the team proceeded to the adjacent residence until 40 households were surveyed. For this study, a household was defined as a unit that ate together, and had a separate entrance from the street or a separate apartment entrance.

	Mid-year 2004 population	Number of clusters
Baghdad	6 554 126	12
Ninewa	2 554 270	5
Basrah	1 797 758	3
Sulamaniyah	1 715 585	3
Thi-Qar	1 493 781	3
Babylon	1 472 405	3
Erbil	1 418 455	3
Diyala	1 392 093	3
Anbar	1 328 776	3
Salah al-Din	1 119 369	2
Najaf	978 400	2
Wassit	971 280	1
Qadissiya	911 640	1
Tameem	854 470	1
Missan	787 072	1
Kerbala	762 872	1
Muthanna	554 994	0
Dahuk	472 238	0
Total	27 139 584	47

Table 1: **Province populations and cluster allocation**

The two survey teams each consisted of two female and two male interviewers, with the field manager (RL) serving as supervisor. All were medical doctors with previous survey and community medicine experience and were fluent in English and Arabic. A 2-day training session was held. Decisions on sampling sites were made by the field manager. The interview team were given the responsibility and authority to change to an alternate location if they perceived the level of insecurity or risk to be unacceptable. In every cluster, the numbers of households where no-one was at home or where participation was refused were recorded. In every cluster, queries were made about any household that had been present during the survey period that had ceased to exist because all members had died or left. Empty houses or those that refused to participate were passed over until 40 households had been interviewed in all locations.

The survey purpose was explained to the head of household or spouse, and oral consent was obtained. Participants were assured that no unique identifiers would be gathered. No incentives were provided. The survey listed current household members by sex, and asked who had lived in this household on January 1, 2002. The interviewers then asked about births, deaths, and in-migration and out-migration, and confirmed that the reported inflow and exit of residents explained the differences in composition between the start and end of the recall period. Separation of combatant from non-combatant deaths during interviews was not attempted, since such information would probably be concealed by household informants, and to ask about this could put interviewers at risk. Deaths were recorded only if the decedent had lived in the household continuously for 3 months before the event. Additional probing was done to establish the cause and circumstances of deaths to the extent feasible, taking into account family sensitivities. At the conclusion of household interviews where deaths were reported, surveyors requested to see a copy of any death certificate and its presence was recorded. Where differences between the household account and the cause mentioned on the certificate existed, further discussions were sometimes needed to establish the primary cause of death.

The study received ethical approval from the Committee on Human Research of the Johns Hopkins Bloomberg School of Public Health, Baltimore, MD, USA, and the School of Medicine, Al Mustansiriya University, Baghdad, Iraq.

Statistical analysis

Data entry and analysis was done with Microsoft Excel, SPSS version 12.0, and STATA version 8. Period mortality rates were calculated on the basis of the mid-interval population and with regression models. Mortality rates and relative risks of mortality were estimated with log-linear regression models in STATA.[13] To estimate the relative risk, we used a model that allowed for a baseline