

Methods and tools to evaluate mortality in conflicts

:

Critical review, case-studies and
applications

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Abbreviations

BHP	Bandim Health Project
CDC	Centers for Disease Control
CI	confidence interval
CMR	crude mortality rate
CE-DAT	Complex Emergency Database
CRED	Centre for Research on the Epidemiology of Disasters
DRC	Democratic Republic of Congo
HIS	health information system
IDP	internally displace person
IFHS	Iraq Family Health Survey
MSE	multiple systems estimation
MSF	Médecins Sans Frontières
NGO	non-governmental organisation
RMS	retrospective mortality survey
SMART	Standardized Monitoring and Assessment of Relief and Transitions
TRC	Sierra Leonean Truth and Reconciliation Commission
U5MR	under 5 mortality rate
UN	United Nations
UNDP	United Nations Development Programme
UNICEF	United Nations International Children's Fund
UNHCR	United Nations High Commission for Refugees
WHO	World Health Organization

Executive summary

1. Critical review of methods for quantification of excess mortality

The changing profile of modern conflict has led to an increased burden on civilian populations. The shift in the nature of conflict necessitates more accurate definitions and methods for the estimation for conflict-related mortality, namely the “excess mortality” which exceeds the expected mortality found in a country during normal situations. First, some definitions:

1. *Crude Mortality Rate (CMR)* expresses the total number of deaths which occurred in a population of known size which is at risk of death in a certain period of time.
2. *Under 5 Mortality Rate (U5MR)* is the age-specific mortality rate which expresses the number of deaths which have occurred among a population of children under five years of age of known size which is at risk of death in a certain period of time.

The numerical difference between a “crisis CMR” and the “baseline CMR” is termed the “*excess mortality*”. This value represents the mortality that is specifically attributable to a crisis and is therefore used for estimating the magnitude of the emergency and monitoring the humanitarian response.

Excess mortality is traditionally broken down according to presence of violent causes into two types of death: direct deaths and indirect deaths. *Direct deaths* are defined as those that are caused by war-related injuries and attacks. Accidents are sometimes grouped under violent/direct deaths as they specify a grey area where deaths may have indeed been due to violence. *Indirect deaths* include the deaths which are caused by the worsening of social, economic and health conditions in the conflict-affected region. Indirect deaths are inherently difficult to quantify and attribute to conflict-related causes.

There are three common techniques for quantifying indirect deaths. A *retrospective mortality survey (RMS)* is an assessment tool used to derive mortality rates in situations where the prospective collection of mortality data is not possible. They are most commonly conducted by NGOs and field agencies at a sub-national level for operational purposes. The *prospective surveillance* of mortality through health information systems (HIS) is a superior method of documenting and verifying mortality in stable environments. The *analysis of multiple data sources* attempts to reconstruct mortality profiles using sources of mortality statistics collected before, during and after the conflict.

Executive summary

2. Estimation using multiple sources

South Sudan: Direct mortality was estimated from data on killings in all documents found on the internet, through fellow researchers, and in libraries. Using this technique, the total number of direct deaths between 1999-2005 was put at 1,381. For estimating total excess mortality, we plot the CMR and U5MR of all surveys in the CE-DAT database against the years studied, and investigate the trend in mortality. Next, we apply mortality rates to regions, arriving at an as differentiated as can be estimate. Applying these mortality rates to estimated population sizes, we arrive at a total excess mortality of 427,337. Indirect mortality is next defined as the difference between total excess mortality and direct mortality. Of this excess mortality, the percentage of direct deaths is 0.3%.

Sierra Leone: We estimate excess mortality and direct mortality in Sierra Leone between 1991-2002. We estimate indirect mortality as the difference between excess mortality and direct mortality. To estimate direct mortality, we use the distribution of direct deaths as reported by the TRC. We assume that all killings in the period under investigation followed this trend. Lastly, we set the level of this trend curve such that it matches the available data on direct killings between 1996-1999. This leads to a total estimated direct mortality of 26,704. For excess mortality, we estimate a hypothetical population size in 2002, had the population grown uninterrupted in a non-conflict situation. We extrapolate the population size in Sierra Leone in 1990, that equalled 4,087,000, using a conservative growth rate of 1.96. Next we estimate actual population size in 2002. Backcalculating from the 2004 census, and correcting for migration, we estimate the population size by early 2002 at approximately 4,517,330. This means that total mortality is approximately $4,979,321 - 4,517,330 = 461,990$. Roughly speaking 94% of excess mortality was indirect, attributable to other causes than proximal violence.

Iraq: Three nationwide mortality surveys conducted in 2004 and 2006, reported values for both violent and non-violent mortality. Based on the data obtained from the mortality surveys, one can estimate a tentative range of indirect deaths due to the conflict, by calculating the difference between the post-invasion and the pre-invasion rates. Based on data from 3 mortality surveys, the death toll in Iraq due to non-violent causes can be estimated to go from a reduction of 250,000 deaths to an increase of almost 450,000 with a point estimate of around 150,000.

Executive Summary

3. Using mortality ratios as an indicator of conflict violence

Indirect deaths among civilian populations are modeled using data from the Complex Emergency Database, from the year 2000 to present, and two key assumptions regarding the distribution of deaths. The first assumption is that in armed conflicts under five year-old children will be considerably less likely to die of violent (ergo direct) causes than adults. The second assumption is that for various reasons under five year-old children are assumed to be the first (e.g. disproportionate) victims of indirect causes of death.

The model is constructed on the basis of two key indicators from NGO and intergovernmental field surveys on mortality in conflict settings. These indicators are the Crude Mortality/Death Rate (CMR) and Under 5 Mortality/Death Rate (U5MR). Both are relative rates and subject to limitations inherent to the surveys. Increases in CMR and U5MR above expected baseline rates are used to construct three scenarios for modeling conflict deaths:

-
1. *increase in U5MR/increase in CMR > 1* : the main causes of death are likely to be indirect
 2. *increase in U5MR/increase in CMR < 1* and *increased U5MR* : both direct and indirect death occur
 3. *increase in U5MR/increase in CMR < 1* and *not increased U5MR* : the main causes of death are likely to be direct

Conflict mortality is then graphically modeled for five countries (Afghanistan, Angola, DR Congo, Sierra Leone, and Sudan) using best available assumptions for expected mortality baselines. Each country is modeled using provincial averages. Only provinces with an increase in CMR over the baseline are modeled and the strength of these averages relies on the number and representativeness of data points.

The results of the analysis are graphically illustrated and show that in virtually all cases the burden of mortality falls within scenarios one and two. In some cases, the burden of mortality seems heavily shifted towards indirect deaths.

1. Critical review of methods for quantification of excess mortality

1.1. Introduction

The changing profile of modern conflict has led to an increased burden on civilian populations. Since the end of the Cold War, the number of interstate conflicts has decreased. Yet the overwhelming majority of conflicts (95%) are now fought within national borders in very poor countries, often reflecting ethnic and political disputes and trapping civilians in insecure situations (Human Security Centre, 2005). This drop in interstate conflict may reflect the increasing commitment of the UN and the international community to conflict resolution, although structural factors such as poverty, low economic growth and lack of state capacity continue to increase the risk of armed conflict (Human Security Centre, 2006).

Most conflicts tend to be either low-intensity civil wars that involve poorly trained armies who target civilians or asymmetric wars that pit a well-equipped army against a weak opponent (Human Security Centre, 2005). Both scenarios incur violent (“direct”) and non violent (“indirect”) deaths among civilians. In contrast to World War I, where the majority of deaths were suffered by soldiers engaged on the battle field, now formal and informal armies act on both soldiers and civilians and have widespread consequences on the health and economic infrastructures of whole countries. While violent death among civilians may be the only evidence of armed conflict, disease and malnutrition have prevailed as the main causes of death among civilians in most major conflicts of the past two decades (Guha-Sapir and Degomme, 2005).

The shift in the nature of conflict necessitates more accurate methods for the estimation of mortality, namely the “excess mortality” which exceeds the expected mortality found during a normal situation. This first section of this report provides an overview of the epidemiologic and demographic methods available for estimating excess mortality, the current knowledge gaps and scientific challenges¹. In the second section, case studies of the estimation of indirect deaths in South Sudan, Sierra Leone and Iraq are presented. In the third section, a novel approach, which uses mortality survey data from the Complex Emergency Database (CE-DAT) to assess the distribution of indirect and direct deaths within a conflict-affected country, is described.

¹ This overview is written primarily for an audience untrained in epidemiology in order to present the context for conflict-related mortality measurement. As civilians are the population of concern for excess mortality estimation, we do not address military deaths (“battle deaths”) here.

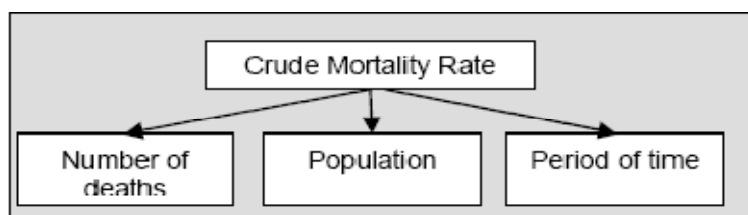
1.2. Definitions of mortality indicators and types of mortality

1.2.1. Mortality indicators

Epidemiologists use mortality rates to assess the state of emergency and the severity of the human impact of conflict on civilian populations affected by complex humanitarian emergencies (Toole and Waldman, 1997; Guha-Sapir et al., 2005; Checchi and Roberts, 2005). The use of standardized mortality calculations makes possible valid comparisons between populations and the ability to judge the severity of a crisis. Two different mortality rates² are commonly used by humanitarian agencies such as WHO, UNHCR, CDC, MSF and Sphere:

- **Crude Mortality Rate (CMR)** expresses the total number of deaths which occurred in a population of known size which is at risk of death in a certain period of time. It is hence composed of three essential elements: the number of deaths, the population size and the specific period of time (see Figure 1).

Figure 1. Elements of a crude mortality rate calculation



Source: Guha-Sapir, Degomme and Altare (2007)

- **Under 5 Mortality Rate (U5MR)** is an age-specific mortality rate which expresses the number of deaths which have occurred among a population of children under five years of age of known size which is at risk of death in a certain period of time. While CMR makes no distinction by age, U5MR includes only children below 59 months of age (~5 years of age).

² The terms “death rate” and “mortality rate” are used in different ways by demographers and epidemiologists. Under 5 Mortality Rate is defined by demographers as the probability of dying before the age of 5. Its unit is “per 1,000 live births”. Epidemiologists define U5MR as the number of deaths of children under 5 years of age per unit of time divided by the under-5 population. Its unit is typically “per 10,000 persons per day”. This last indicator is known by demographers as the Under 5 Death Rate (U5DR). In this document, U5MR refers to the epidemiological definition of the indicator.

- CMR and U5MR are calculated using the formulas below:

$$\text{CMR} = (\text{number of deaths}) / (\text{midterm population at risk} \times \text{duration of time period}) \times 10,000 \text{ persons}$$

$$\text{U5MR} = (\text{number of deaths of U5s}) / (\text{midterm population of U5s at risk} \times \text{duration of time period}) \times 10,000 \text{ persons}$$

The use of a **midterm population** takes into consideration the changes in the population composition over the period of time measured. This is achieved by adding one half of the individuals who leave the population (due to deaths and emigration) and subtracting one half of the individuals who enter the population (due to births and immigration) to the population at the end of the period (Checchi and Roberts, 2005). The calculation implies that the rate of change is constant over the entire recall period, a condition which does not always hold. To avoid this problem, an alternate method of estimating the population at-risk using “person-time” is used (ibid). This method considers the exact period during which each person was at risk of dying and in so doing, each individual contributes to the denominator for the time s/he has spent in the population at-risk. Although the person-time method is more precise, both methods provide similar results.

CMR can be expressed using **different units** which are useful for various purposes. For instance, demographers and researchers for the UN’s annual statistical yearbooks often use *deaths per 1,000 persons per year* as annual rates are most useful in this context. In conflicts and other complex emergencies, *deaths per 10,000 persons per day* is the standard unit since it is most practical for monitoring a humanitarian situation over a short period of time. Despite the various usages, CMR can be easily inter-converted using basic equations (see Figure 2).

Figure 2. Inter-conversion of CMR.

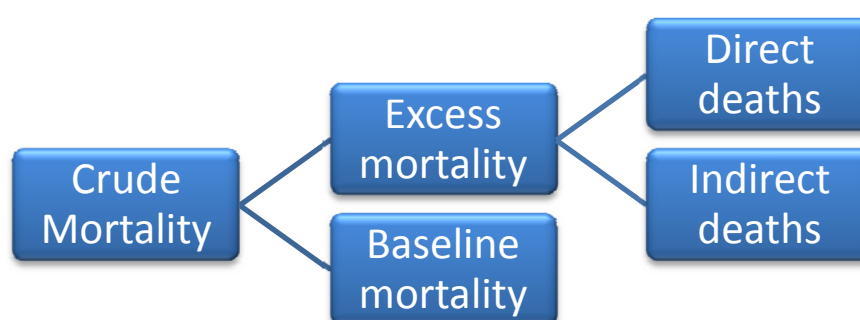
$$\begin{aligned} 1 \text{ death}/10,000/\text{day} &= 3,04 \text{ deaths}/1,000/\text{month} \\ &= 36,5 \text{ deaths}/1,000/\text{year} \end{aligned}$$

Source: Guha-Sapir, Degomme and Altare (2007)

1.3. Excess mortality, direct deaths and indirect deaths

The CMR is only informative when compared against either the national or regional **baseline CMR** (the “expected” mortality in a country in a normal situation) or the designated alert level thresholds which signify a crisis situation³. The numerical difference between the “crisis CMR” and the “baseline CMR” is termed the “**excess mortality**”. This value represents the mortality which is attributable to the crisis and is therefore used for estimating the magnitude of the emergency and monitoring the humanitarian response. Excess mortality is traditionally broken down according to presence of violent causes into two types of death: direct deaths and indirect deaths (see Figure 3).

Figure 3. Typology of conflict mortality.



Direct deaths are defined as those that are caused by war-related injuries and attacks (such as those inflicted by a bullet, bomb, mine, machete or assault) (SMART, 2006). Accidents are sometimes grouped under direct deaths as they specify a grey area where deaths may have indeed been due to violence. **Indirect deaths** are defined as deaths which are caused by the worsening of social, economic and health conditions in the conflict-affected area. They can result from a variety of different factors including, but not limited to, inability to access health care, damage to health systems and public health infrastructure, changes in human behavior which increase the emergence of diseases and outbreaks, malnutrition, unsanitary living conditions, food insecurity and loss of livelihood and agricultural land (Guha-Sapir and van Panhuis, 2002; Gayer et al., 2007).

With so many potential determinants, indirect deaths are difficult to quantify and verify. However, the assessment of the magnitude of indirect deaths, in addition to direct deaths, is essential for understanding the true human impact of a crisis. Though a relatively nascent exercise, it is conceivable that the quantification of indirect deaths may contribute to the process of holding legally accountable those political and military leaders who are ultimately responsible for these deaths (Human Security Centre, 2004; Thoms

³ The use of alert thresholds are further described elsewhere (Checchi and Roberts, 2005, p. 7).

and Rons, 2007). The estimation of indirect deaths has been neglected by human rights organizations who have traditionally aimed to document the number of direct deaths due to violence (Human Security Centre, 2004). More generally, collaborations between epidemiologists, statisticians and human rights organizations have been encouraged in order to address the larger picture of the indirect costs of conflict (Thoms and Ron, 2007; Asher, Banks and Scheuren, 2008).

From a public health perspective, the concept of indirect deaths has clear utility as it represents those deaths that may have been prevented through a bolstering of the public health system. This provides further strong evidence for the prioritization of basic public health interventions (i.e., infectious disease surveillance, immunization, disease control programs, water and sanitation) in conflict and post-conflict situations. For instance, the International Rescue Committee's series of mortality surveys in the Democratic Republic of Congo (DRC) found that 5.4 million excess deaths occurred between August 1998 and April 2007, with 2.1 million occurring since the formal end of war in 2002 (Coghlan et al., 2008). Of these 2.1 million excess deaths, only 0.4% was attributable to direct deaths. Nearly all deaths (99.6%) were reportedly indirect and caused mainly by preventable infectious diseases, malnutrition and neonatal- and pregnancy-related conditions which have emerged in the resource-poor post-conflict environment.

1.4. Fundamental challenges to collecting and using data on indirect deaths

Indirect deaths are inherently difficult to quantify and attribute to conflict-related causes. There are three key issues. First, in conflict situations the on-going collection of health information is difficult to maintain due to the breakdown of information systems, the loss of fundamental human resources and the loss of freedom of movement. Health information systems (HIS), which encompass vital registration, epidemiological surveillance and health service data systems, traditionally aggregate data to provide key epidemiological information on morbidity, mortality and early warning and response. However, as health systems break down during conflict periods, it follows that HIS similarly deteriorate (Working Group for Mortality Estimation in Emergencies, 2007). Even prior to a conflict, HIS may already be under resourced and under developed. There are numerous examples of the poor functioning and aggregation of HIS during conflict situations. In South Sudan in 1998, a relapsing fever outbreak continued for six months due to the lack of an effective early warning system (Gayer et al., 2007). A similar lapse occurred in Angola in 2005, where health authorities were unable to identify a large, deadly outbreak of Marburg hemorrhagic fever in its early stages due to the reduced ability to detect the

disease with poorly functioning surveillance systems (Guha-Sapir and Le Polain de Waroux, unpublished; Ndayimirije and Kindhauser, 2005).

Without working information systems, it follows that the standard practices for verifying causes of death are not possible. Objective indicators which are normally used (including death certificates and hospital records) are frequently missing or inaccessible (Checchi and Roberts, 2005). A logical means of validating non-violent causes of death during conflicts would be verbal autopsy techniques. These interview-based protocols have been developed for community workers in low-resource contexts to obtain information about a single cause of death (Setel et al., 2006). However, the length of time required for interviews and the intensiveness of training are impediments for use in conflict situations though specific research on feasibility in this setting is warranted (Utzinger and Weiss 2007, Working Group, 2007).

Second, and perhaps even more daunting, there is no straightforward methodological replacement for the determination of baseline mortality rates in areas where for decades there have been no public services and hence, little accurate data collection (see Box 1). Furthermore, it is difficult to designate a point in time with which to compare the impact of conflict on mortality in countries such as Somalia and DRC which exist in a cycle of chronic emergency (Utzinger and Weiss, 2007).

Third, how to attribute indirect deaths to the indirect impacts of conflict remains a major unanswered research question (Checchi and Roberts, 2005). Loss of livelihood, poor diets, lack of food, displacement, poor sanitation and countless other factors are often spoken of as the distal determinants of mortality within the conflict. However, which deaths would normally be attributed to adverse environmental and economic conditions, such as drought and poor diet, which are prevalent in most developing countries where civil conflicts occur? While distal conflict factors may manifest themselves through deaths due to disease and malnutrition, an approach for the attribution of these conditions to conflict is still undeveloped.

1.5. Methods for quantifying indirect deaths

Three approaches for the quantification of indirect deaths are described below (retrospective mortality surveys, prospective surveillance and analysis of multiple data sources). The objective of this section is to provide a broad overview of the uses, strengths and weaknesses of these approaches, rather than a detailed description of statistical methods and logistical approaches. These methods should not be thought of in isolation;

in effect, they are best used together as ‘building blocks’ or alternative sources to derive the best estimates of mortality in a conflict situation (see Table 1).

1.5.1. Retrospective mortality surveys

A retrospective mortality survey (RMS) is an assessment tool used to derive past mortality rates in situations where the prospective collection of mortality data is not possible. They are most commonly conducted by NGOs and field agencies at a sub-national level for operational purposes. Country-level surveys are rare, with those conducted in Iraq, DRC and Kosovo being some of the exceptions (Spiegel and Salama, 2000; Burnham et al., 2006; Coghlan et al., 2008). In a RMS, mortality information from a past time period is collected from a representative sample of a population. The household is the basic sampling unit to which surveyors administer a standard questionnaire to collect information on deaths in that household. Mortality rates are then derived from the sample and interpolated to the total population to provide a statistically-sound estimate of death tolls for the specified time period.

The major advantages of RMS are their use in the rapid assessment of mortality in areas where prospective surveillance is not in place. RMS also provides a range of sampling options for populations at different levels of organization, from refugee camps with household registration lists to IDPs in large areas where accurate demographic information does not exist. RMS methods have been standardized through an interagency initiative yet still require validation and optimization (SMART, 2006; Working Group, 2007).

It is problematic to capture the true medical causes of death using RMS and therefore surveys may aim to capture conservatively whether a death was “violent” (due to acts of war, war injuries or accidents) or “nonviolent” (all other causes) (Checchi and Roberts 2005; SMART, 2006; Working Group, 2007). For “non-violent deaths”, it is difficult to validate the reported cause of death without medical records and death certificates. Practitioners have reasoned that causes of death are more interpretable and relevant among children and if defined by local terms, though common medical conditions such as measles and diarrhoea can be difficult to identify retrospectively (Checchi and Roberts, 2005). Questioning respondents on violent deaths also raises issues of trustworthiness and response bias as the process may be prone to inflation or deflation due to political bias or fears of repercussion (Thoms and Ron, 2007).

Only information on mortality during a *past* period is sought from respondents. As such, there are two biases associated with this retrospective reporting. First, only persons from the population who survive until the time point during which the questionnaire is

undertaken may be included in the sample, introducing a *survivor bias*. Second, information on a death is subject to the respondent's ability to remember and willingness to recount the event. As described by Silva and Ball (2006), 'social memory is partial' and therefore, *recall bias* affects the data collection.

If the population under examination is of a manageable size, an exhaustive survey of the total population may be carried out through the collection of information from each household. Since this is not usually feasible, a representative sample of the population is usually defined. There are several ways in which the sample can be defined. The availability of an updated list of households in a small and organized population allows for the application of *simple random sampling* which provides households with an equal probability of selection through random sampling. *Systematic random sampling* requires that households are arranged in a manner that can be clearly delineated (this scenario may be seen in a refugee camp). An updated population list is not required, but the total number of households is necessary for calculating a sampling interval. Once the sampling interval is defined and the first household is randomly selected, one household in every interval is visited.

The last and most common method is the *multi-stage cluster sampling*. This is usually applied to large populations where the disordered distribution of households does not allow for simple or systematic random sampling and population size is unknown. The sampling method was originally developed by the WHO's Expanded Program on Immunization for the assessment of vaccination coverage among children (Working Group, 2007). It has been adapted somewhat for the assessment of retrospective mortality.

Essentially, geographic areas are divided into 'clusters' that are then randomly selected for the assessment of mortality. First, the smallest administrative divisions (such as districts, communes, sub-divisions of a settlement etc.) are identified. If no administrative data are available, the area can be divided into equal parts by geographical area. Each administrative division must have a probability of selection proportional to its population size (i.e., the larger its population, the more clusters it is designated). Second, households to be interviewed in each cluster are sampled using simple or systematic random sampling within the cluster. Once the households are selected, the head of the household is interviewed using a standard mortality questionnaire. There are specific rules delineated for selecting another household if the dwellers are absent or the household is not accessible (see SMART, 2006). Usually 30 clusters of at least 30 households are chosen to yield 900 households; this results from the practice of embedding mortality

surveys within nutritional assessments which use 30 by 30 clusters (Checchi and Roberts, 2005).

In cluster sampling in conflict situations, it is assumed that households within the same cluster may have similar mortality risks (Working Group, 2007). As evidenced by the burning of villages in Darfur and measles outbreaks in many complex emergencies, it is conceivable that disease-related mortality and violence can be geographically concentrated. This may lead to an overestimation (through selection of these clusters) or underestimation (through their lack of survival of potential witnesses) of mortality experiences across the sample. This phenomenon is known as the *design effect* and has the result of reduced precision around the mortality rate. The design effect is accounted for by the mathematical adjustment of the sample size and the increase of the number of clusters sampled.

The results obtained from a cluster sample can be interpolated to the entire population over the stated time period, but the results from each cluster are not representative of that geographical location. It follows that drawing conclusions on mortality rates for each cluster is methodologically erroneous. However, stratification of the sample is possible and gives the attractive alternative of generating mortality rates for sub-groups such as children under 5 years of age, women and men etc. (Checchi and Roberts, 2005).

In general, RMS may very well be the only option for mortality assessment in areas where the implementation of prospective mortality surveillance (discussed below) is not possible and mortality measurement is needed to inform humanitarian action. However, acute conflict settings are insecure and these studies require substantial human support and generate politically-sensitive data which may put surveyors' and respondents' lives at risk. These are serious concerns which should be weighed against the ultimate goals for the research.

1.5.2. Prospective mortality surveillance

The prospective surveillance of mortality through health information systems (HIS) is a superior method of documenting and verifying mortality in stable environments. By targeting health facilities and death registries, these systems can provide accurate and timely mortality data.

However, HIS are almost universally weak in conflict-affected areas and moreover, Fottrell (2008) estimates that in any case, between two thirds and three quarters of the world's population are not subject to any type of health surveillance. In spite of this, mortality detection can be integrated through a surveillance network of NGO-driven health

operations or ad-hoc surveillance within a humanitarian operation (Thieren, 2005). To calculate mortality rates, such a system requires that a network of community workers actively track deaths by visiting community households and health facilities on a regular basis and maintain accurate population figures for purpose of comparison (Checchi and Roberts, 2005). Such conditions are most realistic for refugee camps and for other populations that are delineated and stable for a considerable amount of time. Prospective surveillance systems have been identified in refugee settings, including the UNHCR's Health Information System. However, an analysis by CRED found that such systems may be prone to under-reporting due to their use of passive data collection approaches, the lack of accurate demographic information and inconsistent operational definitions (CRED, 2006). Defining the cause of death is also problematic for prospective surveillance and is symptomatic of the general lack of standard sources for the medical verification for deaths in conflict situations.

Practitioners have stated that retrospective methods should be considered only when prospective methods are not possible; however, prospective approaches have not traditionally been considered a priority in the humanitarian response (Checchi and Roberts, 2005; Woodruff, 2006). More generally, demographic information systems have been implemented at the sub-national level through partnerships with INDEPTH, a network of 38 localised demographic surveillance systems in 19 developing countries (Utzinger and Weiss, 2007; Fottrell, 2008). In particular, the Guinea-Bissau Ministry of Health operates the Bandim Health Project (BHP), a demographic surveillance system for four districts within the capital (Nielsen et al., 2006). During the 1998 to 1999 conflict, BHP was able to track mortality rates throughout the period among populations displaced from the area.

1.5.3. Analysis of multiple data sources

The analysis of multiple data sources permits the reconstruction of mortality profiles using sources of mortality statistics collected before, during and after conflict. Demographers and statisticians offer several approaches based on the availability of appropriate and accurate data sources (which may include prospective mortality surveillance and previously-conducted RMS) and the derivation of the best estimates using these sources.

To assess mortality during the Khmer-Rouge years in Cambodia (1970 to 1979), where little data on deaths was available and the trustworthiness of said data is an open question, a demographer used transformations of the 1962 population census and the 1992 UN electoral lists to reconstruct measures of excess mortality (Heuveline, 1999). These figures were assessed historically against key political and social events, such as

the famine of 1979 to 1980 and adjusted to produce minimum, medium and maximum scenarios of excess mortality. The separation of excess mortality into indirect and direct deaths is based on assumptions about cause of death by age group and a projection across population figures. The use of this demographic method across conflict areas may be limited by the availability of good quality pre-conflict census data and the requirement of a post-conflict population figure.

Often times, there is an effort to assess the distribution of direct deaths and indirect deaths according to the type of data source used. For instance, in Timor-Leste, the Benetech Human Rights Data Analysis Group used Multiple Systems Estimation (MSE) techniques involving a database of human rights violations, a census of public graves, and a RMS to estimate mortality during the 1974 to 1999 post-invasion period (Silva and Ball, 2006). MSE uses a statistical technique to derive “best estimates” of each data source in order to produce an estimate of direct deaths (“violent deaths”) and indirect deaths (“deaths due to hunger and disease”) for the period. A similar analysis of mortality during the conflicts in Bosnia and Herzegovina from 1992 to 1995 involved the triangulation of ten databases of death records, exhumations and missing persons with household survey results to account for overlap and duplication and to derive an estimate of excess mortality (Tabeau and Bijak, 2005).

A decade earlier, a statistician took a similar approach to estimate deaths during the 1993 Persian Gulf War (Daponte, 2008). Statistics from the 1987 Iraqi census, the 1989 National Child Health Survey and the 1990 UNICEF Immunization, Maternal and Childhood Mortality Survey were used to derive pre-conflict population figures. Information on indirect deaths was derived from a life table containing information on child mortality before, during and after the war and the application of these rates to the total population.

Other approaches attempt to best utilize sub-national RMS estimates to create a picture of the larger conflict situation. CRED’s work on the estimation of mortality in Darfur, Sudan and Iraq collected and assessed mortality estimates from several RMS and other data sources (Guha-Sapir et al., 2005; Guha-Sapir and Degomme 2007). The authors also used this approach to highlight the strengths and weaknesses of each source in order to create the strongest representation of the universe of data.

For Darfur, CRED used contextual information from interview-based data from the Atrocities Documentation Team, an RMS conducted by the WHO in West and North Darfur and the WHO’s projection of mortality. Data was extracted from 24 surveys conducted by NGOs and UN agencies contained in CE-DAT (Guha-Sapir et al., 2005). To assess direct deaths in Iraq, CRED used multiple sources including two RMS conducted by Johns

Hopkins Bloomberg School of Public Health, verified data from the Iraq Body Count database and the UNDP's Iraq Livelihoods Condition Survey (Guha-Sapir and Degomme, 2007).

In general, the clear advantage for the use of multiple data sources is the focus on the assessment of quality among the data sources to derive a best estimate; in the case of MSE, there is even a statistical method for which to derive a judgment. However, the approach could also aggregate potentially flawed sources of secondary data, which may result in inaccurate results. As well, the approach is taken after data is collected on site. That is, its use is restricted to a historical study, after the intensity of the conflict has been reduced. While this may limit its use for timely humanitarian action, it highlights its potential for conducting a thorough investigation that may influence humanitarian law.

1.6. Box 1 : Using baseline mortality rates to contextualize excess mortality

Using Baseline Mortality Rates to Contextualize Excess Mortality

The comparison of baseline and crisis mortality rates is essential in order to assess the level of severity a conflict situation and to calculate excess mortality. The computation and utilization of national-level baseline mortality rates is a fundamental dilemma for the estimation of mortality (Guha-Sapir and van Panhuis, 2004). Currently, there is no broad consensus among humanitarian researchers on the methods for derivation and comparison of baseline mortality rates.

There are two primary challenges with the computation of baseline mortality rates in conflict areas. In several conflict areas such as the Democratic Republic of Congo and Sierra Leone, there has been poor coverage by vital registration for decades and hence, little accurate data collection that can be used to provide the demographic profile of a population. In addition, it is difficult to designate a time point with which to base a useful comparison in countries which exist in a cycle of chronic conflict and/or emergency. For instance, as Somalia has been in civil war since the early 1980s, it may not be useful to compare current mortality rates to the out-of-date mortality baseline statistics for the country which are affected by normal demographic factors. Of note, there are currently initiatives which drive the routine collection of demographic and mortality data in some areas affected by conflict (i.e., the Bandim Health Project in Guinea-Bissau, part of the INDEPTH Network) (Nielsen et al., 2006).

Notwithstanding the challenges to collecting data, at present the most widely used datasets which include baseline statistics for most countries are collected by the United Nations Population Division and often referenced in UNICEF's annual State of the World's Children report. This data is derived from the last census and is therefore limited by the quality of data collection and time of collection.

Mortality rates are also compared to UNICEF's regional baseline rates rather than those of single countries. This approach is useful where no country-level or sub-national level baseline data exist and has been recommended by the Sphere Project (Sphere, 2004).

An important conclusion to this discussion is that the "normal", peacetime baseline rate may not be ideal or acceptable for the health of the population of concern (Guha-Sapir and van Panhuis, 2004). However poor, this merely represents the mortality rate in the absence of conflict.

1.7. Table 1: Comparison of methods for measuring excess mortality

Method	Appropriate setting	Advantage	Disadvantage
Retrospective mortality survey	• During conflict • Post-conflict	• Useful for rapid assessment where prospective surveillance is not in place • Does not require population denominator • Practical for use in disorganized settlements	• May be difficult to carry out due to logistical needs and insecurity • Recall bias, response bias, survivor bias • Measures past death, so not in real time • Statistical analysis is relatively complicated
Prospective surveillance	• During conflict • Post-conflict	• Occurs in real time and has strong operational usage • Relatively simple analytical procedures are involved	• National information systems to track health and mortality are usually weak in conflict settings so an ad-hoc system is required • Requires regular updating of data and population size to be useful • Possible only in camps and stable populations
Analysis of multiple data sources	• Mainly post-conflict (as it is dependent on other primary data sources)	• Used to assess the quality and strengths of multiple sources of data • Statistical techniques are available to employ the best aspects of data sources (i.e., Multiple Systems Estimation)	• Dependant on the quality and type of primary data sources (i.e., data source such as a graveyard database may not have clear information on type of death) • Dependant on the availability and timeliness of primary data sources

Source: Checchi and Roberts (2005), Guha-Sapir, Degomme and Altare (2007)

2. Estimation using multiple sources

2.1. Estimating direct and indirect mortality in Southern Sudan, 1999-2005⁴

Authors: Catrien Bijleveld, Olivier Degomme, Shanna Mehlbaum

Since Sudan's independence in 1956, civil wars have raged in southern Sudan, with a spell between 1972-1983. The period between 1983-2005 was the longest and in all likelihood, the deadliest spell. In January 2005, the Comprehensive Peace Agreement formally ended the fighting, and relative calm has since returned. We estimate direct and indirect mortality during the last phase of this second civil war in southern Sudan, i.e. between 1999-2005. Estimates of total excess mortality until 1998 are available from the literature.

Large-scale human rights violations have been committed within the context of the 1983-2005 civil war, in particular against the civilian population of southern Sudan. Massive population movements have taken place; famines have been recurrent. Food aid to the affected population has in numerous instances been denied or purposely obstructed. We estimate direct and indirect mortality between 1999-2005 in southern Sudan. Southern Sudan is defined as the former regions Bahr el Ghazal, Equatoria and Upper Nile, which have since become 10 states that encompass the same area.

Direct mortality is estimated from data on killings in all documents that we could find on the Internet, through fellow researchers, and in libraries. A criterion for documents to be used was that they provided *independent* information on mortality during the conflict. Incidents and casualties were collected in one file, and identified by location and date, to prevent double counting. Verbal descriptions ('many') were quantified (see Bijleveld, Degomme and Mehlbaum, 2008).

For estimating total excess mortality, we plot the CMR and U5MR of all surveys in the CE-DAT database against the years studied, and investigate the trends in mortality (CRED, 2008). Any outliers are removed, meaning that we arrive at a conservative estimate. Next, we apply mortality rates to time frames and regions, arriving at an as differentiated as can be estimate.

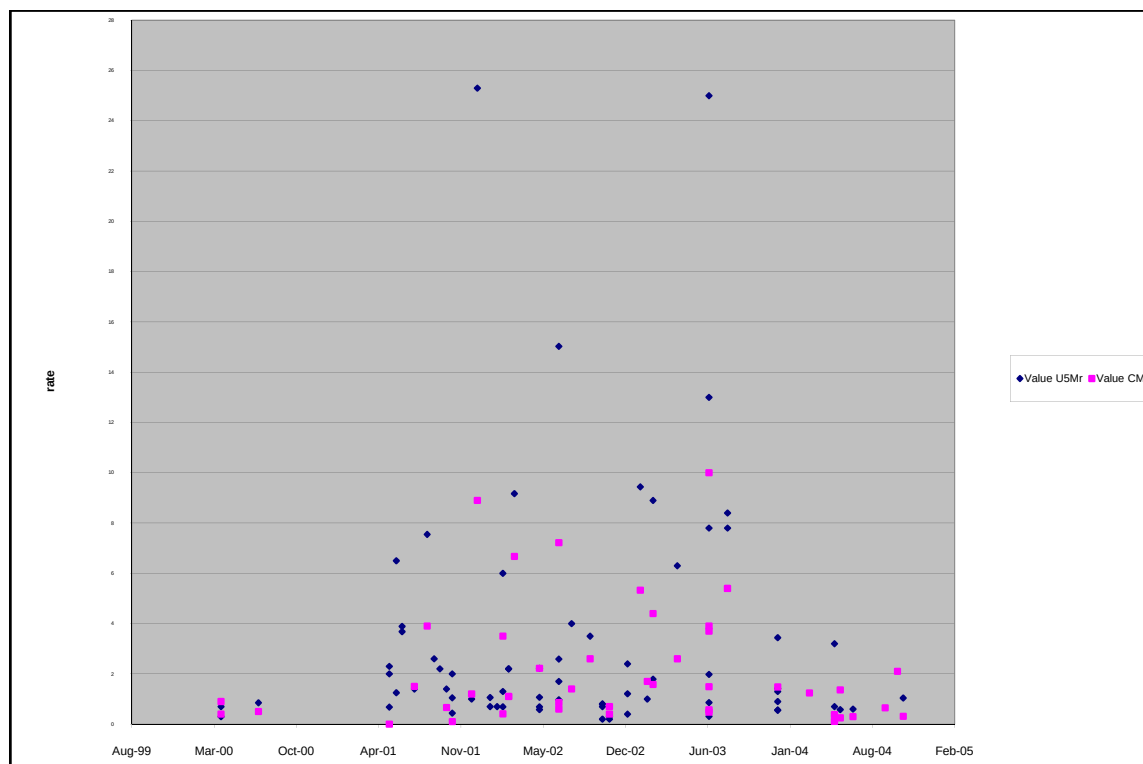
Indirect mortality is defined as the difference between total excess mortality and direct mortality. The total number of direct deaths in southern Sudan between 1999-2005

⁴ A summary of a broader paper by Bijleveld, Degomme and Mehlbaum (2008). A very dark number. Vrije Universiteit Amsterdam, Working paper.

was 1,381 (594 in Bahr el Ghazal region, 520 in Upper Nile, and 167 in Equatoria region). For estimating total mortality, we were able to find 78 surveys that gave either a CMR or U5MR. Only 37 of these gave a recall period, but as the largest recall period found was three months, and as population estimates for southern Sudan are yearly and thus fairly coarse anyway, we decided to use all surveys, whether they reported a recall period or not, and time the mortality rate to the time that the survey was actually administered. Most surveys were conducted by NGOs active in southern Sudan, both in towns like Aweil and Bentiu and in the rural areas. No surveys were found for 1999. One outlier with an U5MR of 33 was removed (see Figure 1).

Virtually all surveys that reported CMRs and U5MRs above emergency level are surveys conducted between June 2001 and August 2003 in the Upper Nile and Jonglei states. These rates are problematic, as they are excessively high and would have to have been reflected in massive starvation, which was, while Upper Nile and Jonglei states were stricken between 2001-2003, however not reported during those years. In addition, the surveys were reported to be also methodologically different from subsequent measurements. We therefore use the median of the CMR from the surveys (2.1) as a more conservative estimate. Exclusive of these elevated rates, the mean CMR was 0.58.

Figure 1. U5MRs and CMRs plotted against time



For the Bahr el Ghazal and Equatoria regions, we use the average non-elevated CMR of 0.58 for the entire period. For 1999, we assume the 2000 mortality rates to hold. For the Upper Nile region, we use the 0.58 CMR for 1999, 2000 and 2004. As the mortality surveys show elevated mortality for Upper Nile and Jonglei from only mid 2001 and onwards, we use 2.1 for 2002 and 2003 for the entire Upper Nile region. For all of these rates, to find the excess mortality, we subtract expected mortality, which we set – conservatively – at 0.5. Applying these mortality rates to estimated population sizes, we arrive at a total excess mortality of 427,337 (339,342 for Upper Nile, 58,663 for Bahr el Ghazal and 29,332 for Equatoria).

Of this excess mortality, the percentage of direct deaths is 0.3%. It appears as if there was relatively more direct mortality in Bahr el Ghazal during this period of approximately 1%.

Our estimates are all dependent on assumptions, and in the case of direct deaths, partly the quantifications of verbal statements. These may be off the mark. However, even if we suppose that we missed 90% of all direct mortality, or if total excess mortality were only 50% of what we estimate here, still almost all excess mortality is indirect, and only a fraction the immediate consequence of violence. Thus, the conclusion is that by far, the largest contribution to mortality in southern Sudan between 1999-2005 was indirect deaths. On a more general note, our calculations are on the edge of feasibility. Absolutely speaking there is extreme data paucity. Our estimates should be used with caution.

2.2. Direct and Indirect Mortality in Sierra Leone, 1991 - 2002⁵

Authors: Catrien Bijleveld, Lotte Hoex

Gross human rights violations took place in the context of the civil war in Sierra Leone between 1991 to 2002. During almost 11 years of the conflict, many were displaced internally or fled the country. As the conflict zones moved through the country, refugee and IDP flows moved accordingly. With infrastructure destroyed and/or facilities looted in most conflict zones, (parts of) the population were unable to plant and had severely reduced access to medical facilities. In addition to being caught in the fighting, the civilian population was also actively targeted. Amongst the crimes committed are widespread and systematic sexual violence, sexual slavery, abduction, use of child soldiers, murder, robbery, destruction, displacement of people and starvation. Different estimates of civilian mortality as an immediate consequence of these gross human rights violations do exist, ranging from 35,000 to 200,000 deaths (cf. Bijleveld and Hoex, 2008). Estimates are however barely substantiated. Also, it is unclear what part of mortality is direct, and what part is indirect, i.e. as a consequence of disease, starvation, exhaustion, etc.

We estimate total excess mortality and direct mortality in Sierra Leone between 1991 and 2002. We estimate indirect mortality as the difference between total excess mortality and direct mortality.

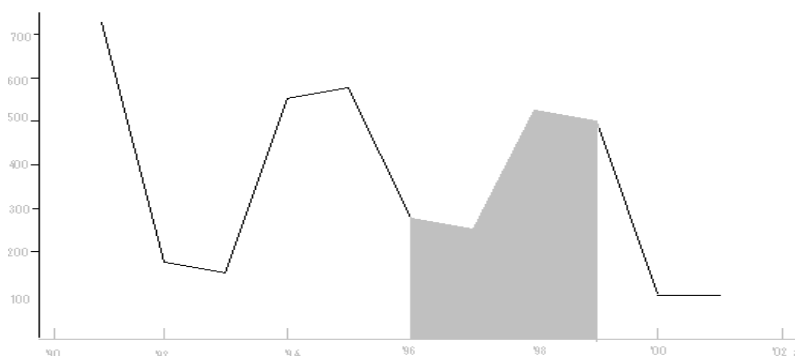
To estimate direct mortality, we use the distribution of direct deaths as reported by the Sierra Leonean Truth and Reconciliation Commission (TRC). It is clear from inspection of other sources that these data are an underestimate. For instance, in January 1999, around 5,000 were killed in Freetown, while the total TRC number adds up to approximately 4,500. Next we assume that all killings in Sierra Leone in the period under investigation did follow the trend as given by the TRC report. Lastly, we set the level of this trend curve such that it matches the available data (mainly from UN and Amnesty International sources) on direct killings between 1996-1999. This produces Figure 1.

This leads to a total estimated direct mortality of 26,704, which is in all likelihood an underestimate: the Amnesty International deaths are themselves an underestimate as only 6 months were reported upon in 1996, only 5 months in 1997 and 8 months in 1998, not all districts were covered and some periods and areas were too dangerous to survey.

⁵ The authors thank Ian Smillie, Lansana Gberie, Krijn Peters and Linda Polman for their valuable comments on a previous version of this text. The full text of this summary can be found in Bijleveld and Hoex (2008b). Direct and indirect mortality during the conflict in Sierra Leone 1991-2001. Vrije Universiteit, Amsterdam, working paper.

For estimating total excess mortality, we estimate a hypothetical population size in 2002, had the population grown uninterruptedly in a non-conflict situation. We extrapolate the population size in Sierra Leone in 1990, which equalled 4,087,000, using a conservative growth rate of 1.96. Correcting for migration we arrive at a hypothetical population size by 2002 of $4,022,000 * 1.0196^{10.5} = 4,979,321$.

Figure 1. Distribution of killings over time.



Source: Benetech report to the TRC. (Conibere, e.a., 2004).

Next we estimate actual population size in 2002. Back calculating from the 2004 census, and again correcting for migration, we estimate actual Sierra Leonean population size by early 2002 at approximately 4,517,330.

This means that total mortality, estimated as the difference between the hypothesized and the actual population, is approximately $4,979,321 - 4,517,330 = 461,990$. It should be stressed that this is a conservative estimate; Bijleveld & Hoex (2008) give a range.

Given that we estimate that 460,000 Sierra Leoneans lost their lives as a result of the conflict in Sierra Leone between 1991 and 2002, and given that of these deaths we estimate that 26,704 were most probably direct, this means that about 6% of all deaths were attributable to violence. Roughly speaking, 94% of the total excess mortality was indirect, attributable to other causes than proximal violence.

These estimates are all dependent on assumptions. It may for instance have been that the Sierra Leonean population would not have grown at the rate that we assumed, but at a much slower rate. In that case, the percentage of indirect deaths becomes higher. However, even if we set the growth rate at the lowest rate ever measured (1.4%), which is clearly unrealistic and much too low, still around a quarter of total excess mortality is direct, and three quarters is indirect. Thus, the conclusion appears that by far the largest part of mortality is indirect.

2.3. Indirect deaths in Iraq

Author: Olivier Degomme

Mortality data from Iraq has mainly been studied for the analysis of deaths directly attributable to the war. These studies have resulted in figures ranging from 82,771 for the 5 years of the conflict (Iraq Body Count, 2008) to over 1.2 million violent deaths for the first 40 months (Opinion Business Research, 2007). Translated into mortality rates, this equals approximately 0.7 to 14.4 violent deaths per 1,000 people per year. In other words, the exact number of deaths due to violence remains unknown.

Meanwhile, little attention has been given to the number of persons who have died from indirect causes, such as diseases and malnutrition. Data collection systems that actively track events that result in violent incidents are of much value for the estimation of direct deaths, but are unfortunately not useful for the assessment of indirect deaths.

Three nationwide mortality surveys conducted in 2004 and 2006, reported values for both violent and non-violent mortality. Table 1 gives an overview of the results of the non-violence mortality rates.

Table 1: Overview of indirect mortality rates from 3 mortality surveys

	Survey year	Pre- invasion (/1,000/year)	Post- invasion (/1,000/year)
Roberts et al. [2004]	2004	4.9	6.0
Burnham et al. [2006]	2006	5.4 [4.1; 6.8]	6.0 [4.8; 7.5]
Alkhuzai et al. [2008]	2006	3.1 [2.6; 3.6]	4.9 [4.5; 5.4]

Based on the data obtained from the mortality surveys, a tentative range of indirect deaths due to conflict can be estimated by calculating the difference between the post-invasion and the pre-invasion rates. According to the study by Burnham et al. (2006) the excess indirect deaths would thus account for -2 to 3.4 per 1,000 people per year. Extrapolating to

the total Iraqi population (26 million) and the total duration of the conflict so far (5 years), we obtain a range from -260,000 to 442,000 people. In other words, this data suggests that the conflict resulted in a reduction of around a quarter of a million indirect deaths but may have caused around half a million extra indirect deaths.

A similar analysis using the Iraq Family Health Survey data results in an indirect death toll of around 120,000 to 350,000 (Alkhuzai et al., 2008). Roberts et al. (2004) does not provide a confidence interval for its estimates. Using the point estimates, we obtain a figure of almost 150,000 indirect deaths.

In conclusion, the estimate for excess indirect mortality in Iraq is probably as vague as the estimate for direct deaths. Based on data from three mortality surveys, the indirect death toll in Iraq has a point estimate of around 150,000, with a wide range of a reduction of 250,000 deaths to an increase of almost 450,000 deaths.

3. Using mortality ratios as an indicator of conflict violence

3.1. A Model for assessing the magnitude of indirect deaths

As discussed earlier, the science of mortality measurement is difficult to carry out with precision in insecure and logistically challenging conflict-settings. Moreover, the scientifically sound quantification of indirect deaths and the attribution of these deaths to conflict-related causes are particularly problematic tasks.

A novel approach which uses the comparison of Crude Mortality Rates and Under 5 Mortality Rates for the assessment of the distribution of indirect and direct deaths is presented. This method takes into account expected mortality rates ('baseline mortality rates') in order to separate the mortality that would be expected in a normal situation from the excess mortality that can be attributed to a conflict.

For this methodology, multiple sources of survey data were sourced from the Complex Emergency Database (CRED, 2008). CE-DAT is an international initiative maintained by the World Health Organization Collaborating Centre on the Epidemiology of Disasters (CRED). The database was initiated in order to compile, validate, and standardize data on mortality and nutrition in populations affected by complex emergencies for use by humanitarian actors, donors, and researchers. The goal of CE-DAT is to improve evidence-based policy on conflict prevention and response by providing standardized data on the human impact of conflict. The database contains the results of nearly 2,000 surveys on mortality and nutrition collected on-site by NGOs, UN agencies and academic units since 2000. The data from the surveys are triangulated and validated by the CE-DAT staff in consultation with a technical advisory group of experts.

3.2. Assumptions for the model

The methodology that was developed to evaluate the distribution of indirect and direct deaths is based on two assumptions.

I. *In armed conflicts, children are considerably less subject to direct deaths by violent causes compared to adults*

There are several explanations for the assumption that children under 5 years of age⁶ are less subject to violence. In terms of age groups, adult males are traditionally prone to violence, as has been seen in recent conflicts in Kosovo, Iraq and Darfur (Spiegel and Salama, 2000; Depoortere et al., 2004; Grandesso et al., 2004; Alkhuzai et al., 2008). This is probably due to selective targeting or their increased exposure to public places. There are specific instances where children are selectively affected by violence for example through the use of child soldiers. However, for our purposes, it is not expected that children *under 5 years of age* are recruited for military purposes. In addition, landmine injuries are known to have a specific burden on children, though most likely among older children over 5 years of age who are mobile and relatively independent of adults (Moss et al., 2006).

II. *In humanitarian situations, children are the first victims of diseases and malnutrition (indirect causes of death).*

Children are most susceptible to the medical causes of death brought on by the breakdown of health systems, poor access to food and malnutrition. Their vulnerability is a result of the effects of acute malnutrition on their immunity to infectious diseases, lowered food intake during disease spells which maintains the acute malnutrition and reduced vaccination coverage (Checchi et al., 2007). This is especially illuminating when it is revealed that the major causes of morbidity in complex emergencies continue to be the same high-mortality childhood diseases found in developing countries in normal situations: measles, malaria, severe malnutrition, diarrheal diseases, acute respiratory infection and neonatal conditions (Toole et al., 1989; Salama et al., 2004; Moss et al., 2006). The difference is that the scale of morbidity and mortality due to these diseases is amplified. Spikes in deaths due to disease among all age groups may occur, but they are most often the results of acute outbreaks linked to contaminated water, unhygienic environments and

⁶ Unless otherwise specified, our definition of 'children' refers to persons younger than 5 years of age.

contaminated food which affect the total population (Connolly et al., 2004; Moss et al., 2006).

Children are also dependant on maternal care. A death may be related to a disruption in the child's dependency on the mother in terms of poor access to breastfeeding, post-natal care, positive health behaviors or the fragmentation of families.

Refugee camp settings provide a clear example of the specific vulnerability of children. In these settings, it is expected that level of armed violence are generally lower than that found in unstable conflict-affected areas due to the presence of security. Therefore, the main risks are likely related to disease and malnutrition. Consistent evidence of this age-specific vulnerability has been shown for Cambodian refugees in Thailand in 1987 (deaths among children were 20% greater than the same age group in a stable population), Iraqis on the Turkey-Iraq border in 1991 (children constituted 63% of deaths), Rwandan refugees in Zaire in 1994 (children aged 1 to 4 were 6000% more likely to die compared to a stable population) (CDC, 1992, Davis, 1996, Elias et al., 1990, as cited in Keely et al., 2001, Moss et al., 2006).

Post-conflict periods provide another useful example of the specific burden of death among children in a relatively non-violent setting. The results of the International Rescue Committee's national-level mortality survey in the DRC in 2007 found that 47.2% of deaths were due to communicable disease and malnutrition among children while only 0.4% of all deaths were due to violence (Coghlan et al., 2008). Notably, children made up only 19.4% of the sample population. The relative risk of death for children compared to persons over 5 years of age was 3.5 (95% CI 3.2-3.8). Moreover, five preventable diseases and conditions were reported to account for over 55% of all deaths (fever/malaria, diarrhea, respiratory infections, tuberculosis and neonatal conditions), which generally corresponds to the burden of childhood diseases in developing countries. Measles alone accounted for 9.9% of child deaths, which is in line with evidence for the high risk of mortality due to the disease among children in complex emergencies (Toole et al., 1989).

3.3. Explanation of the model

Considering these two assumptions, one can hypothesize that the ratio between child deaths and adult deaths can suggest the main causes of death. Situations where almost no children die are unlikely to be situations of severe humanitarian crisis. However, if only the adult mortality is increased, one can assume that those deaths will typically be due to targeted fighting or attacks, where adults, typically males, are the principal victims. On the

other hand, situations where child mortality is increased considerably are typically those characterized by poor health conditions with resulting indirect deaths.

A valuable source of data is retrospective mortality surveys. Many humanitarian organizations such as NGO's, UN organizations, academia or governments conduct mortality surveys in situations of armed conflict or humanitarian crisis. These surveys typically report two related indicators: the Crude Mortality/Death Rate (CMR) and the Under 5 Mortality/Death Rate (U5MR)⁷. The former refers to the deaths in the total population, whereas the latter only takes children under 5 years of age into account. Use of the two indicators provides a figure for child mortality, but not for adult mortality (or, "over-5 mortality"). It is possible however to calculate the adult mortality using CMR, U5MR and the proportion of children in the population. Unfortunately, this latter figure is not always available. We have therefore decided to use the CMR instead of adult mortality, bearing in mind that children are included in the CMR. In practice, this means that any increase in U5MR will result in an increase in CMR, albeit smaller than the U5MR increase.

The ratio of "*increase in U5MR*" to "*increase in CMR*" would thus be a potential indicator for the distribution of the causes of death. A ratio greater than 1 would mean that there are relatively more children that die compared to the entire population. In all likelihood, this would be due to indirect causes such as disease or malnutrition. On the other hand, if the ratio is less than 1, there are less children dying than we would expect based on the deaths in the total population. In other words, there are relatively more persons older than 5 that are dying. Since diseases would typically also affect children, other causes should be considered. The most obvious cause is violence, resulting in a direct death.

It is clear that this approach oversimplifies reality. There are always children dying from violence as well as adults dying from indirect causes. To account for this, a "grey zone" has been added to the model. The grey zone includes situations where the U5MR is increased, but the CMR is increased further. This refers to a case where the entire population is affected by indirect causes of deaths, but adults are also more affected by violence. This results in a higher increase in CMR as compared to U5MR.

In short, we distinguish 3 categories:

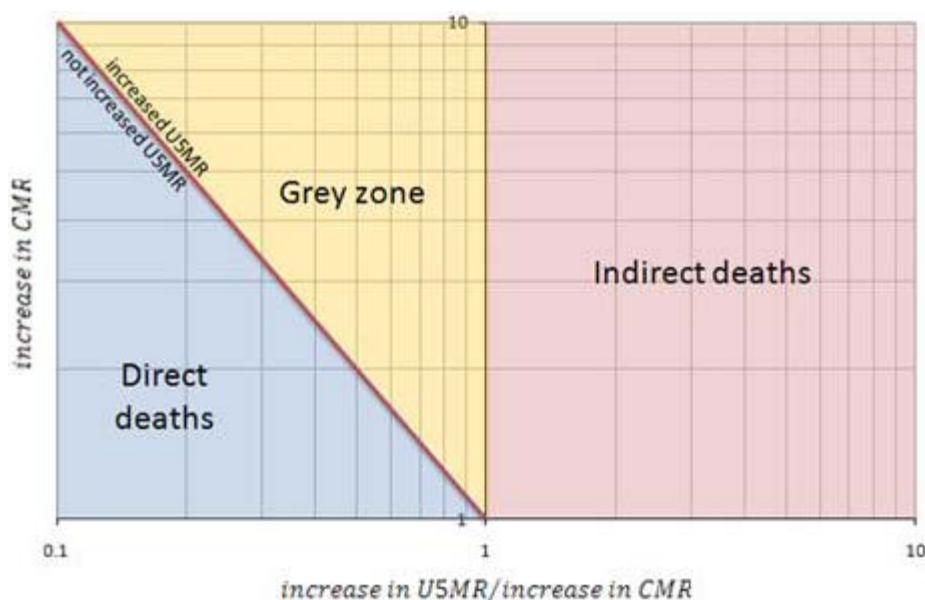
⁷ The terms "death rate" and "mortality rate" are used in different ways by demographers and epidemiologists. Under 5 Mortality Rate is defined by demographers as the probability of dying before the age of 5. Its unit is "per 1,000 live births". Epidemiologists define U5MR as the number of deaths of children under 5 years of age per unit of time divided by the under-5 population. Its unit is typically "per 10,000 persons per day". This last indicator is known by demographers as the Under 5 Death Rate (U5DR). In this document, U5MR refers to the epidemiological definition of the indicator.

1. *increase in U5MR/increase in CMR* > 1 : the main causes of death are likely to be indirect
2. *increase in U5MR/increase in CMR* < 1 and *increased U5MR* : both direct and indirect death occur
3. *increase in U5MR/increase in CMR* < 1 and *not increased U5MR* : the main causes of death are likely to be direct

3.4. Visualisation of the model

In order to visualize the model, the CMR (the indicator for mortality in the total population) is plotted against the *increase in U5MR/increase in CMR* ratio (see Figure 1, note: axes of the chart are in a logarithmic scale).

3.4.1. Figure 1: Chart representing the U5MR/CMR ratio vs CMR

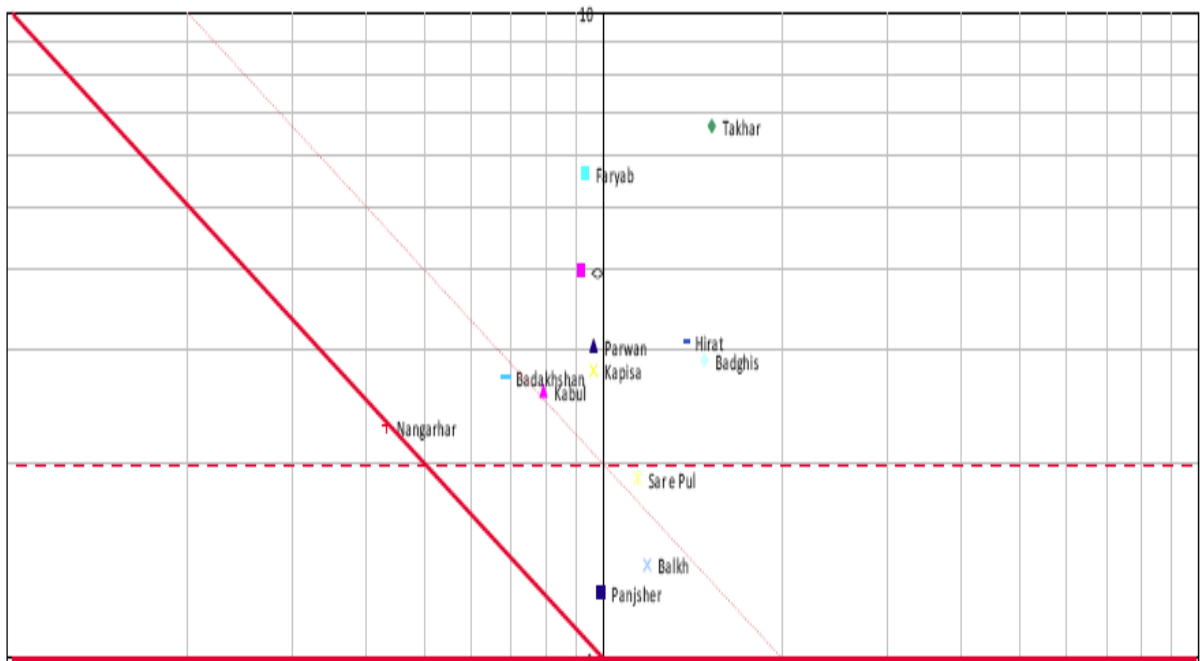


The location of the mortality surveys in this chart can give us an idea of whether a crisis causes mainly direct or indirect deaths. Below are charts⁸ for 5 countries: Afghanistan, Angola, DRC, Sierra Leone and Sudan. The coordinates of each point are the average value for U5MR/CMR ratio and the average increase in CMR for the different provinces in the country. Provinces for which the average CMR was not increased are not plotted. The data represented in the chart includes surveys from the CE-DAT database for the period 2000 to 2007. National-level data on conflict-related mortality is rarely available

⁸ In addition to the lines discussed for Figure 1, the charts in Figures 2 to 6 also show dashed lines. These lines represent the level of mortality equal to twice the baseline value. This is considered by Sphere (2004) to be the threshold for emergencies. All points above these lines therefore represent emergency situations.

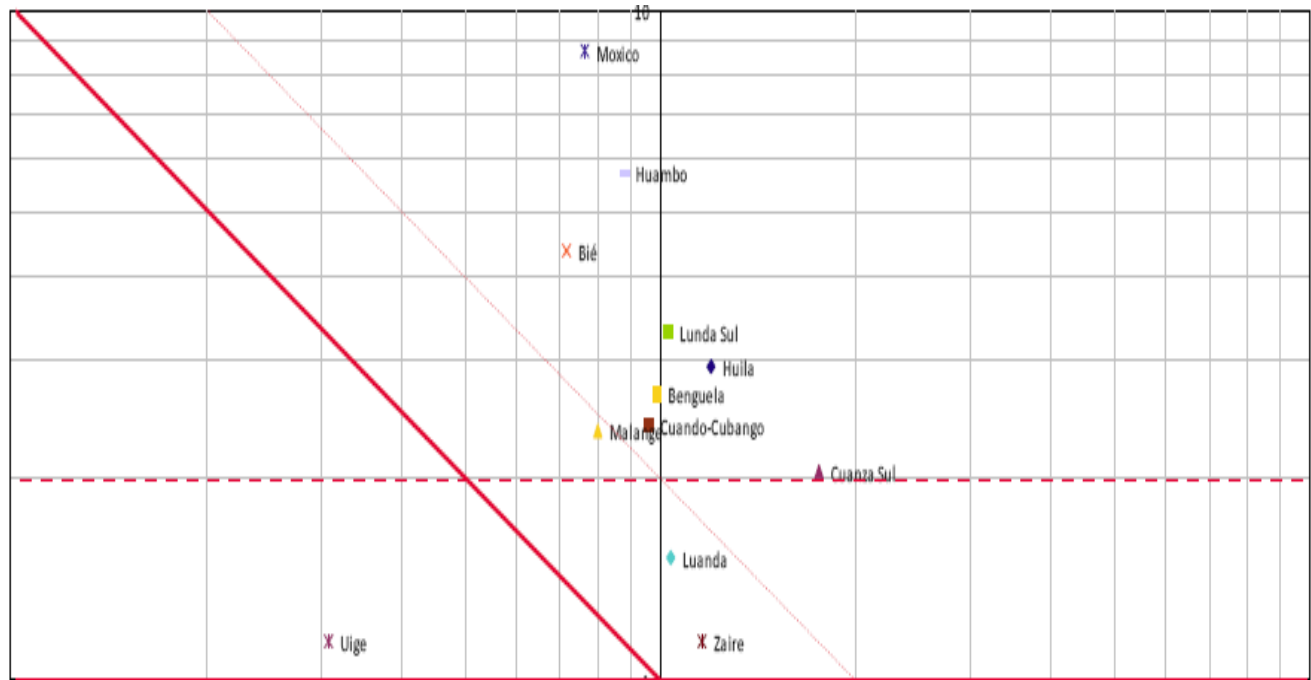
and therefore, data from sub-national mortality surveys was aggregated at the provincial level.

3.4.2. Figure 2: Afghanistan



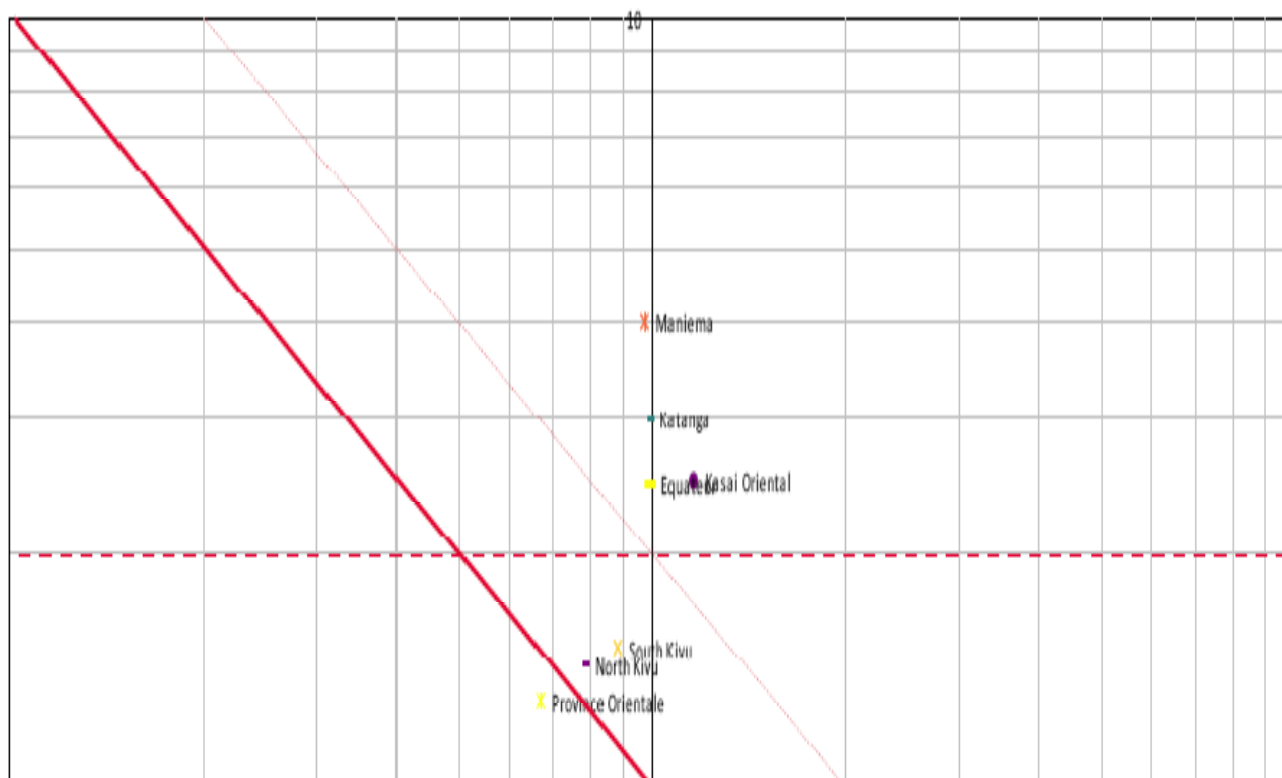
The chart suggests that an important share of the death in Nangarhar province is due to direct causes of the conflict. Provinces such as Takhar and Faryab show very high mortality, but probably mainly due to indirect causes.

3.4.3. Figure 3: Angola



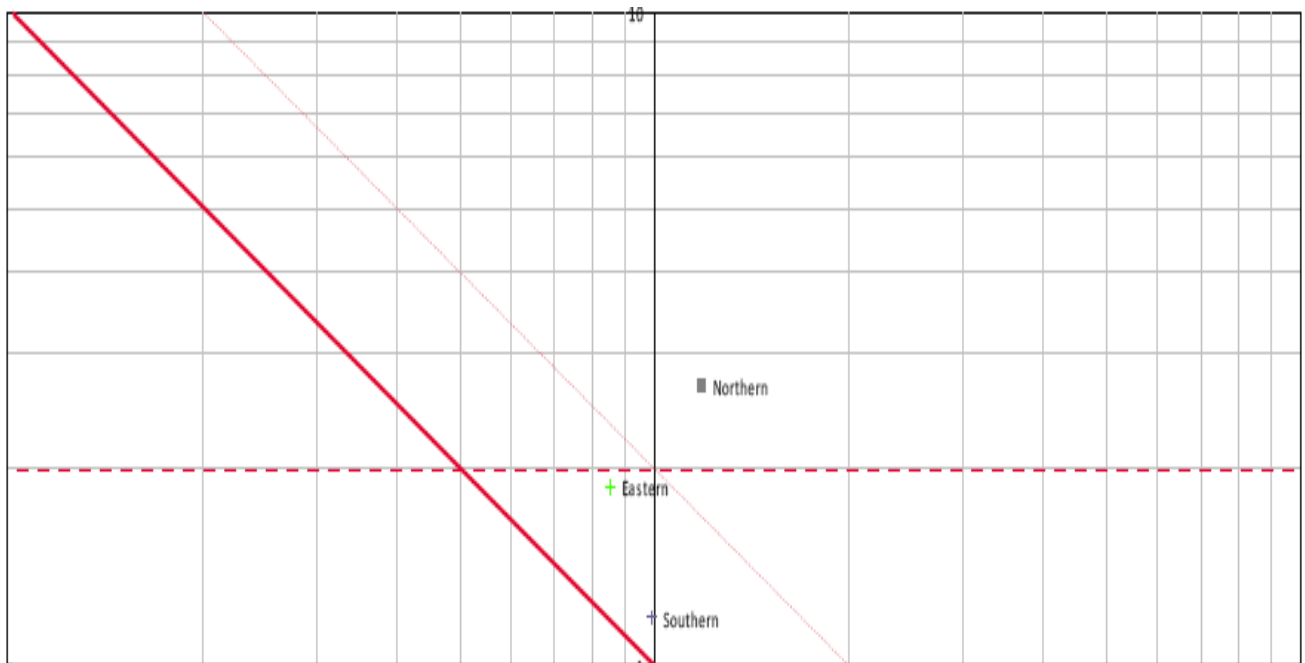
Surveys from Uige suggest that there was no increase in child mortality in that province. The small increase in CMR is probably due to direct causes. Moxico is clearly the province with the highest mortality, slightly more due to increased over 5 mortality than under 5 mortality. It is likely that mortality in that province resulted from very high indirect, but also from direct mortality. In Cuanza Sul on the other hand, mortality was probably mainly due to indirect deaths.

3.4.4. Figure 4: DRC



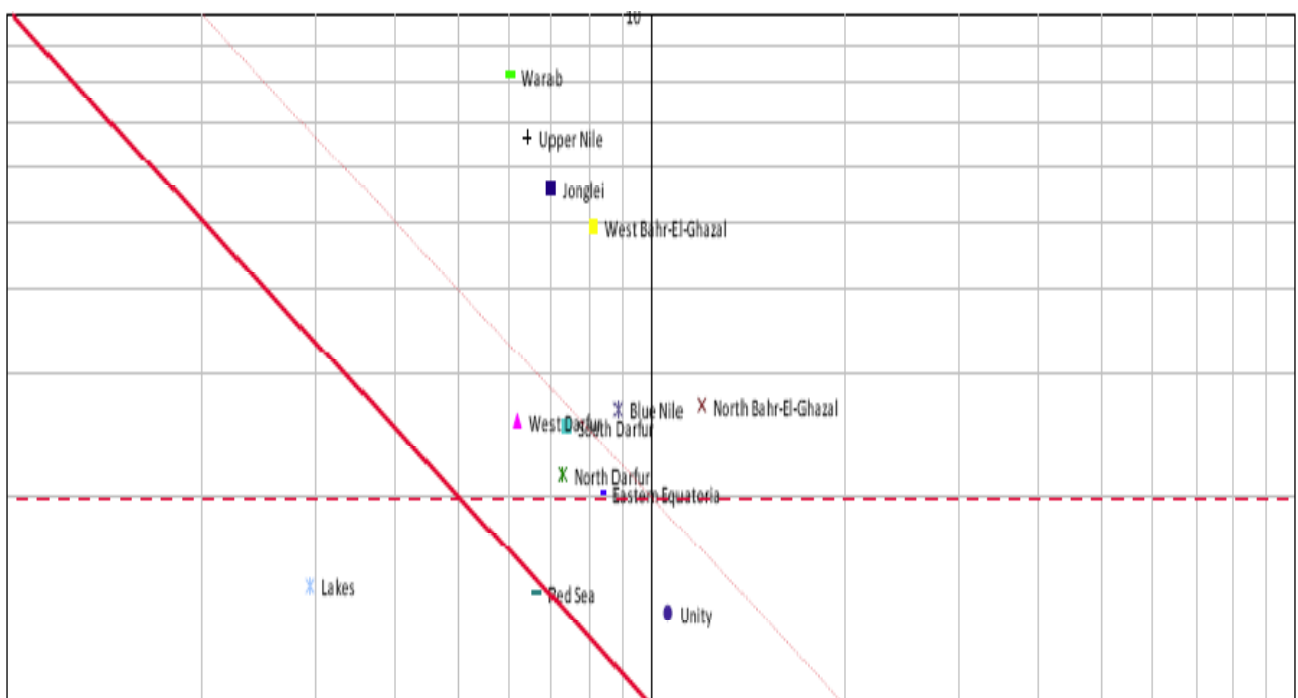
In general, few deaths in DRC seem to be attributable to direct causes. However, the Kivu provinces and Province Orientale have probably experienced a considerable amount of direct deaths. The other provinces show higher mortality, but mainly attributable to indirect causes.

3.4.5. Figure 5: Sierra Leone



For Northern and Southern provinces there is little evidence of high numbers of direct deaths. Eastern province seems to have some morality attributable to direct causes, but this remains relatively low.

3.4.6. Figure 6: Sudan



The general picture for Sudan seems to suggest a mix of direct and indirect deaths. Four provinces from Southern Sudan have extremely high mortality rates, likely to be mainly indirect, but probably with some direct deaths. A similar distribution can be noticed for the

Darfur region, albeit with a lower magnitude of mortality. North Bahr-El-Ghazal appears to be the province with the highest share of indirect deaths. Finally, the chart suggests that Lakes and Red Sea provinces had the highest proportion of direct deaths. For the province of Lakes however, the CE-DAT staff judged the quality of the surveys to be questionable and therefore the result could be unreliable.

3.5. Limitations

The methodology is subject to some important limitations.

1. The estimation is based on mortality surveys. Its accuracy therefore depends on the quality of the mortality surveys that are used. In general, the more recent surveys tend to be of a better quality than older surveys. Several initiatives have been launched and widely adopted in recent years to improve survey quality, ie. Standardized Monitoring and Assessment in Relief and Transition (SMART, 2006).
2. The methodology does not consider the absolute value of CMR or U5MR. Instead, the increase of the rates compared to a baseline rate ($\text{increase} = \frac{\text{observed CMR}}{\text{baseline CMR}}$) is used. A baseline rate is the rate we would expect in the country in a normal situation. The Sphere baselines were used as reference values for the expected mortality in the different countries. A different choice of baselines could change the results slightly, although the change would probably be negligible.
3. Since the graphical representation uses averages by province, it is clear that provinces for which many surveys are available will provide a more accurate estimate than provinces with very few surveys. For provinces where only one survey is available, the figure might not be reliable. That is to say, data from one survey is not enough to give a proper idea of a situation.

Conclusion

The quantification of excess mortality and indirect deaths is clearly a difficult task. Several scientifically rigorous methods have been developed and improved by epidemiologists, demographers and statisticians alike in order to provide estimates. These methodologies continue to benefit from research developments in the aforementioned fields and standardization, as evidenced by the SMART initiative and the general increase in quality of data collection and analysis in humanitarian research. Continued innovation in measuring indirect mortality in conflicts will be imperative for understanding the true human impact of mortality in conflicts, prioritizing public health goals for the prevention of disease and malnutrition and providing the evidence base for legal accountability.

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