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Burden of Intentional Injury in Baghdad During the Iraq War

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Abstract

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Introduction

The impact of injuries on the worldwide burden of morbidity and mortality is gaining significant recognition. However, there is no agreed upon methodology for the calculation of the burden of injury on conflict stricken populations.

Methods

This analysis applied a variation of the Global Burden of Disease (GBD) methodology to calculate incidence Disability Adjusted Life Years (DALYs) due to intentional injury for the city of Baghdad from 2003-2014. The basis for these calculations was data obtained on a household survey of Baghdad by Lafta et al. in 2014.

Results

Our analysis arrived at an estimation of 5.60 million DALYs incurred due to intentional injuries occurring between 2003 and 2014 in the city of Baghdad. The burden of mortality in Baghdad from intentional injury was 4.99 million Years of Life Lost (YLLs). The estimated burden of injury morbidity for the city was 606,000 Years Lived with Disability (YLDs).

Conclusion

The GBD methodology can be applied to conflict specific data to generate an estimate of the burden of intentional injury. The use of this methodology should be expanded to additional conflicts to further validate our results and to better describe conflicts worldwide.

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Chapter 1. INTRODUCTION

1.1 CONTEXT OF CONFLICT RESEARCH

The impact of injuries on the worldwide burden of morbidity and mortality is gaining significant recognition. When compared to mechanisms such as road injuries, however, much less is known about the effects of conflicts on the worldwide burden of injury and even less is known about the burden of injury within specific regions of conflict.^{1,2} Armed conflict has always presented a challenge for epidemiological surveillance and public health efforts, but changes in armed conflict since the end of the Cold War have worsened rather than improved these challenges.^{3,4} Interstate conflicts between two uniformed military forces has become a rarity with most armed conflicts occurring as civil wars and insurgencies within nations, with a concurrent increase in the involvement of non-state actors in warfare.⁴ It is possible that this changing nature of conflict has also brought on an increase in attacks against non-combatants. Access to areas of conflict is always a challenge, but doing so in the presence of a force hoping to conceal war crimes, can be near impossible.⁴ Additionally, the most recent conflicts in Syria and Iraq have seen an erosion of the humanitarian space in violation of the protections afforded to medical personnel by the 1st and 4th Geneva Conventions.⁵ This devaluing of the humanitarian space has compounded preexisting challenges with absent or neglected data systems, social breakdown, forced migration, and reporting bias due to fear of retribution.⁴

Conduction of public health surveillance and research in a conflict zone is a highly challenging task. The reality of the field is often that public health researchers focus primarily on infectious and non-communicable diseases and political scientists primarily focus on the

decisions by national leaders to engage in conflict, with neither group able to consistently link policy decisions to the human suffering in the field.⁶ Due in part to the challenges associated with conducting rigorous surveillance of populations, information for policy makers often comes from reporters or individuals on the ground, documenting singular acts or instances with smartphones and cameras, with increasing internet access making these accounts instantly available to the world.^{4,6}

1.2 SUMMARY OF RESEARCH IN THE IRAQ WAR

Fortunately, many individuals have risen to the challenge of studying the effects of recent conflicts. The effects of the Operation Iraqi Freedom (OIF), the United States (U.S.) led invasion of Iraq in 2003 has been among the most analyzed conflicts of all time, providing not only a more complete picture of the situation within the country but an opportunity to refine the necessary methods for studying future conflicts.

Extensive work has been done regarding the effects of combat injuries on U.S. service men and women and mental effects of combat and on families at home, using databases kept by the U.S. Department of Defense.⁷⁻⁹ However, the majority of studies focus on members of coalition forces. The limited studies that focus on non-combatants are often focused on the effects of care on subsets of the population, such as women and children.^{10,11} While these works have led to great improvements in the delivery of trauma care, they do not provide a complete picture of the effects of conflict on local populations.

Several major works have sought to describe the effects of the Iraq war on the local population. Roberts et al. conducted a cluster sample survey of Iraq in order to compare mortality in the 14.6 months leading up to the invasion of Iraq and the 17.8 months following the

invasion. They identified a 2.5-fold increase in the risk of death following the invasion, or a 1.5-fold increase if a cluster in Fallujah that accounted for two thirds of all deaths was excluded.¹²

Due to the short time frame of the Roberts study, this work was updated by Burnham et al. in 2006. This follow up study documented a decreased proportion of deaths due to coalition forces compared to the initial study and a rise in the numbers of deaths related to car bombs, although gunshot wounds (GSWs) remained the primary cause of conflict related deaths.¹³ This follow up study clearly demonstrates the importance of ongoing surveillance of the effects of conflict. The authors were able to document and capture the true scale of the high-profile changes in the war, such as the increase in high-profile car bombings, while demonstrating the underlying reality that GSWs remained the largest driver of conflict related injury.

The Iraq Family Health Survey provided a separate effort to document the increase in mortality in Iraq during the invasion. This work captured deaths and injuries occurring from 2002 – 2006, utilizing a survey of over 9000 households. The team calculated that an excess of 151,000 deaths had occurred due to the invasion, including adjustments for underreporting among survey participants.¹⁴

The United Nations High Commission for Refugees (UNHCR) estimates that 2.2 million people had fled Iraq by 2007.¹⁵ Adjustment of war mortality estimates for the migrating populations seen in Iraq was addressed by Hagopian et al. This study added to the existing body of this work by utilizing a two-stage cluster sampling method of 2,000 households throughout Iraq.³ Fluctuating population levels during conflict can present a persistent issue in establishing a denominator for population based calculations, particularly when studies are conducted at the country wide level. Dr. Hagopian and her team reviewed demographic data and secondary

sources to estimate the number of deaths missed by not surveying households who had fled the country and added this number to the total death count captured by the household survey.

Lafta et al. have provided the most recent update to the growing body of work related to the conflict in Iraq. This study was more narrowly focused on the city of Baghdad compared to the other works mentioned here. Migration was not adjusted for, however, the survey covered all injuries sustained from 2003-2014.¹

1.3 PURPOSE

These works have focused primarily on death counts, with some capture of non-fatal injuries and resulting disability, particularly by Dr. Lafta's team. Non-fatal injuries, however, represent an important metric for the effects of conflict on a population and can have long lasting effects. Amputations due to landmines are the most commonly noted manifestation. As a result of conflict, individuals never return to the state of full health enjoyed prior to the injury. Indeed in 2015, conflict related morbidity accounted for nearly one-third as much morbidity burden as road injuries, (27.45 DALYs per 100,000 vs. 80.8 DALYs per 100,000). While road traffic injuries are recognized as the major driver of the worldwide burden of injury, it is becoming increasingly apparent that conflict is taking a significant toll on human health as well.^{2,16}

The next step in building on the important work of the teams mentioned above is a more detailed description of the burden of injury that encompasses both the effects of non-fatal injuries and the stresses placed on a society by conflict related deaths. In order to accomplish this, we have combined the work of Lafta et al. with a variation of the methodological approaches for measuring burden of injury and disease of the Global Burden of Disease (GBD) project to provide a description of the burden of intentional injury in Baghdad from 2003 - 2014.

Chapter 2. METHODS

2.1 DATA COLLECTION

Data collection regarding death, injury, and disability in Baghdad from 2003-2014 was accomplished using a survey instrument developed by international and Iraqi team members and based on World Health Organization (WHO) community injury survey guidelines, injury surveys in Ghana, and the Surgeons OverSeas Assessment of Surgical Need.¹⁷⁻²⁰ The study was designed and conducted by Lafta et al.¹ The results of this work and specific details on its design have been previously published and the data made publicly available, however, the specifics are crucial to the understanding of this work and therefore are summarized here as well.²¹ An injury consisted of, “any intentional or unintentional physical harm that required medical care, whether received or not, and with or without intervention, and which resulted in loss or reduction in normal activities for a period of time.”¹ A disability was defined as any limitation to normal activities stemming from an injury, and blasts and explosions were counted as intentional if it was felt that deliberate harm was intended. The survey instrument specifically requested information regarding the year an injury occurred and stressed that the surveyors were only requesting information on injuries occurring from 2003-2014.

The survey was conducted as a randomized cluster household survey with a household defined as, “a group of individuals living together in a dwelling with a separate outer door and kitchen.” Information regarding household composition, injured household members and consent for interview were obtained from the senior adult or head of household following verbal consent. Interviews were conducted between May 8th and June 1st, 2014.

Clusters for the survey were assigned based on the population data for the 14 administrative units in Baghdad, using probability proportional to estimated size (PPES) techniques (Lafta).

This study did not adjust for population migration. Thirty clusters were selected to cover the city of Baghdad (Figure 2.1).

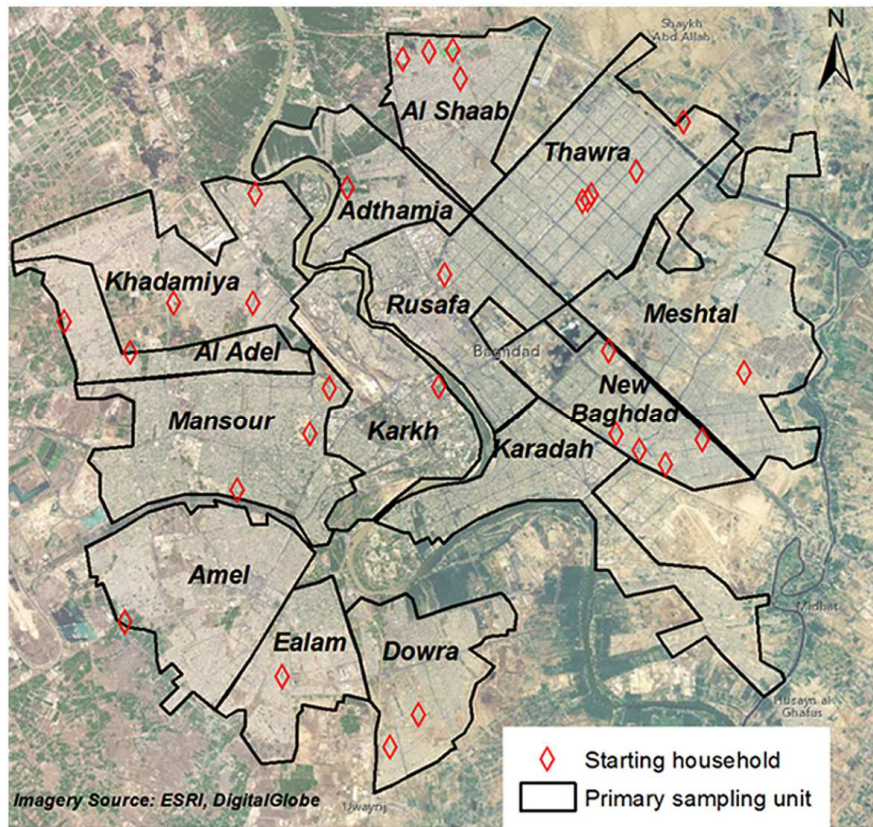


Figure 2.1. Sample distribution of clusters for data collection within Baghdad's administrative units.¹

2.2 ANALYSIS AND DATA MANIPULATION

All analyses, data manipulation, and cleaning were conducted using the R programming language.²² This analysis involved utilization of the dplyr, tidyr, readr, ggplot2, and lazy eval packages.²³⁻²⁷

2.2.1 *Defining the Scope of the Analysis*

This analysis focused on intentional injuries occurring in Baghdad from 2003-2014. An intentional injury was defined as either being caused by criminal activity or related to war. With criminal acts defined as, “events caused during robbery, assassinations, kidnapping, hijacking, or assaults likely carried out for personal reasons with the individual being specifically targeted or a bystander to a specifically targeted person.” War or conflict related injuries were defined as being, “injured in the course of wider indiscriminate intentional violence whether by militias or organized military and whether for sectarian or in the course of organized military operations.”¹

2.3 BURDEN OF INTENTIONAL INJURY METHODOLOGY

Quantification of the burden of disease from intentional injuries was accomplished via calculation of disability adjusted life years (DALYs), and the application of the GBD methodology to these specific data. This methodology is constantly updated by the Institute for Health Metrics and Evaluation (IHME). This work utilized methods, values, and techniques described as part of the 2013 GBD study.² DALYs were calculated by summing the Years of Life Lost (YLL) and Years Lived with Disability (YLD) from those patients who were reported to have intentional injury as described above. The primary outcome measure for this work was incidence YLLs and incidence YLDs. YLDs were calculated by multiplying the duration of disability by the disability weights (DW) as defined for the GBD 2013 study.²⁸ YLLs were calculated by multiplying deaths by the remaining life expectancy at age of death based on a standard life table selected as the norm for estimating premature mortality for the GBD.^{29,30}

2.3.1 *Disability Weights*

The calculation of DWs for the 2013 GBD study is described in detail by Salomon et al. This analysis utilized three specific sets of DWs: short term DWs, long term DWs for patients with treated injuries, and long term DWs for patients with untreated injuries. Estimation and quantification of the effects of injuries has inherent uncertainty. This uncertainty stems from, but is not limited to, uncertainty surrounding collection of data from a sample of the population and uncertainty in effects of a given health state on individuals (i.e. no two individuals are likely to be affected in exactly the same way or to the same degree by a given injury).³¹⁻³³ The 2013 DWs utilized here were estimated as a mean value from 0-1 (0 corresponding to a state of complete health, and 1 corresponding to death). Following this, a bootstrapping approach was used to generate 1000 replicate samples regarding the mean value.³¹ The result of this process is the presence of 1000 values that can be applied for each of the 52 nature of injury categories for the long-term weights and 40 nature of injury categories for the short term weights. A representative example of the distribution of these DWs around a mean can be seen in Figure 2.2. The specific application of these DWs to these data can be found later in this manuscript.

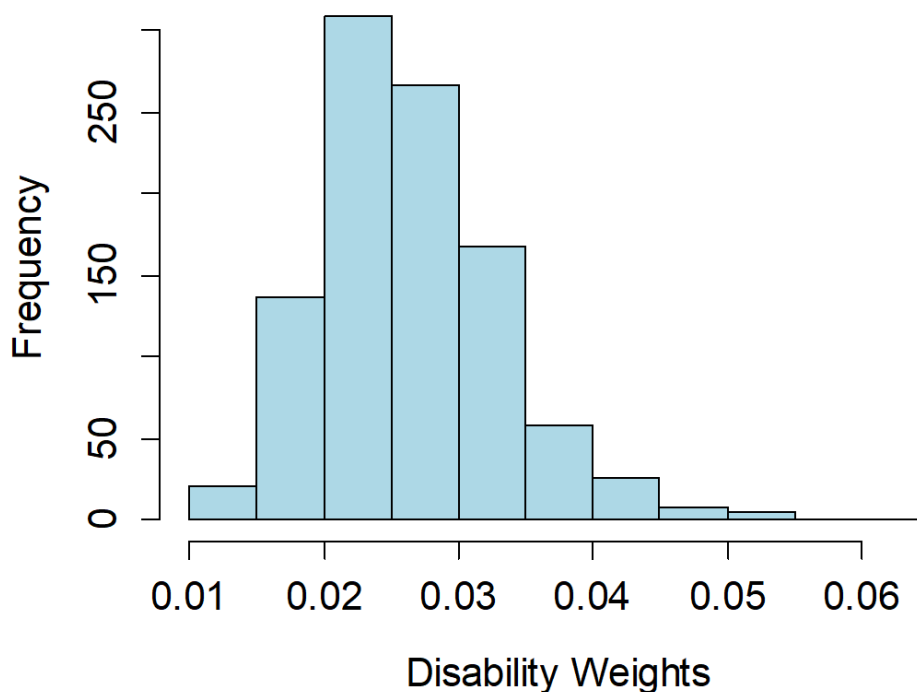


Figure 2.2. Histogram demonstrating DWs for a single disability code (N17: fracture of foot bones without ankle fracture), demonstrating the skewed distribution of the 1000 draws.

2.3.2 *Life Expectancy*

As stated previously, the GBD standard life table was the primary metric for life expectancy used in this analysis.^{29,34} Estimation of life expectancy is integral to the calculation of burden of injury DALYs, however, estimates of life expectancy differ by country and, particularly in low and middle-income countries, change over time. Life expectancy or choice of the proper life table becomes then a value choice. The reference standard life table is meant to represent the aspiration for healthy life span for all individuals. This table was developed by identifying the lowest observed death rate for any age group in countries with more than 5 million people. This results in a life expectancy of 86.5 years at birth.³⁴

For the purposes of comparison and examination of the methods for calculating the burden of disease in the context of conflict DALYs were also calculated using the life expectancy for Iraq in 2014. This life expectancy table was based on World Bank estimates. The most recent year with available data was 2014 and for this year the life expectancy at birth for Iraq was 69.4 years.³⁵ Sample and Baghdad Total DALYs were calculated using Iraqi life expectancy in order to examine the sensitivity of the results in truly capturing the burden of disease for a war-torn society. Methods did not differ from those used for calculations using the GBD life table except to alter the life expectancy within the calculations. Of note, one individual sustained an injury with continuing disability at age 70. This individual was excluded from the portion of the analysis utilizing Iraqi life expectancy, due to having already surpassed the available figure for Iraqi life expectancy.

The choice of life expectancy that should be used for GBD calculations has been heavily discussed during the evolution of the GBD methodology. This debate culminated in the 2011 *Critical Ethical Choices for DALYs meeting*.³⁶ The choice of which life expectancy to use for definitive calculations is of utmost importance as YLLs have a large impact on DALY calculations, an impact likely to increase in areas of conflict. The philosophical or value based argument for using a global rather than country-specific life expectancy can be summarized as: if country-specific life expectancies were used, the result would be that a life lost in Iraq is less “valuable” than a life lost in Japan for an individual of the same age, as the Japanese population typically has a higher life expectancy than the Iraqi population. This egalitarian principle has been one of the pillars of the DALY calculation from early on, but was codified for the GBD 2010.^{34,37} There are two additional benefits to the use of a global life table. First, the use of such a table allows for ease of comparisons across different countries. Second, in many countries life

expectancy is increasing, which can lead to seemingly rapid increases in the burden of disease from a specific cause, when the actual prevalence or effect of that disease on a population has not changed or has even decreased.³⁷

2.4 DESIGNATION OF INJURY PATTERNS

The calculation of DALYs upon a specific dataset varies slightly between individuals and requires alignment of the GBD methodology with the methods used in the collection of the dataset. YLDs in particular require the use of different inputs and differing DWs for each injury pattern. In order to allow for burden of injury calculations based on the Baghdad injury data, six separate injury patterns were identified.

2.4.1 *Assessing Duration of Disability*

The survey instrument contained the questions, “Did the injured person suffer any disability that affects the ability to do normal activities for some days?” A follow up question asked to specify the duration of disability expressed in years, months, weeks, days, or offered a box to check if the disability is continuing. Based on the responses to this question, we created a new variable expressing this output in fractions of years for the purposes of performing DALY calculations.²¹

2.4.2 *Deaths*

Calculation of YLLs is, from a computational perspective, the most straightforward portion of this analysis. For individuals who died between 2003 and 2014, the age at time of

death was recorded. Using the recorded age at death, two estimates of YLLs were calculated for each person: YLLs based on Iraqi life expectancy and YLLs based on global life expectancy. YLLs were calculated if it was recorded that a person died due to intentional injury, an outcome specifically recorded on data collection. There were 3 individuals whose death was either deemed unrelated to the injury, or as possibly related to the injury. These individuals were not included in the YLL calculation, but were instead included in YLD calculations for the documented duration of their disability. YLLs have an outsized effect on total DALY calculations, therefore only YLLs were calculated for individuals who definitively deemed as having died due to their injury.

2.4.2 *Short Term Injury*

In the most recent iteration of the GBD study, an injury was deemed to be a “short term” injury if that injury persisted for less than one year.² This definition was replicated in this analysis. Specific DWs for short term injury were used in the calculation of YLDs due to short term injury.²⁸ DALYs caused by short term injury were calculated by multiplying the short term injury disability weight for each patient by the duration of disability in fractions of years.

2.4.3 *Long Term Injury with Recovery, Treated and Untreated*

Individuals with injuries resulting in disability lasting one year or longer with subsequent recovery by the time of the data collection formed the second distinct injury pattern. Data were collected on duration and nature of disability, specifically regarding whether patients had recovered or remained disabled. In burden of injury calculations, a distinction is made between individuals that have received health care following their injury and individuals who have not. All injured individuals within the survey were classified as having received care at a hospital,

health clinic, at place of employment, by a nurse, or as having received no care. All levels of the healthcare system were considered equal for this analysis. The burden of injury was therefore calculated by multiplying the duration of the disability by the appropriately matched untreated DW code if they were designated as having received “No Care.” DALY calculations for individuals receiving care at any additional level of healthcare utilized the matched DWs from the treated DW set.

2.4.4 *Long Term Injury without Recovery, Treated and Untreated*

Individuals who remained disabled at the time of data collection do not have a known endpoint to their disability and were therefore classified as having permanent disability. These individuals were also classified according to whether they received care for their injury. Treated and untreated DWs were applied to these individuals as well, based on identical criteria to those individuals who recovered from their injury. Given that no numerical disabled duration was available, the assumption was made that these individuals would not have a shorter life expectancy due to their injuries and would not recover. DALY calculations were therefore made by multiplying treated and untreated DWs by the theoretical maximum life expectancy corresponding to the person’s age at the time they were injured.

Similar to YLLs, the Iraqi life expectancy was used for a separate calculation in order to generate YLDs and total DALYs using each of the two life expectancies.

2.5 MAPPING OF DISABILITY CODES

The individual health data as collected by Lafta et al. has very specific information on the cause of an injury as well as the effect of the injury on the life of an individual. The process of calculating the burden of injury requires that the *cause of injury*, i.e. a gunshot wound to the leg,

be correlated with the *nature of injury*, i.e. a lower leg fracture.^{33,38} Therefore, calculation of the burden of injury required that each patient's injury be assigned, or "mapped," to one of the 52 treated and untreated long-term disability health states or 40 short term health states associated with DWs.

2.5.1 *Mapping Process*

Individual scenarios were created for each DW code. They encompassed the variables for type of intentional injury (i.e. gunshot Wound, blast/explosion), transportation following injury, nature of injury (i.e. amputation of unilateral limb, burn with <20% skin affected, Fracture), primary body part damaged, secondary body part damaged and other sequelae (i.e. Emotional changes that prevented usual activities) and paired with both a primary and secondary code for a health state available in the DWs. These patterns were then used to match each patient in the study with the injury code corresponding to the most applicable health state and that state's associated DWs. Of note, these codes are the same across each of the 3 sets of DWs, with the exception of some codes which are not applicable to short term injuries excluded from the short term injury DWs. Therefore, the determination of which set of DWs should be applied to each patient was made after the mapping process. Information on medical co-morbidities was not captured in data collection and therefore were not included in these burden of intentional injury calculations.

2.5.2 *Injury Hierarchy and Secondary Injury Codes*

This analysis was restricted to physical injuries. While we are aware of the profound psychological consequences of living in a war zone, these consequences were not taken into account. Recent editions of the GBD have utilized an injury hierarchy in order to ensure that

effects of various health states on quality of life are used correctly, in other words to ensure that the most burdensome health states within a population are calculated and not excluded because of other minor health states.^{2,34} Initially the data was evaluated using primary and secondary injury codes with the goal of establishing an injury hierarchy.

However, in creating the cause of injury categories based on information specific to this data set. The presence of anxiety, fear, or emotional changes preventing usual activities or employment was present in 38% of subjects of the study. Correspondingly, these diagnoses were present in 43% of the nature of injury mapping scenarios. The use of these diagnoses in an injury specific calculation was deemed inappropriate due to the fact that the injuries could only be reasonably interpreted as moderate, severe, or mild traumatic brain injury (TBI) in the context of our injury specific calculations. The result of this was a preponderance of TBI diagnoses as the secondary injury code, even when no evidence of head injury was documented in data collection, and the cause of injury could not account for head trauma (i.e. Gunshot wound to the foot). As mapping of the primary codes were appropriate based on cause of injury, and anatomic location of the injury, it was decided to utilize the primary codes for the calculation. The exclusion of these codes could result in an underestimation due to not including the significant burden of injury from TBI. However, the application of these secondary codes, for a person with only the fear and anxiety inherent to being exposed to conflict, could result in an overestimation, given the high DW attributed to severe TBI (0.637). Therefore, as there was no way to determine the state of injuries surrounding these secondary injury codes, the analysis was completed utilizing only the primary injury code mapped to each patient.

The inherent challenge of diagnosing TBI on household survey in conflict zones is a limitation of this data, and there is likely a role for refining the identification and estimation of burden of injury from these patients in the future.

2.6 PULL CALCULATIONS

The calculations involved in burden of injury calculations for this robust data set present ample opportunity for error. In an effort to mitigate the effects of computational or data manipulation errors via early detection, a “pull” calculation technique was employed. The pull system is adapted from the Lean Manufacturing techniques pioneered by the Toyota © corporation and has become popular with regard to software development.³⁹ We applied this approach by identifying the “demand,” or the types of cases that required a specific calculation in order to arrive at a DALY count for that individual. These initial calculations were done by hand in order to identify the “correct” answer for each individual. The design behind the necessary statistical code could then be “pulled” toward an eventual product that would achieve these “correct” answers. Each of the four cases was sampled at random from all cases with an identical injury pattern, and are summarized in Table 2.1.

Table 2.1. **Pull Calculations.** The four types of injury patterns chosen at random for hand calculation. Pull DALYs represents the hand calculated column, and calculated DALYs represents calculation for these specific cases following full data set calculation, and utilizing a different DW weight draw from the same injury code.

Injury Pattern	Age at Injury	Injured Part	Cause of Injury	Disability Length	Care	DW Code	DW Language	DW Draw	Calculated DALYs	Pull DALYs
Death	24	Head	GSW	NA	NA	NA	NA	NA	62.96	62.96
Long-term Disability without Recovery	29	Lower leg	GSW	Disability is continuing	Hospital	N48	Multiple fractures	0.04605	2.67	2.70
Long-term Disability with Recovery	44	Lower leg	Other	For years	Nurse /Other	N17	Fracture of foot bones except ankle	0.02455	0.049	0.048
Short term Disability	25	Lower leg	GSW	For weeks	Hospital	N48	Multiple fractures	0.1662	0.00639	0.0067

2.7 USE OF INCIDENCE AND PREVALENCE YLDS

Readers familiar with the GBD methodology will note that the calculations described here are based on the use of incidence, rather than prevalence YLDs. For the 2010 iteration of the GBD, the methodology was changed from using incidence based YLDs to prevalence based YLDs.² YLLs remained incidence based, creating what some have referred to as a hybrid approach.⁴⁰ The difference in these approaches and the specific type used here warrant specific discussion as the results are not directly comparable.

The pull calculation for long term injury without recovery provides an opportunity to lay out the difference between the two calculations. The calculations described above result in incidence YLDs. In these calculations, all subsequent YLDS for the lifetime of the patient are ascribed to the intentional injury that resulted in the disability. It is important to keep in mind when thinking of YLDs in this manner that, for a patient who sustains an injury with lifelong disability in 2006, all of the injury burden for the *remainder of the individual's life*, is ascribed to

the year of 2006. If we were to calculate prevalence DALYs for the individual with long term injury without recovery described featured in pull calculations, we would simply count the individual as contributing the selected DW, in this case 0.0465 YLDs, each year for the remainder of this individual's life. The number of YLDs for this individual would likely be the same over the course of his lifespan, provided the patient lived too close to the life expectancy used in the calculation. However, the calculation for the year 2006, or the duration of this study (2003-2014) would be drastically different (0.0465 vs. 2.7 YLDs).

The calculations were performed using both incidence and prevalence based YLDs, indeed application of this methodology to future conflicts should likely continue to use both approaches. Prevalence YLDs will allow for long term comparison of country specific burden of injury across the globe. However, for the purposes of studying the effect of a conflict on the population, we would posit that incidence YLDs may provide a better short term picture of the effects of a specific conflict. Incidence based YLDs are individuated based on the onset of a specific event or pathology.⁴⁰ Due to the fact that we are studying the effects of an event, in this case the war that began with onset of OIF in 2003, our outcomes are already individuated to a specific set of circumstances, and therefore incidence based YLDs should be used in order to better capture the long-term effects associated with these events on the population.

2.8 BOOTSTRAPPING

Burden of disease estimates have an inherent degree of uncertainty that arises from data collection, adjustments to the data, and statistical models. We would argue that the very nature of quantifying the burden of an individual's health state is also subject to some degree of uncertainty as an injury of both the same cause and nature may "burden" two individual patients to different degrees.

Therefore, in accordance with GBD methods, uncertainty was propagated through the data set by repeating each calculation 1000 times, with each drawing from the 1000 draw distributions around each individual DW code.

Following data cleaning and removal of individual subjects with incomplete data capture, there were 225 individual patients in the survey who sustained an intentional injury between 2003 and 2014. One hundred eighty-one patients had adequate information to allow for matching to DWs. These 181 individuals were resampled with replacement to create 1000 separate samples; a randomly selected set of matched DWs from the appropriate DW table was mapped to each sample. Summary statistics were then calculated off of these 1000 iterations.

2.9 EXTRAPOLATING ESTIMATES TO THE POPULATION OF BAGHDAD

Population estimates for total DALYs were calculated using the mean of the total DALYs for the sample due to intentional injury from the bootstrapping function. This number was divided by the number of persons in the sample to get mean DALYs per person in the entire study population and subsequently multiplied by the population of Baghdad at the time of the survey. This was repeated for the lower and upper ends of the uncertainty interval. Cause and sex specific DALY counts were generated in a similar fashion, again after applying bootstrapping methods to data stratified by cause of injury or sex.

Chapter 3. RESULTS

The initial sample contained 5,148 patients of whom 225 (4.4%) suffered intentional injuries between 2003 and 2014. Forty-four of these patients were excluded due to missing data

required for the analysis, leaving a final sample of 181 patients who were either injured or died due to intentional injury.

3.1 SAMPLE ESTIMATES

From 2003 – 2014 we estimate that there were 4150 DALYs (95% UI 3480 - 4830) lost due to intentional injury in the data sample. Subjects who suffered intentional injuries had a mean of 23.2 DALYs lost per injury (95% UI 19.5 – 26.9). This correlates to 0.81 (95% UI 0.68 – 0.94) DALYs lost per person in the data sample. YLLs accounted for 3700 YLLs (95% UI 3410 – 3960) of the burden of intentional injury in the study sample. The mean number of YLLs attributable to each death was 51.4 (95% UI 47.9 – 54.6). We estimate a total number of 450 YLDs (95% UI 292 – 626) in the entire sample population from intentional injuries. The mean number YLDs attributable to each injury was 4.28 (95% UI 2.81 – 5.95).

3.2 ESTIMATES OF BURDEN OF INJURY FOR THE CITY OF BAGHDAD

The population of Baghdad at the time of data collection was 6,943,579 persons.¹ This figure can be used to estimate a total burden of injury for intentional injury for the city of Baghdad as the initial survey clusters were assigned using PPES techniques. Our analysis arrived at an estimation of 5.60 million DALYs (95% UI 4.70 million - 6.51 million), incurred due to intentional injuries occurring between 2003 and 2014 in the city of Baghdad. The burden of mortality in Baghdad from intentional injury was 4.99 million YLLs (95% UI 4.60 million – 5.35 million). The estimated burden of injury morbidity for the city was 606,000 YLDs (95% UI 394,000 – 844,000) if calculated with incidence YLDs. Mortality among men accounted for a large proportion of the total DALY estimation with 4.53 million YLLs (95% UI 4.22 million – 4.84 million) attributable to deaths among men. Cumulative men’s morbidity incurred during

2003 – 2014 was estimated to be 441,000 YLDs (95% UI 282,000 – 637,000). Women made up only 16.2% of those individuals suffering intentional injuries, but were not spared the effects of conflict, the citywide estimates for morbidity and mortality among women were 180,000 YLDs (95% UI 106,000 - 276,000) and 450,000 YLLs (384,000 – 518,000). The year by year estimates by DALYs, YLLs, and YLDs for the city of Baghdad are summarized in Figure 3.1. The year by year estimates of YLDs calculated by both incidence and prevalence techniques are summarized in Figure 3.2.

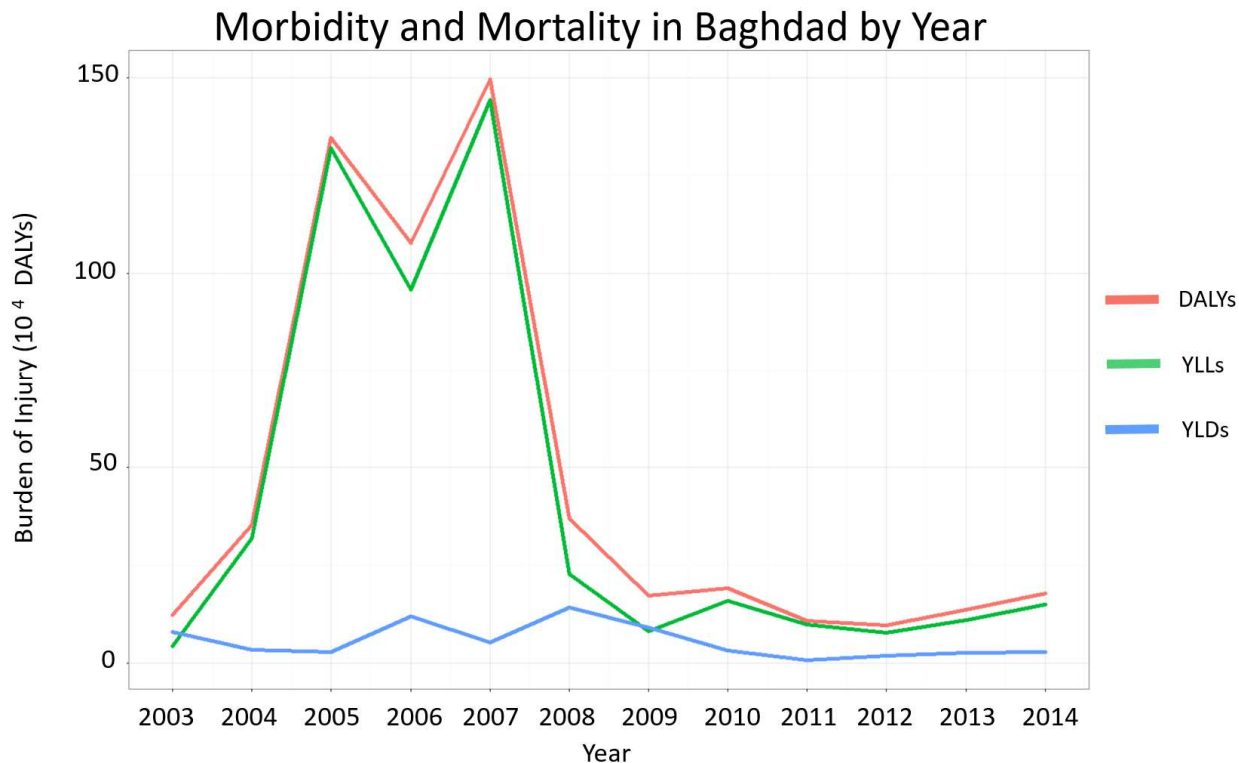


Figure 3.1. Time trends for 2003 – 2014 for estimated total DALYs, total YLLs, total YLDs for the city of Baghdad.

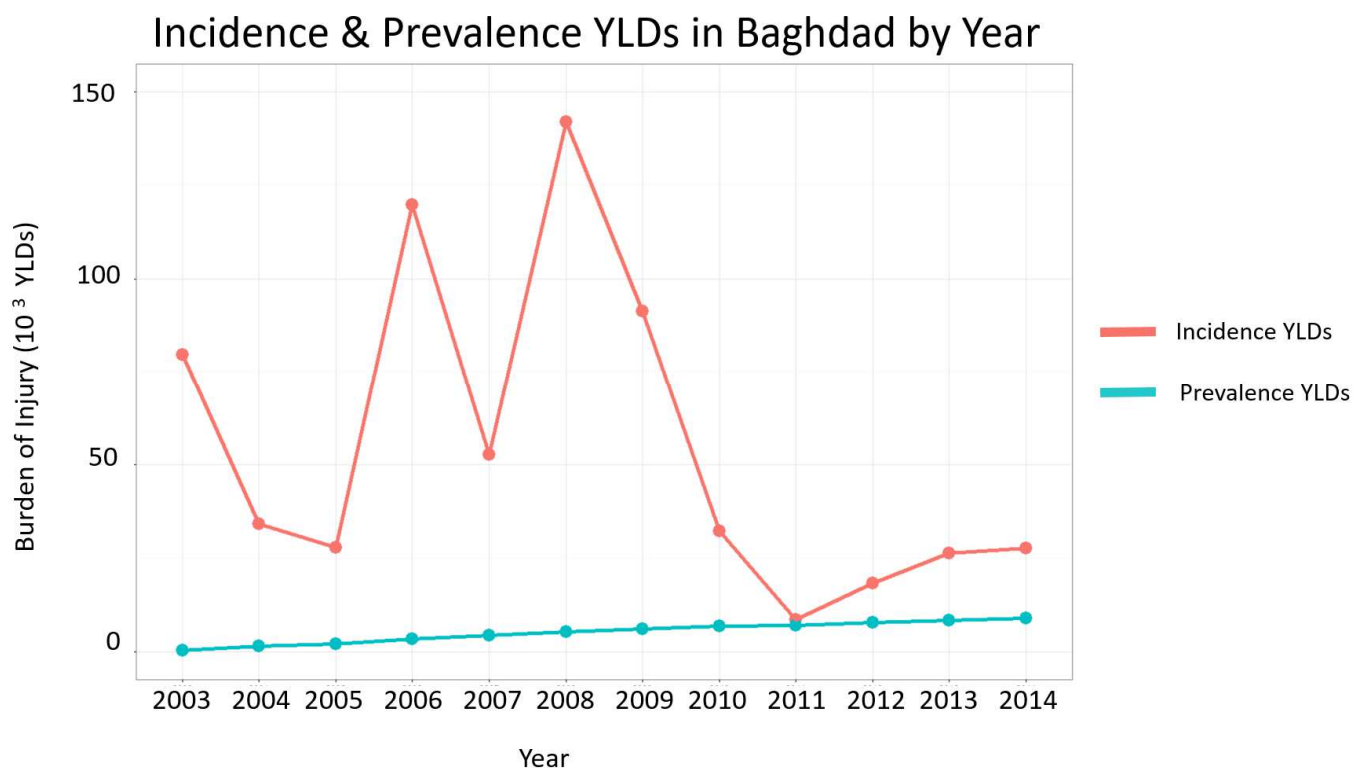


Figure 3.2. Plot of incidence YLDs and prevalence YLDs by year for the city of Baghdad.

3.2.1 *Cause Specific Burden of Injury*

There were 7 causes of intentional injury, identified Table 3.2. Only one case of torture was documented, although people may have been unwilling to share this with the survey team. The single case of torture died due to injuries sustained and accounted for 58.01 DALYs. Gunshot wounds made up the majority (55.8%) of all DALYs. Ten percent of the sample

DALYs were attributable to blasts and explosions, and shelling and unspecified mechanisms accounted for 16% and 14.3% respectively.

Table 3.2. Table containing proportion of DALYs by cause, total DALYs by cause for the sample, estimated DALYs for the population of Baghdad, with 95% UI.

Cause	Proportion of DALYs	Sample Total DALYs	Population Estimate DALYs	95% Uncertainty Interval (DALYs)
Gunshots	56.0%	2,340	3,155,000	2,582,000 -- 3,706,000
Shelling	15.7 %	623	840,000	502,000 -- 1,218,000
Other	14.3%	569	767,000	441,000 -- 1,094,000
Blasts & Explosions	9.66%	430	580,000	295,000 -- 889,000
Stabbing	1.48%	77.3	104,000	83,250 -- 166,000
Burns	1.69%	58.4	78,800	12.8 -- 191,000

3.2.2 Use of Iraqi Life Expectancy

Some authors have posited that cohort specific life expectancies should be used for DALY calculation in order to avoid overestimation of the burden of disease.⁴¹ As stated, above this is as much a philosophical and value based choice as a statistical one, however in order to better inform this debate we have performed the DALY calculation with the use of Iraqi life expectancy as well as the GBD Life table life expectancy. The total DALYs for the survey sample based on Iraqi life expectancy were 2710 DALYs (95% UI 2210 – 3190). The total DALYs for Baghdad from 2003-2014 using Iraqi life expectancy were 3.65 million (95% UI 2.99 million – 4.31 million).

3.3 USE OF INCIDENCE RATHER THAN PREVALENCE YLDS

In order to better elucidate the effects of the use of incidence vs. prevalence DALYs on the calculation of burden of intentional injury incurred over the course of the study time frame, the YLD calculation was repeated with prevalence DALYs. As stated previously, we estimate a total of 449.47 incidence YLDs due to intentional injury incurred between 2003 and 2014. These account for YLDs that will not technically be “experienced” by the injured individual for many years, but are related to the effects of the Iraq war on the sample population.

After modifying the bootstrap calculation to produce prevalence YLDs, we would estimate that over the same period the study population would experience 49.7 YLDs (95% UI 30.9 – 72.4). The large difference in the two totals can largely be attributed to the fact that with incidence YLDs we are estimating YLDs far beyond the year 2014, and with prevalence YLDs we are confining our estimate to the burden of injury suffered between 2003 and 2014.

Chapter 4. DISCUSSION

While the DALY count of 5.60 million DALYs is a large number, the unique methodology of this work makes this estimate difficult to compare to other conflict based burden of injury estimates, both due to an increased reliance on modeling for those estimates and due to the fact that these numbers are generated on a countrywide versus citywide level. Additionally, while the GBD must rely on aggregation of different data sources in order to generate burden of injury and disease estimates at the country level, our work focused on a single robust data set specific to the city of Baghdad.^{31,42} In essence, our data provides a great deal more granularity from which to draw conclusions regarding the effect of the conflict on the population, although it would be much more difficult to generalize to populations outside of the city of Baghdad.

The most important outcome of this work is to establish a methodology for application of the GBD methodology to specific sets of conflict data. This can both create a standardized way of calculating the burden of injury from conflicts, as well as inform future data collection efforts to ensure that surveys contain the key variables needed to perform these calculations. In other words, we believe that until more studies along the lines of this work are performed, it is the methods rather than the results that are our best contribution to the field.

4.1 DATA COLLECTION FOR FUTURE STUDIES AND FOLLOW-UP

The Lafta et al. survey was well suited for this analysis because it captured the key data points needed in order to perform this study. The minimum points of information needed to perform this type of calculation are: some method of determining the effects of the injury (i.e. broken leg, amputation, or TBI), the duration of disability resulting from the injury, whether the person died due to the injury, and the age at which the injury or death occurred. Information regarding the cause of injury (i.e. gunshot wound, explosion) can also be helpful with regard to providing useful information for the process of “mapping” or assigning injury codes and for gaining a better understanding of the type of conflict being studied. One area that might improve the understanding of the drivers of the burden of injury would be improved collection of information regarding the responsible parties. The responsible party was unknown in 60% of cases in this data set. However, there may be some recall bias at work. Individuals may, understandably, be reticent to place blame on any armed group due to fear of reprisal. So, while, additional information regarding responsible parties may be useful to obtain in additional studies, the respondent’s desire to avoid antagonizing armed parties must be respected.

4.2 LIMITATIONS

We did not attempt to adjust for changes in population over the course of the study, and citywide estimates were not weighted by administrative unit. The original sample was a representative sample of the city of Baghdad so no adjustments were required following analysis. Additionally, we were unable to correct for recall bias among the survey participants. It is possible that some households were selective in what they reported to the survey teams regarding either the duration or circumstances of deaths or injuries within their households. Individuals were also asked to recall up to 12 years in the past regarding the circumstances surrounding the injury or death of a family member. Mock et al. demonstrated that for many injuries there was a significant rate of decline in recall after one month.⁴³ However, the same study showed that for injuries resulting in more than 30 days of disability, there was minimal decline in recall. It should be noted that this study was done in Ghana, and therefore not in an area of active conflict. However, under the methodology used here, YLLs have the largest effect on DALY totals. Therefore, patient recall due to the length of time between injury and survey is likely negligible. Any injuries missed are likely to be of the short term injury pattern that does not exert a large degree of influence on the study totals. Recall bias may, however, have an impact on the YLD-specific portions of our estimates. This can be visualized in the YLD line in Figure 3.1. While we would not expect the YLD line to approach the YLL line, it is reasonable to expect that the lines should be correlated to some degree. we have no reason to believe that an increase in violence that results in an increase in mortality would not also result in a simultaneous increase in morbidity. Therefore, there may be some degree of recall bias at play with regard to injuries not resulting in death. This recall bias could manifest as either forgetting about smaller injuries all together or possibly misattributing the actual date of injury for non-fatal injuries.

4.1 CHOICE OF LIFE EXPECTANCY

The choice of life expectancy for this analysis was a debated topic. It is possible to argue that applying a global life expectancy to those individuals living amidst conflict is an unrealistic expectation and does not reflect the reality of the situation on the ground. Modern conflicts, however, tend to occur in low and middle-income countries that may have relatively low life expectancies, compared to high income countries. These life expectancies are often less static and therefore may change significantly over the course of the conflict, particularly protracted conflicts such as in Iraq. This could create a moving target for those individuals with ongoing disability. The effect would be especially pronounced during very active phases of the conflict.

As evidenced by the trends in total DALYs in Figure 3.1, the burden of intentional injury was not linear, but instead has significant spikes around 2005 and 2007, several years after the initiation of OIF, possibly due to rapidly increasing sectarian violence in 2005, and the commensurate increase in troop levels culminating in 2007.⁴⁴ This could lead to a country specific life expectancy that is impossible to accurately predict from one year to the next. Additionally, the use of a global life expectancy allows for the comparison of the effects of conflicts across different wars and populations, making it more useful from a policy and planning perspective. The single case that was removed from the analysis with Iraqi life expectancy is illustrative of the problems with country specific life expectancies. This individual, having already outlived the most recent life expectancy for Iraq, was given a value of 0 in the subset analysis using Iraqi life expectancy. However, under a global life expectancy this individual would have contributed between 0.49 and 2.07 YLDs to the total burden of injury,

depending on the DW draw used. This could be corrected by the development of life tables for each individual country studied.

4.2 CHOICE OF INCIDENCE DALYS

For this analysis, the decision was made to utilize incidence rather than prevalence YLDs. As YLLs were estimated on an incidence based approach as well, this resulted in an incidence only approach to DALY calculation. This differs from the GBD method, which is a hybrid approach using incidence YLLs and prevalence YLDS, although the approach is often referred to as a prevalence approach due to the fact that YLLs are nearly always estimated on an incidence basis.⁴⁰ Were we to use prevalence YLDs as one of the primary measures of the burden of conflict on a population, it may be difficult to fully appreciate the effects of conflict on the population for many years. The generation of estimates that include the effects of an injury over the rest of an individual's life (i.e. incidence YLDs) may lead to improved responses to the future needs of conflict populations or possibly the cessation of practices that cause disproportionate harm to non-combatants.

4.3 CONCLUSION

It has been stated that accurate assessments of the risks of conflict and magnitude of the consequences raise the possibility of preventing the health consequences of conflict.⁶ In addition, the ability to provide more than body counts when assessing the severity of a conflict may provide better grounds from which to prevent conflicts from occurring.

Additionally, a better understanding of the true effects of different phases of a conflict may help not only medical public health experts to better serve the needs of the noncombatant

population, but also aid combatant commanders in strategic planning. The U.S. Army and Marine Corps Counterinsurgency Field Manual clearly states, “whatever else is done, the focus must remain on gaining and maintaining the support of the population.”⁴⁵ Public health efforts to better understand the effects of war on the local populations would allow for the improved pursuit of that mission.

The findings from this study provide the next step in a better understanding of the war in Iraq on the local population. These methods will be updated along with changes in the constantly evolving GBD methodology. Most importantly, these methods should be applied to other conflicts in order to expand the understanding of the effects of war on the citizens of war-torn nations.

Chapter 5. REFERENCES

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