Appendix A

Measuring Deaths in a Population: The Cluster Survey Method

Measuring population characteristics is almost always based on sampling. This could be about deaths, births, or disease present, but it just as well could be voting intentions, number of pets in the household or most-watched television programs.

The basis of sampling is that a characteristic of the whole can be determined from parts selected at random from that whole. Various mathematical formulae allow calculation of how many parts are required to be assured that the result is indeed representative of the whole. It is usual for a survey to be designed with a 95% confidence that the result is within 80% (or some number that we chose for other reasons) of the true value for the whole (precision). Using such formulae, we can determine how many persons we would have to survey to satisfy the criteria set for the confidence and precision of the results. This is called the *sample size.* The more confidence we desire for our results, and the more precision we want, the larger the sample must be. Sometimes this involves just more people and more training, but as in the case of the Iraq study, it involves increasing the exposure to danger. Survey takers have been killed in Iraq, but fortunately none from our teams.

Once we decide on the sample size, we need to determine how to find those numbers of the parts that make up the whole. For people, we speak of the whole as the *population.* These parts should be found by *random* (not haphazard) methods. The simplest way is to make a list of everyone in the population (the whole), and randomly choose the number needed from this list. This is known as simple random sampling.

Cluster sampling, which involves the random selection of clusters of people (or households) instead of individual people, is a valid alternative to simple random sampling. In conflicts and in many developing countries, the listing of all persons or households in an area to be sampled is seldom available. An alternative is the cluster survey, which selects a certain number of clusters (usually not less than 30) from the area to be surveyed. In the area of interest, each of the towns or administrative units is listed by the best estimate of population sizes, and a running total of these populations is made.

The total population is then divided by the number of clusters to give the *sampling interval.* If we were to visit 30 clusters in a county with a population of 120,000, our sampling interval would be 120,000 ÷ 30 = 4000. This means every 4000^{th} person in the county would live in one of the clusters we will want to visit. We then list all the towns in the county by their population (in any order). Our first cluster is the town where person 4000 lives, our second cluster is in the town where person 8000 lives, the third cluster is where person 12,000 lives, and so on until we have our 30 clusters. We really don't need to know who person 4000 is, just the town where he or she lives. Now if we listed the

towns alphabetically, then we would know automatically which town would be the first cluster chosen, and it would not be random. However, if we pick our first cluster with a random number, then it could be several places. If the random number is too big (bigger than 4000), then we will not get 30 clusters for the country. So the rule is that the random number is chosen for the first cluster, which is less than the sampling interval—in this example, 4000.

As the towns or administrative units are listed by populations, bigger towns are likely to be selected for more clusters. This is a basic sampling principle: the chance of being selected is equal for everyone, whether you live in a big city or a small town. In this way, all people and all households have an equal chance of being included in a survey.

Once the cluster is selected, additional sampling stages are required to locate neighborhoods and eventually a single house where to start. For each of these selection stages, a random process is used so there will be no bias to select one location over another. Once the "start house" or location is selected, then the survey team moves to the next nearest (or sometimes the second or third nearest) house until the specified number of houses are selected (often from 10-50) to be interviewed in that cluster. The same is done for the other clusters.

A problem with cluster surveys is that households adjacent to each other are more likely to be similar than those located farther away. In the case of localized violent events, the same event is likely to affect households close together. This makes simple random sampling a stronger survey method where this is possible. But in war this is seldom possible.

To compensate for this "clustering effect" (sometimes called the *design effect*), the number of households or persons in a cluster sample is increased over that of a simple random sample in order to provide adequate precision. As one does not know the extent of "clustering" before the survey is started, it is usually estimated at two, meaning that a cluster survey would need twice the number of households as a simple random survey in order to have equal statistical power.

Afterwards the clustering or design effect can be calculated from the results to see if the estimate of 2.0 was indeed correct. In the 2006 Iraq mortality study, during its analysis this effect was found to be only 1.6—that is, the number of households in the cluster sample needed to be 1.6 times the size of a completely random household sample in order to have the same statistical power, or in terms of confidence intervals, to give an equally precise result. This standard was achieved, because an effect of 2.0 had been allowed for in the design. In other words, the final number of households surveyed—1849—was greater than what was needed for such precision.

Cluster sampling is the method that gives us much of our information about health of populations in developing countries. It has been accepted as an effective tool for measuring deaths in previous conflict situations such as in the Democratic Republic of Congo,[1] during post Gulf War sanctions,[2] in Kosovo,[3] in Darfur,[4] and in Angola.[5] The

results of these studies were widely used to establish policy by governments and the United Nations. The US Government, the Canadian Government, UN agencies (especially UNICEF) and many other organizations have supported development of these methods both in peacetime and during conflict.

Validation of cluster sampling methodologies as an appropriate alternative to simple random sampling is difficult in conflict situations. However, there have been multiple initiatives to validate this method in measuring public health outcomes such as mortality, demographics, and nutritional and disease status in stable circumstances. The Standardized Monitoring and Assessment of Relief and Transitions Initiative (SMART), a collaborative network through USAID seeking to standardize and evaluate methodologies among humanitarian organizations, has established cluster sampling as an acceptable method of sampling in conflict.[6] In stable situations, the USAID-supported Demographic and Health Surveys (DHS), which frequently use cluster sampling in stable countries to measure death rates, have obtained results that are almost identical to data measured through a national census.[7] The data derived from cluster sampling from DHS have been used to inform many health policy decisions by donor countries, and is one of the United States' major contributions to public health knowledge.

Appendix B

Collecting the Data

The mortality survey was a partnership between American and Iraqi academics with the field data collected by teams of male and female Iraqi physicians. To protect their safety, they are not identified in this report. Pollsters and others trying to collect information in Iraq have been threatened, mistreated, and even killed. After the 2004 Iraq survey of deaths, considerable time was spent designing the follow-on study that would have the maximum precision while minimizing risk to survey teams. This survey—the subject of this report—was completed without deaths or injuries to the survey teams.

The tasks of going out every day to many different locations in the country faced numerous perils. Due to administrative delays at the sponsors' universities, the survey did not begin until late spring, and the often-oppressive heat sometimes reached 55° Celsius (130° F.) in the shade.

Getting to the survey sites was difficult. U.S. checkpoints were particularly challenging, due to the rules of engagement, suspicion, and the doctors' mission. Iraqi checkpoints were less problematic, but militias and political parties, as well as criminals, all posed significant dangers. The militias, says the survey team leader, "are unpredictable, they are very smooth when they know that we are from 'their side.' Generally, they didn't threat our lives. They stopped us three times [in different regions]. In the first, they kept

us for a few hours for checking, in the second they took us to their commander, and the third time they did not allow us to go, so we turned back." The criminal gangs, he says, are "miscellaneous groups with different visions and goals. They may kill for any reason: money, revenge, and even for fun."

Once in the clusters, the teams faced suspicion initially, especially at the first house selected in the random process. Lengthy explanations of the purposes of the survey—and that it would help the Iraqi people—were necessary to allay fears. In some areas, people were more welcoming, and all but a very few of the entire sample were eventually very cooperative.

Returning from the clusters was every bit as perilous as going to them, and the teams were exposed to this danger constantly.

American and Iraqi team members met twice across the border in Jordan, first to plan the survey and later to analyze the findings. The Johns Hopkins members of the research team are in awe of the courage and persistence of our Iraqi colleagues.

Appendix C

Other Accounts of Mortality in Iraq

There are several other efforts to account for the dead as a result of the Iraq war.

Iraq Body Count (IBC) has been the most widely cited source for ongoing civilian casualties in Iraq since the 2003 invasion (www.ibc.org). This independent UK-based project accounts for deaths through comprehensive and thorough surveys of news media sources around the world. After independent review by at least two members of the project team, the maximum and minimum values are compiled onto a website that is updated daily. These figures are derived from a comprehensive survey of online media reports and eyewitness accounts.

The founders of IBC believe that each civilian death is a tragedy, and that it is a moral and humanitarian duty for each death to be recorded and compiled. The website cites a quote by General Tommy Franks stating that, "We don't do body counts" and thus, a primary motivation of this project is to take on the duty they believe is the responsibility of American and British citizens.

The IBC uses passive surveillance techniques, which depend upon available reports from the news media, in contrast to an active search for dead bodies. This brings about the possibility of gross underestimations. A significant number of deaths are not reported by the media, especially ones that occur in less populated or well known areas. In addition, the IBC methodology is conservative and excludes data that do not meet their set

standards. Marc Herold, an economist on the IBC team, believed that the count is likely too low because thousands of deaths may go unreported due to lack of media coverage.[8]

In the absence of active surveillance measures, passive surveillance is a useful and necessary tool to gather information, but it is important that the information is taken in the correct context. Unfortunately the careful and conservative numbers recorded by IBC are often taken out of context and cited as the true body count, thus lulling people into thinking that the human consequence of the war is far less than it really is. IBC has played a highly commendable role in making people aware of the upward spiral of deaths in Iraq.

Working for the **U.N. Development Program**, the highly regarded Norwegian researcher Jon Pederson led a survey that recorded between 18,000 and 29,000 violent deaths during the first year of occupation. The survey[9] was not focused on deaths, but asked about them over the course of lengthy interviews that focused on access to services. While this was more than twice the rate recorded by IBC at the time, Pederson expressed concern for the completeness and quality of the data in a newspaper interview last year.[10] The surveys reported in *The Lancet* were focused solely on recording deaths and count about two and a half times as many excess deaths from all causes over the same period.

The **U.S. Department of Defense**, using passive surveillance techniques, has begun to account for casualties in a broadly defined way, including numbers of attacks, without estimating totals but showing trends lines that are almost identical to IBC and *The Lancet* accounts.[11]

There is also a widely circulated UPI report of a count by '**Iraqiyun,** a humanitarian organization, totaling 128,000 dead over the first 27 months of the war.[12] The methods of this organization—reported to be direct accounts from relatives of those killed—could not be confirmed.

The **Ministry of Health** in Iraq has published some numbers from time to time, but these are generally considered to be unreliable. The registration of deaths in Iraq has been an organized process for many years. Death certificates have traditionally been obtained for the deaths of all adults and older children. Death certificates are required for insurance claims, compensation, payment of benefits, and for burial. Cemeteries do not take bodies for burial without certificates. If deaths occurred outside of hospital, the bodies would be transported to the general hospital for the certificate to be issued. If there were doubts about the cause of death, a post-mortem examination would be carried out before issuing a certificate. Copies of the death certificates would go to the national offices managing vital registration.

This process has continued through the current conflict, with death certificates being required for burial, and with information from certificates being duly recorded. However, the tabulation of data from registration of deaths in Iraq has suffered from the chaos of the current conflict. Beyond this, there is also a suspicion that records of death,

particularly related to violent deaths, is being manipulated and only partially being released for various political reasons.

Even with the death certificate system, only about one-third of deaths were captured by the government's surveillance system in the years before the current war, according to informed sources in Iraq. At a death rate of 5/1000/year, in a population of 24 million, the government should have reported 120,000 deaths annually. In 2002, the government documented less than 40,000 from all sources. The ministry's numbers are not likely to be more complete or accurate today.

The figure below shows trend lines from three different accounts—our mortality survey, Iraq Body count, and the Department of Defense report. Although the numbers we estimate through population-based methods are substantially greater than the numbers of deaths counted by the other two, the figure shows that over time the trends are almost identical. This is clear evidence that the three studies have measured the same events, and further reinforces the results of the population based data. This difference in numbers but similarity in trends is typical of the differences between active and passive public health surveillance seen in many conditions.

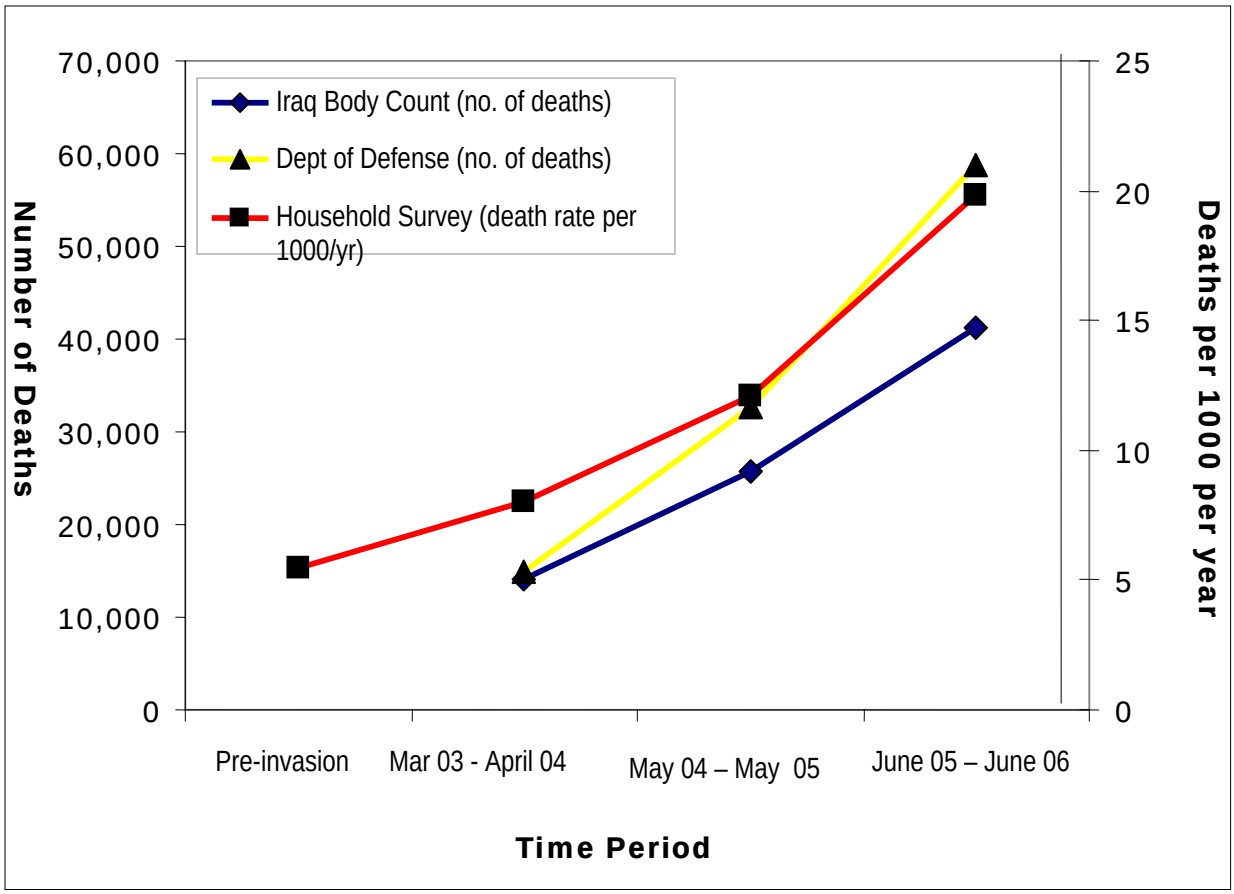

Figure 5. Trend lines of different mortality accounts. The reference axis for Iraq Body Count and the Department of Defense reports are on the left. For this study, the reference axis is on the right.

Appendix D

U.S. Military Casualties and Deaths and Their Long-Term Consequences

Since the beginning of the U.S. invasion of Iraq three and a half years ago, some 2700 American soldiers have been killed, and 20,000 injured. For every death there are just under 8 injuries reflecting military medicine's ability to save lives despite massive injuries. One study reported noted a 97% survival rate in combat casualties at a Naval Hospital Surgical ward in California.[13] The injury rate for soldiers in Iraq is 34 per 1000, with only 3.3 deaths/1000, the lowest in American military history.[14] By contrast, 1 in 3 US personnel with injuries died during World War II, and 1 in 4 in Vietnam.[15]

Because of the high survival from battle injuries, new physical and mental health challenges have arisen. Soldiers who would have never survived their injuries in the past are now living, in some cases, as triple amputees with brain damage.[16] Many injuries include second and third degree burns, broken bones and amputations, shrapnel wounds, brain injuries, paralysis, and blindness.[17] Extremities are especially vulnerable to home-made Iraqi ammunition and are unprotected by Kevlar vests. Two out of three wounds incurred by soldiers involve the extremities, and 436 soldiers more than 2% wounded in action are amputees.[18]

Less visible but just as debilitating is the mental and psychological trauma that many veterans face. A recent study in JAMA reported that 19.1% of returning Iraq war veterans suffer from psychiatric conditions, which most often include depression, anxiety, substance abuse, and Post Traumatic Stress Disorder (PTSD).[19] Other mental health concerns such as difficulty readjusting to civilian life and impairment in social functioning are also prevalent.

Among those surveyed in a 2004 report in the *New England Journal of Medicin*e article, it was reported that the rate of mental disturbance, especially PTSD, was directly proportional to the number of direct firefights encountered while deployed.[20] Strong predictors for psychiatric problems include being shot at or wounded, handling dead bodies, knowing someone who was killed, or killing enemy combatants. Killing of innocent bystanders, or having to witness such killings without the ability to intercede, is also associated with more intense psychiatric manifestations.[21] This is of significant concern due to the large numbers of civilians killed during this current conflict by both coalition forces and the insurgency. The risks of modern military combat will have long-term consequences for the survivors, families, the health care system and society.

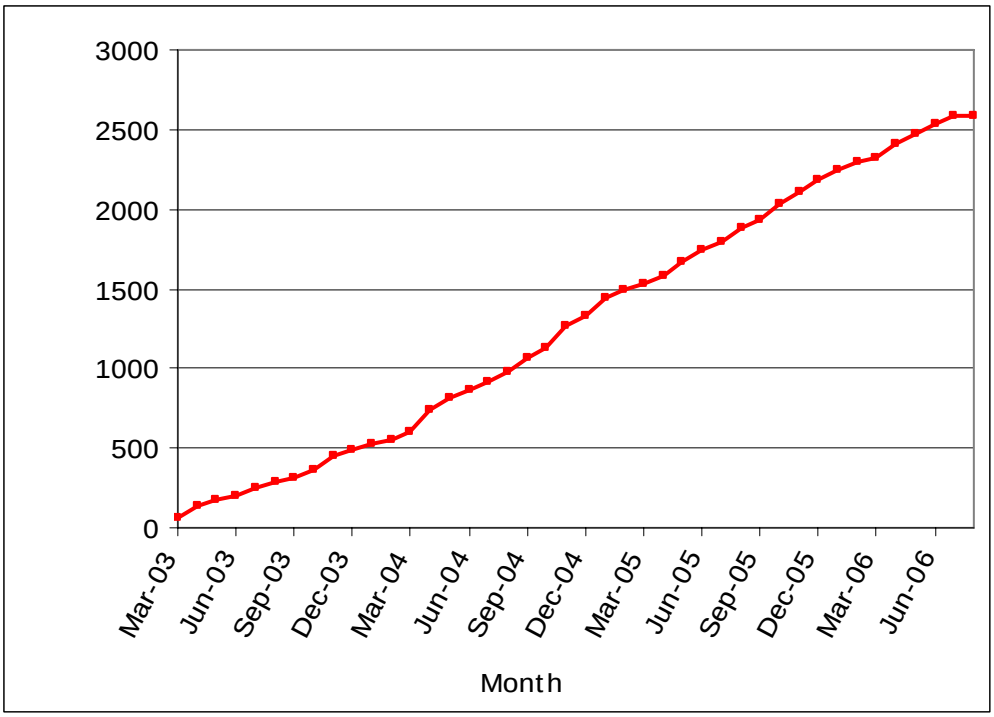

Figure 6. Cumulative U.S. Military Deaths since March 2003

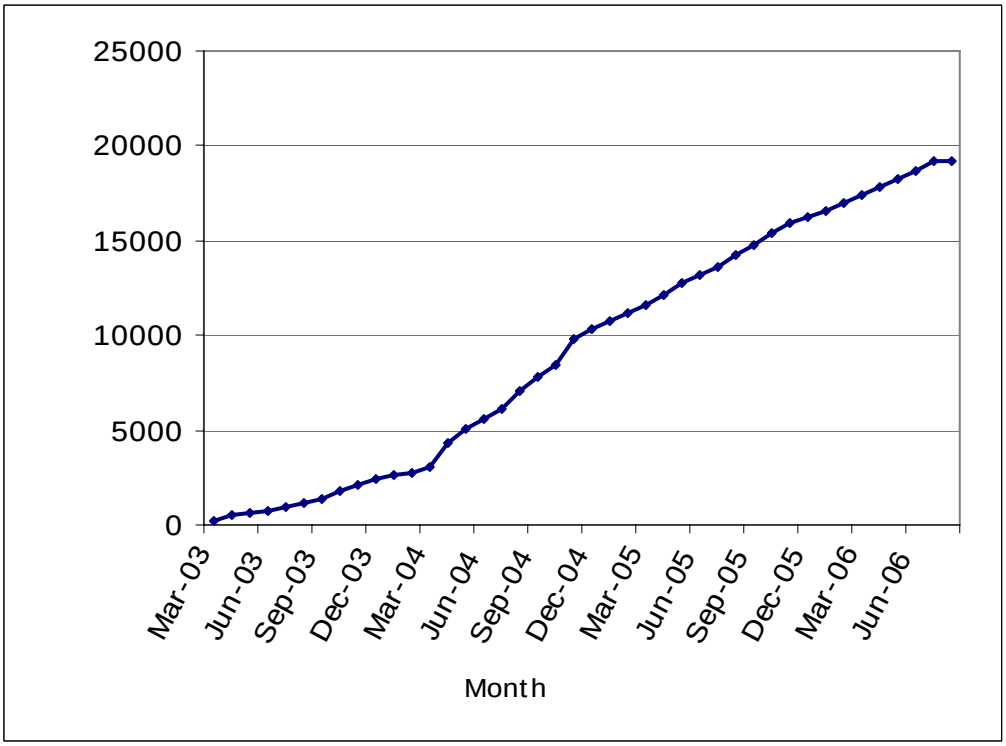

Figure 7. Cumulative U.S. Military Non-fatal Casualties since March 2003

Appendix E

Health in Iraq

The series of events beginning with the Iran-Iraq war through the Persian Gulf War and the period of trade sanctions all had major effects on the health of Iraqis. During this period, several health assessments were carried out, all pointing to a deteriorating health status among Iraqis. Many of these surveys concentrated on measurement of child health. As children are the most vulnerable members of a community, child health is a sensitive indicator of a community's overall health status. Surveys conducted between January and August, 1991, estimated that more than 46,900 children died as a consequence of war and sanctions, a three-fold increase from the period prior to the war.[22] Estimates in 1995 suggested that the effects of sanctions had increased the death toll among children.[23] Evident in the graph below, the UN Oil-for-Food program introduced in 1996 helped improve conditions considerably, but this program had many difficulties.[24]

On the eve of the 2003 Iraq war, the country's social fabric and its infrastructure had not recovered from the 1991 Gulf War, and the country was ill prepared to face new hardships. Food insecurity was still widespread. Over 40% of the population was dependent on government rations and public food supplies, and 15.4% of the population lacked adequate food.[25] In a 2003 survey by the World Food program, 17% of children were found to be underweight and 32% chronically malnourished or stunted.[26] Although children between one and five are particularly prone to these challenges, death due to malnutrition alone is rare. Malnutrition contributes to death from other conditions such as diarrhea, pneumonia and infections such as malaria or typhoid. Nutrition-related mortality is typically concentrated in children in their first year, which includes less than 5% of the Iraqi population. Because of this demographic pattern, food insecurity has relatively little effect on overall crude mortality compared with violent deaths, which affect all age groups.

Environmental hazards from chemical, biologic, and radioactive pollution during prior conflicts also pose a health risk. Oil spills and oil well fires during the Gulf war caused air pollution, soil contamination, heavy bombing, and vehicular movement caused further degradation of the environment. Water and sewerage capacity was never fully restored after the Gulf war bombing.

Of particular concern is the cluster of cancers and genetic defects now being reported from Basra. There has been some suggestion that this is associated with depleted uranium (DU) usage in anti-tank weapons by the US Army during the 1991 war. It has subsequently contaminated the ground water in Basra, on which 40% of Basra's population depends on for drinking water.[27]

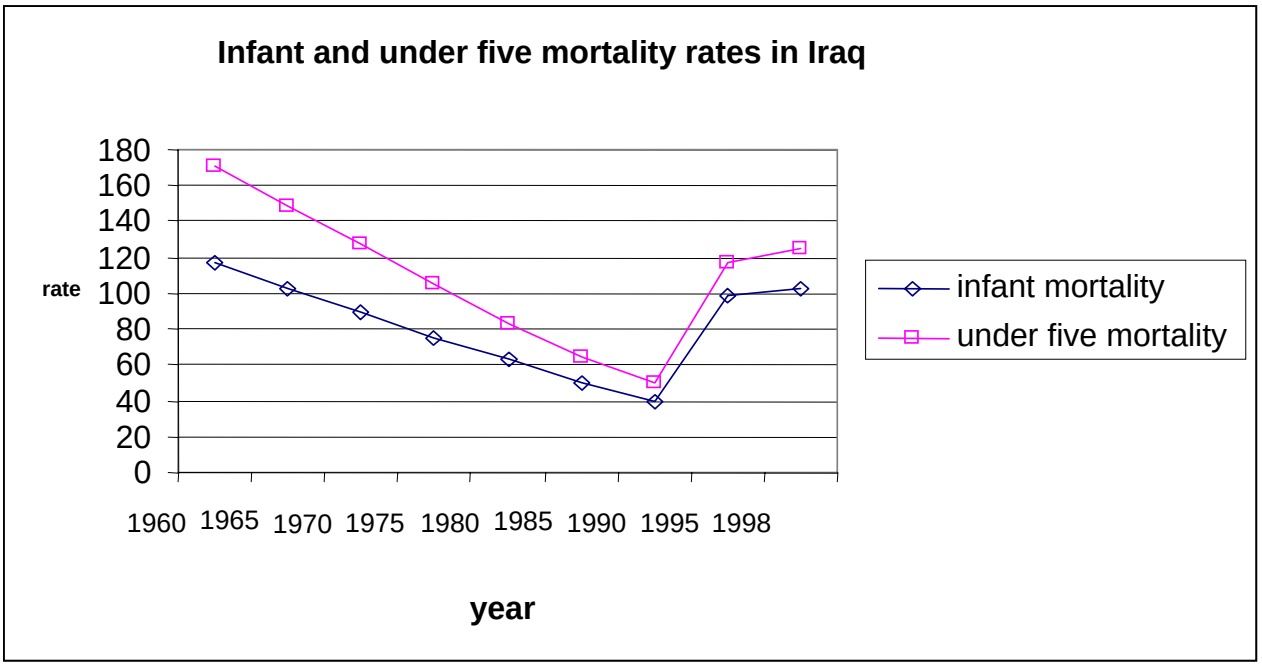

Figure 8. Infant (under 1 year) and child mortality (under 5 years**)** rates (per 1000/year) for Iraq. These declined steadily from the 1960s to reach quite low levels (USA=11) in 1990. The subsequent wars and sanctions have wiped out 20 years of progress in child health.[28]

The Iraqi health care system was once the finest in the region, but has been in decline for several decades. At this time it is no longer able to fully meet the health needs of its population. Fragmented services, poor standards of care, and inefficient referral systems are all in part due to pre-existing corruption, neglect, and shortages that arose during Saddam Hussein's rule and from sanctions. The medical system was also crippled by intellectual embargos that prevented import of medical textbooks or journals into the country during the 1990s. Lack of regulation and management placed a strain on the already dwindling health care resources.

Compounding this issue are frequent health leadership changes in a system that finds it hard to conduct the long-term planning needed to restore health services. Weak supporting structures such as health information systems, finance management and human resource management in health, coupled with a weak government makes it hard for over-extended leadership to act decisively.

The 2003 Iraq War resulted in further destruction of vital infrastructures for food, water, security, and sanitation. As the health system further deteriorates, doctors and other health care workers are leaving Iraq. It was recently estimated that of the 34,000 doctors present in 2003, 12,000 have now emigrated and 2000 have been murdered.[29],[30] Much of the health care now being provided in Iraq comes from the unregulated private sector. The coalition's efforts to rebuild health facilities have largely faltered.

Appendix F

How are so many Fatalities Possible?

Precisely how so many people have been killed in Iraq is a natural question. While the survey is not designed to answer such a question, apart from general attributions, a few observations may be helpful in grasping the scale of mortality during the war.[31]

- Much violence is occurring far from the view of journalists and widely cited mechanisms for counting the dead. Most Western reporters are based in Baghdad. Even there, large-scale events tend to gain attention, not the numerous but scattered incidences of violence that also occur.
- Baghdad has one-fifth of the nation's population, or about 5 million. Another 5 million live in the three Kurdish provinces in the north, which are relatively peaceful. Some 15 million live in the remainder of Iraq, and with the exception of Mosul, Kirkuk, and Basra, where there is some foreign press presence, Iraq is largely hidden from the view of Western journalism.[32] This mortality survey also suggests much more violence is occurring outside Baghdad.
- Those who read the Arabic press say that many incidences of violence are reported in such news media that are never reported in the English-language press.
- The large rise in sectarian violence, and the survey's findings regarding gunshots being the principal cause of death, correlate closely. They also reflect the reports of widespread assassinations. If, for example, there were three such killings daily in each of the 75 or so urban centers of Iraq[33] (outside of Baghdad and the Kurdish north), the total for the 40 months covered by this survey would equal more than 270,000; four such killings daily in those 75 cities would equal 360,000 in that period.
- The deaths attributed to actions by the coalition are a fraction of overall deaths, but are still significant. The U.S. air force and navy fly thousands of sorties annually as "close air support" of ground operations; how much ordnance is dropped is not reported. Thousands more helicopter gunship operations are flown. Between 200 million to one billion small-caliber rounds of ammunition or more have been expended in Iraq by the U.S. forces, and requirements for small and medium caliber ammunitions have risen steadily.[34] It cannot be said what the significance of these numbers are for mortality, but they do indicate a very large scale of operations. Reports of rules of engagement that are assertive also lend credence to the probability of many tens of thousands of deaths (including insurgents).[35]
- We know much more about U.S. and British operations than those of the irregular forces of Iraqis—especially the Sunni Arab insurgents and the Sunni and Shia militias. Here the difficulty of correlating deaths to operations is large. We do know that the numbers of weapons available to militias, criminals, and insurgents

are high. According to one report, more than 4 million small arms and light weapons "went missing" after the March 2003 invasion.[36]

- While not direct evidence of a scale of violence, the very large Iraqi majorities that blame the U.S. for the violence and support insurgent attacks on U.S. troops are both striking and indicative. The polls were conducted in Iraq on behalf of the State Department and Program on International Policy Attitudes at the University of Maryland.[37] Because the polls were large samples (1870 and 1150 respectively) and nationwide, they indicate just how widespread significant violence is in the country.

The war has presented many different challenges to those trying to understand its depth and range. It is unconventional in many respects—not least due to the dispersed and decentralized nature of the insurgents and militias, and the sectarian and ethnic animosities at work in addition to resistance to the occupation. Many aspects of the war are not reported or are reported inadequately. As a result, the overall picture we have of the course of the war has large gaps, and among those is the full extent and nature of violence. Nonetheless, there are plausible explanations for the large scale of violent deaths reported in the mortality survey.

Appendix G

Policy Implications of High Mortality

The large scale of mortality during the Iraq war has implications for how the war is being conducted by the United States. While not within the scope of the survey itself, it is worth raising a few points and questions relevant to political and military policies, strategy, and tactics.

- The overall scale of death from the beginning of the war, and the constant rise in mortality, clearly demonstrates that the United States and other legitimate armed forces are not adequately providing security, and indeed that everyday insecurity is increasing for most Iraqis.
- Large numbers of noncombatants are dying as a direct consequence of the violence.
- The health care system is showing signs of weakening.
- The sharp rise in the respondents' attribution of violent deaths to forces other than those of the U.S.-led coalition clearly tracks with reports of growing sectarian and ethnic violence, as does the steady rise in deaths by gunshots.
- The violence and insecurity throughout the period of the survey could be creating a feedback loop in which greater insecurity leads to greater violence. Insurgents may believe they are acting to protect their families and communities, for example. The American application of force may be a stimulant to more insurgency; recent doctrinal changes in the army reportedly recognize this.

- The overall scale of violence and the large representation of young men in the mortality figures may indicate a much larger insurgency and/or membership in militias than is widely estimated.
- The political arrangements, such as the constitution of Iraq, which may lead to divisions along ethnic and sectarian lines reinforce the distrust and fear that can spur more violence.
- The growth in violence and the primary use of guns in that deadly violence indicate a continuing rise in the numbers participating in violent activities.
- Quite a significant portion of violence is occurring outside Baghdad, even though the capital is the focal point of attention for U.S. security strategy.
- An apparently high prevalence of assassinations, and their growth, underscores how little is known about the militias and insurgencies, and what strategies or tactics could be put into place to reduce this violence.
- The high mortality for young men raises questions about social viability and future reconstruction efforts for Sunni Arab regions in particular.
- Recent opinion polls in Iraq, published by the Washington Post (Sept. 26-27), indicate very large majorities of Iraqis believe that the application of U.S. military force is responsible for the widespread violence in their country, and believe that withdrawing U.S. troops will reduce violence.
- It cannot be predicted, based on the mortality figures and trends, how a rapid withdrawal of U.S. forces would affect security for Iraqis.

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[31] This Appendix and Appendix G were written by John Tirman.
[32] Dexter Filkins of the *New York Times*, one of the longest serving American reporters during the war, says that "98% of Iraq, and even most of Baghdad, has now become 'off-limits' for Western journalists." *Editor & Publisher* (Sept. 16, 2006); www.editorandpublisher.com/eandp/news/article_display.jsp?vnu_content_id=1003122985 (accessed 4 Oct 2006).
[33] www.world-gazetteer.com/wg.php?x=&men=gcis&lng=en&dat=32&geo=-105&srt=npan&col=ahq&pt=c&va=x, (accessed 22 Sept 2006).
[34] In 2006, according to Central Command and Air Force Link web sites, these sorties were averaging about 1200 or more monthly.
[35] On rules of engagement, several journalistic accounts have taken this up, including Thomas E. Ricks, *Fiasco: The American Military Adventure in Iraq* (Penguin, 2006), interalia; see also Juan Cole's report on this, which includes a link to the official documents, www.juancole.com/2005/08/us-military-rules-of-engagement-and.html (accessed 24 Sept 2006).
[36] A. Khakee and H. Wulf, "Following the Trail: Production, Arsenals, and Transfers of Small Arms *HGF Review*, Spring 2005, 26-30.
[37] Both polls were reported in the *Washington Post*, Sept. 26-27, and are available online. The PIPA results are available on line at http://www.pipa.org/.