Mortality in the
Democratic Republic of Congo:
Results from a Nationwide Survey

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Executive Summary

A complex and violent conflict has raged across much of the eastern Democratic Republic of the Congo (DRC) since August of 1998. In 2000 and 2001, the International Rescue Committee (IRC) surveyed areas in the five eastern provinces of the country to document the magnitude of the humanitarian crisis. With improved access and security during 2002, the IRC was able to measure the mortality rate among 9.3 million people accessible in the east, and among 31.2 million people in the west, by conducting a statistical sample survey. In both the east and the west, 10 health zones were selected systematically, proportional to population, and 225 households were interviewed in each health zone. The findings indicate that:

- **The mortality rate in the DRC is higher than the United Nations reports for any country in the world.** The crude mortality rate (CMR) among the people surveyed in the east was 3.5/1000/mo. (95% CI = 2.2 - 4.9); the figure was 2.0/1000/mo. (95% CI = 1.5 - 2.6) among those surveyed in the west. This indicates a national mortality rate of 2.2/1000/mo. if the 5 million inaccessible easterners are ignored, or 2.4/1000/mo. if the inaccessible are assumed to have the same mortality as the surveyed eastern population. This rate is twice the African average and almost twice the 1.3/1000/mo. reported by UNICEF for the DRC in 1997, the year before the war began.

- **Health conditions in the east are far worse than in the west.** Aside from having a higher crude mortality, the under-five-year-olds in the east die at twice the rate of those in the west: 9.0/1000/mo. [95% CI = 4.0 - 14.0] vs. 4.4/1000/mo. [95% CI = 3.2 - 5.7]. Likewise, population growth is non-existent in the east and is 1.6% per year in the west. People in the west have a higher birth rate, one-third the rate of lost pregnancies, and lower rates of death from disease. In three of the ten health zones visited in the east, more than half the children die before the age of two years.

- **The rate of death from violence in the east has decreased dramatically.** Compared to previous IRC surveys, in 2002 people in the east reported less than one-tenth the previous reported rate of death from violence. Both in places surveyed in the past and again in 2002, and as an overall average, the rate of violent death decreased dramatically in 2002 compared to the previous three years. In past surveys, violent death rates have consistently been correlated with the overall crude mortality. Probably not by chance, the only surveyed health zone with a large recorded outbreak of violence, Kisangani Ville, was the one place where the CMR increased from previous mortality surveys.

- **Mortality in the eastern DRC decreased in 2002 compared to past years.** The CMR of 3.5/1000/mo. recorded during the 2002 surveys contrasts with the IRC's previous CMR estimate of 5.4/1000/mo. for the period August 1998 to April 2001. In four out of five locations previously surveyed during this war and revisited as part of this survey, the CMR dramatically decreased. The lower rates of death and violent death, and an increase in the areas accessible to survey teams, all indicate an overall improvement of conditions in the eastern provinces.

Based on past and current IRC data,[3] it is estimated that **3.3 million people have died as a result of this war.** While this estimate could vary from 3.0 to 4.7 million depending on assumptions about the populations excluded from the survey, the conclusion remains the same: this is the most deadly war ever documented in Africa, indeed the highest war death toll documented anywhere in the world during the past half-century.

Many factors may have contributed to the improved health conditions in eastern DRC in 2002. While historians, public health workers and politicians would benefit from studying the causes of this exceptionally deadly conflict, they may profit still more by determining what caused the favorable turn of events during the fourth year of the war.

Nevertheless, the present CMR of at least 3.5/1000/mo. among 9 to 14 million people in eastern DRC is a crisis of extraordinary proportions, and the adverse consequences of this war continue. If the world's peacemakers and the international community fail to give due attention to this crisis at this crucial time, all of the gains made to date could easily be lost. It is hoped that the positive trends in mortality rates documented in this report will encourage diplomatic and humanitarian efforts and inspire the international community to stay the course toward peace.

List of Terms

ARI	Acute Respiratory Infection
CBR	Crude Birth Rate
CDC	Centers for Disease Control and Prevention
CMR	Crude Mortality Rate
DRC	Democratic Republic of the Congo
EPI	WHO Expanded Program on Immunizations
GPS	Global Positioning System
IRC	International Rescue Committee
MCZ	Medecin Chef de Zone
MERLIN	Medical Emergency Relief
MLC	Mouvement de Libération du Congo
MSF	Medecins Sans Frontieres
<5MR	Under Five-Year-Old Mortality Rate
NGO	Nongovernmental Organization
RCD	Rassemblement Congolais pour la Democratie
TB	Tuberculosis
U.N.	United Nations
UNICEF	United Nations Children's Fund
WHO	World Health Organization

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Background

Following the genocide in Rwanda in 1994, many of the perpetrators fled into eastern Zaire. In subsequent years, these former Rwandan soldiers and militia committed numerous atrocities in Zaire and neighboring areas of Rwanda. In 1996, Uganda and the new administration in Rwanda, in consort with armed Zairean groups, invaded eastern Zaire, purportedly to improve security along Rwanda and Uganda's borders. Within a few months the invading forces, with their Zairean allies, gained control and overthrew the Zairean government, installed a new administration and renamed Zaire the Democratic Republic of the Congo (DRC). Within a year, tensions grew between the Ugandan and Rwandan forces and the newly installed Congolese government. The Rwandan and Ugandan forces largely withdrew from the DRC after an acrimonious falling-out with the new government. In August 1998, Rwanda and Uganda sent troops back into the DRC, reportedly to control the insecurity on their western borders. Within six months, troops from at least seven neighboring countries were fighting in the DRC, along with a variety of Congolese groups taking allegiance with different invading armies.[1] Most of the fighting over the past four years has occurred in the five eastern provinces, which had a population of 19.9 million at the time of the last census in 1996.[2]

In 2000, the International Rescue Committee (IRC) conducted mortality surveys in five health zones in the eastern DRC. The IRC repeated three surveys and studied an additional three zones in 2001. Based on all 11 surveys, the IRC estimated that between August 1998 and April 2001, approximately 2.5 million people died as a result of the war.[3] Most of these deaths were related to infectious diseases induced by displacement, severe poverty and social dysfunction.

In 2001, an accord between Rwanda and the DRC resulted in decreased tensions along the formal line of conflict between the Kinshasa-based government and the invading forces and their two largest Congolese allies: the Rwanda-supported Rassemblement Congolais pour la Democratie (RCD) led by Dr. Adolphe Onusumba, and the Uganda-backed Mouvement de Libération du Congo (MLC) led by Jean-Pierre Bemba. This agreement did not, however, stop the conflict between the RCD (and its foreign allies) and an assortment of Congolese counterinsurgent groups and bands of Rwandan and Burundian rebels inside the DRC. Over the past year, sporadic fighting has continued in parts of all five of the eastern provinces, although the frequency and intensity appears to have diminished compared to the preceding three years.

Since that first accord, there have been many positive developments in the eastern provinces. The number of humanitarian aid programs and the breadth of their services have increased. Approximately 5500 U.N. observers have taken up posts in the DRC, primarily in the eastern provinces. Most importantly, peace talks in South Africa led to the withdrawal of most foreign troops from the DRC in late 2002 and have created a framework for implementing a peace accord and creating a government of reconciliation.

In this environment of improved security and optimism, the IRC undertook a third round of mortality surveys to document the current level of the humanitarian crisis. Unlike in past years, the surveys were taken as a sample of the accessible areas, and the sample was roughly stratified into areas of RCD control and government control to facilitate comparisons between regions. In

total, this survey provides a national estimate of the crude mortality rate during the first 10 months of 2002.

Methods

The Crude Mortality Rate (CMR) was estimated using a three-stage cluster survey. In the first stage, 20 health zones (10 in five eastern RCD-controlled provinces, 10 in western DRC) were selected for study systematically, proportional to population (the WHO EPI method). Thirty-five percent of the 14,273,888 people in the rebel-controlled areas lived in health zones too unstable to visit. These areas were excluded from the site selection process. All government-controlled areas, as well as rebel-controlled areas of the Kasai's and Equateur Province, were considered available for selection on the western side.

In the second stage, 15 clusters were assigned to the smallest unit to which populations could be attributed from the documents in the health zone offices. In different health zones, these units were either clinic areas, urban avenues or villages.

In the final stage, specific locations were selected using one of three methods:

Population-based Sampling (preferred): Clusters were assigned to population units by village, urban avenues or urban neighborhoods, where the population was known. Ideally, communities were broken down by administrative unit or by geographical areas with fewer than 100 households. These areas were mapped, or the houses counted, and one household was selected at random to be visited by interviewers. The interviewers also visited the 14 occupied households closest to the first. In settings where the houses were spread over a large area, a GPS unit was used to determine which households were closest to the primary one.

Neo-population-based Sampling: If further population breakdowns were unavailable within a clinic area or urban neighborhood, a specific location was selected by choosing a village or urban neighborhood or avenue even though the exact population of them was unknown. Clinic workers or local leaders were asked if any villages were particularly large or small, and how much larger or smaller they were compared to neighboring villages. In the case of urban areas with avenues, the length or density of housing on the avenue was visually examined to make a crude weighing of the relative populations of the avenues. Then villages or avenues were assigned numbers, with the larger populations assigned multiple numbers, and a location was selected by choosing a number at random. In rural villages where the organization of the houses did not permit an organized division, and where the huts were too numerous to count within a few minutes, the village was subdivided into areas of 20 to 100 households. The houses in these areas, villages or avenues were counted, and one house was selected at random as the starting point. As described above, the closest 14 occupied households within the sub-divided area were also interviewed.

Spatial Sampling (last resort): Where the location of the population was not precisely known, or the population was widely spread (not in villages), the starting point for clusters was selected using the Global Positioning System (GPS). Within each clinic area, a crude map was made, usually by measuring the distance across the clinic area with a GPS unit. Then, an imaginary grid was superimposed on the map. Random numbers were assigned to locations on the grid. For example, if

an area was 1.00 km north-south by 1.00 km east-west, and the reference point (0,0) was the southwest corner, two numbers between 001 and 100 would be chosen. The first number would correspond to the distance (in tens of meters) that interviewers would travel north from the reference point, and the second number would correspond to the distance they would move east to the starting point. The interview team approximated their present location on the grid and calculated the distance and direction to the chosen random point. A GPS unit was used to guide investigators to the targeted locations (± 10 meters). The 15 households closest to each chosen location were visited.

For all sampling methods, a minimum sample size was selected to enable detection of +/- 1.0 with an overall mortality of 5.0/1000/mo. in the eastern DRC. This calculation assumed that visiting clusters of 15 households would reduce the statistical power of each health zone sample by 23% (the "design effect" = 1.3), and the sampling of 10 health zones on each side of the line of conflict would produce a design effect of 4.0.

For all three household selection techniques, if no one was home, or if members of a household refused to be interviewed, that house was skipped and the next was visited. After the survey team explained the purpose of the survey and obtained a verbal willingness to participate, all interviewed households were asked the age and gender of each household member. Only those who had slept in a particular household on the preceding night were included as household members. Decedents needed to have slept in the interviewed household or been with the interviewed family at the time of their death to be considered for analysis. Interviewees were asked to list all known pregnancies that had occurred during 2002. Pregnancies were recorded in one of four ways: as a live birth, an ongoing pregnancy, a spontaneous abortion, or a stillbirth. Interviewers then inquired about any deaths that may have occurred, and if they had, the age and gender of the decedent, and the cause and month of death. No independent confirmation of these deaths was obtained.

Analysis

CMR is defined as:

[(the number of deaths in sample) / (the number of living in sample + ½ deaths in the sample population during the recall period – ½ those born during the recall period)] x (1,000) / (the recall period).

Mortality in this report will be expressed as 'deaths/1,000 population/month.' (For comparison to the "emergency" mortality unit of 'deaths/10,000/day': 3 deaths/1,000/mo. = 1 death/10,000/day = 36 deaths/1000/yr.)

The under-five mortality rate (<5 MR) is estimated as:

[(deaths among those <5) / [(those alive <5 + ½ deaths <5 during recall period)] x (1,000) /(recall period).

This equation makes the assumption that the total number of children born during any window of the recall period and the number of children turning five during any window of the recall period remained constant.

The under-one mortality is expressed as a percentage of all births occurring in a year that result in death before the child reaches 12 months of age. That is:

%<1 mortality = [(deaths among those <1 during recall period) / those born during recall period)] X 100

Unlike the rates described above, many, if not most, of the under-one deaths that had occurred in the recall period were among children born before the recall period. Thus, this estimate makes the assumption that the birth rate remained constant throughout the year preceding the survey.

The recall period was defined as the length of time between Jan. 1, 2002, and the median day of the specific survey. That is, if a survey was conducted from Sept. 21 through Sept. 25, the recall period would be said to end Sept. 23.

Crude birth rate (CBR) in this report is reported as live births per 1000 living population.

Results

Validity

Two of the 10 health zones selected in the east could not be surveyed, one because of the refusal of local authorities to cooperate and the other because of the refusal of pilots to fly to unstable areas. In each case, the closest neighboring health zone was surveyed as a substitute. Of the 150 cluster locations selected in the east, five (3%) were not completed due to time and logistical constraints, and an additional five (3%) could not be reached for security reasons. In the case of insecure villages, the nearest accessible population was visited as a substitute. In the west, all 10 selected health zones were successfully surveyed and all 150 populations assigned clusters were successfully reached. Of the total 295 clusters interviewed, 186 (63%) involved households selected by population based sampling, 92 (31%) involved neo-population-based sampling, and 17 clusters (6%) relied on spatial sampling.

Over the course of the study, 0.2% (nine households) refused to participate, although 18% of households in the east and 23% of households in the west were unoccupied at the time of the visit. Some of these households may have been abandoned, but we believe that most of the residents of these households were simply away for a period of hours or days. In order to explore the potential differences between occupied and unoccupied households, we repeatedly visited 20 households in Kalima that were empty at the time of the initial visit and successfully interviewed 18 of them. The data from these interviews was not included in the Kalima mortality estimate. The initially empty households were slightly smaller (6.9 vs. 7.6 persons) and had experienced more mortality (4.3 vs. 3.0 deaths/1000/mo.), although neither of these differences was statistically significant, perhaps because of the small numbers of revisited households. Thus, the limited evidence available indicates that the empty households may result in a survey estimate of mortality that is lower than the actual rate.

Mortality

The CMR in the eastern DRC was 3.5/1000/mo. (95% CI = 2.2 - 4.9) and the <5 MR was 9.0/1000/mo. (95% CI = 4.0 - 14.0) over the first 9.1 months of 2002. The CMR in the western DRC was 2.0/1000/mo. (95% CI = 1.5 - 2.6), while the <5 MR was 4.4/1000/mo. (95% CI = 3.2

- 5.7) over the first 9.3 months of 2002. Although the CMR appears to be higher in the east than in the west, this finding is not quite statistically significant (p=.07 using a d-test for comparing two distributions using a pooled variance). The results for individual health zones are shown in Tables 1 & 2.

Table 1: Results of 10 health zone evaluations in the eastern DRC

	Place	Date	Interviewed Population	Births	Deaths	CMR (deaths/ 1000/mo.)	<5 MR (deaths/ 1000/mo.)
1	Katana	9/25/06	1323	45	22	1.9	2.9
2	Kalemie	9/28/30	1372	34	51	4.2	14.9
3	Butembo	9/29 – 10/2	1373	34	5	0.4	2.1
4	Kayondo	10/3-4	895	26	7	0.9	1.4
5	Pweto	10/5-7	1119	40	50	4.8	15.8
6	Kisangani	10/8-9	1902	64	110	6.2	10.4
7	Kalima	10/10-13	1712	61	47	3.0	8.9
8	Aketi	10/11-15	1354	60	58	4.6	9.4
9	Mweso	10/16-18	1066	52	65	6.3	24
10	Isiro	10/20-22	1309	40	28	2.2	4.7
		Total	13425	456	443	3.5 (95% CI= 2.2 - 4.9)	9.0 (95% CI= 4.0 – 14.1)

Design effect = 17.1

Table 2: Results of 10 health zone evaluations in the western DRC

	Place	Date	Interviewed Population	Births	Deaths	CMR (deaths/ 1000/mo.)	<5 MR (deaths/ 1000/mo.)
1	Kimbanseke	9/14-15	1523	36	23	1.8	4.3
2	Popokabaka	9/17-23	1064	34	28	3.0	8.9
3	Lukula	9/26-27	1232	50	15	1.4	4.6
4	Lukonga	10/2-3	1161	51	41	3.9	7.9
5	Bipemba	10/4-5	1199	62	30	2.8	5.1
6	Kabongo	10/12-13	1381	69	29	2.3	5.5
7	Panda-Kapolwe	10/18-19	1019	47	16	1.7	4.1
8	So. Lodja	10/25-26	1653	66	20	1.2	5
9	Kahemba	11/1-4	1278	38	18	1.4	3.3
10	Gbadolite	11/14-16	1407	63	26	0.6	3.9
		Total	12,917	516	246	2.0 (95% CI = 1.5– 2.5)	4.4 (95% CI = 3.2 – 5.7)

Design effect = 3.9

If the 5 million inaccessible people in the east are left out of the equation, these results indicate that the weighted average mortality in the DRC from January to October 2002 was 2.2/1000/mo. If the 5 million inaccessible people are assumed to have the same mortality as those easterners surveyed, the mortality rate was 2.4/1000/mo.

Cause of Death

Families attributed a cause to almost all reported deaths. Among children <5 years of age, the majority of reported deaths were ascribed to febrile illnesses, diarrhea, neonatal mortality, acute respiratory infections (ARI), measles and malnutrition. Among people >4 years of age, the majority of deaths were ascribed to febrile illness, diarrhea, TB, ARI and malnutrition. It should be emphasized that causes of death were not verified and that no formal verbal autopsy procedure was employed. The reported causes of death for those <5 years and those >4 years are presented in Figures 1-4 for both the eastern and western areas surveyed. [Due to logistic constraints, western cause of death data is not included for South Lodja (this includes 10 deaths among children <5 and 10 deaths among those >4).]

Of note is the apparent abundance of measles deaths in the east (21 in the east vs. 4 in the west), as well as HIV-attributed deaths (10 in the east, 0 in the west).

Violence

War-related violence accounted for no deaths in the west and only 7 of 443 deaths (1.6%) reported in the east. This compares to 69 violent deaths of 624 deaths (11.1%) recorded by the IRC in 2000, and 84 violent deaths of 894 (9.4%) in 2001.[4] By chance, two areas (Kalima and Kalemie) were selected for both the 2001 and 2002 surveys, and were evaluated both years using similar methods. Kalima and Kalemie are important because they had the highest rates of mortality and violence of the six locations surveyed in 2001. Kalima had a CMR of 7.1 (95% CI: 6.3 - 8.7) between January 2000 and March 2001, which decreased to 3.0 (95% CI: 2.2 - 3.9) deaths/1000/mo. in 2002. Kalemie had a CMR of 10.8 (95% CI: 9.5 - 12.1) between January 2000 and March 2001, which decreased to 4.2 (95% CI: 2.8 - 5.6) deaths/1000/month during 2002.

Table 3: Mortality in Kalima and Kalemie, 2000 vs. 2002

Time Frame	Kalima		Kalemie	
	CMR	Confidence Int.	CMR	Confidence Int.
Jan '00-Mar '01	7.1	95% (6.3-8.7)	10.8	95% (9.5-12.1)
2002	3.0	95%(2.2-3.9)	4.2	95% (2.8-5.6)

Combining these two areas, the 69 violent deaths among 600 households over 16 months seen in 2000-2001 (1.04 violent deaths/1000/mo., 95% CI: 0.79 - 1.29) correspond to a violent death rate 26 times higher than the one violent death reported by 450 households over 9.1 months of 2002 (0.04 violent deaths/1000/mo.).

Kisangani Ville was the only place visited where multiple violent deaths were reported (5), and all were shootings, allegedly by Rwandan soldiers. These violent events are further explored in the Discussion section.

Birth Rates

The crude birth rate (CBR) in the east (44/1000 population/year [95% CI= 38 - 50/1000/year]) was lower than in the west (52/1000 population/year [95% CI= 43 - 60/1000/year]). The population-based rate of spontaneously aborted pregnancies plus stillbirths was 2.3 times greater [95% CI= 1.55 – 3.45] in the eastern areas than in the west. Of the 395 pregnancies recorded in the eastern areas, 82 (21%) ended with a dead fetus, compared to 34 of 487 (7%) in the west. Thus, known pregnancies in the east were 3.0 times [95% CI= 2.0 – 4.3] more likely to end in a spontaneous abortion or a stillbirth compared to known pregnancies in government-controlled areas of the west.

Survey Limitations

There are several factors that are likely to cause the survey to underestimate the level of mortality experienced in the Congolese population. These include:

Limited Access

Almost 5 million Congolese, primarily in the northeastern parts of Orientale Province and in the Haut Plateau, were excluded from this survey due to insecurity. It is strongly suspected that these people had a higher mortality rate during 2002, based on past surveys that found higher mortality in insecure areas.

While the methods of selecting and interviewing households in past and present IRC surveys were similar, it should be noted that there were major changes in the way health zones were selected for study. In the past, few health zones were accessible and locations were visited as security permitted. In 2000 and 2001, however, one or two "hot" places were inadvertently surveyed. Because the level of information regarding security was superior in 2002, the current survey excluded one-third of the population from visitation. Thus, while the 2002 surveys were undertaken using a more scientifically rigorous process, they may be biased toward a low mortality estimate because the most violent areas were avoided.

Substitution of Selected Sites

The fact that Pawa Health Zone in the east became insecure between August 2002, when it was listed as accessible, and October 2002, when the interviewers wanted to visit, may further bias sampled populations toward lower mortality. The substitution of Kayondo for Musienene Health Zone, where the authorities prohibited the survey team from working, is likely to have lowered the mortality estimate, as the CMR in Kayondo was the second lowest seen in all of the DRC. There is no known problem or bias with the populations accessed within those health zones selected. Likewise, five of the 150 cluster sites selected in the east were substituted because of safety issues, suggesting a slight potential for downward bias in the mortality estimate.

Influence of Empty Households

The fact that nearly one-fifth of households selected were empty at the time of our visit is worth consideration. The follow-up interviews with 18 of these households in Kalima, while limited in scope, indicate that absenteeism may have artificially lowered the mortality estimate of this survey. If the trend seen in Kalima (mortality 43% higher among those households not at home)

were true throughout the Congo, the corrected CMR for the east would increase from 3.5 to 3.8 deaths/1000/mo. and in the west from 2.0 to 2.2 deaths/1000/mo. While this trend does not dramatically alter the perception of the level of suffering, it implies that the survey results may underestimate the number of deaths.

Under-Reporting of Child Deaths
Past experience has indicated that the under-reporting of infant deaths is a consistent problem in surveys in rural Africa. The Centers for Disease Control and Prevention (CDC) in Atlanta undertook a series of studies in the former Zaire about the ability of "cold call" interviews to estimate infant and child mortality.[4] They reported that women 50 to 54 years of age failed to report 72% of children born to them if the child had died, while women aged 15 to 19 years failed to report 50% of children born to them who had died. The CDC findings raise the concern that this survey may have underestimated mortality. Becker et al. have shown a similar level of infant death under-reporting in Liberia.[5] To overcome this potential for mothers to under-recall children who died, the recall period during this survey was limited to 2002, and all households were asked about pregnancies in the past year before they were asked about deaths.

Seasonal Mortality Patterns
Finally, a seasonal death rate has been observed in some health zones in past surveys, with peaks of mortality generally associated with the end of the rainy season, which falls between November and January. Because the months of November and December were not captured in this survey, there is the potential of a downward bias in the mortality estimate.

Limitations on Reported Cause of Death
It is difficult to validate data relating to cause of death. While we suspect that deaths from violence, accidents and measles are reported accurately, deaths resulting from ARI and malaria are probably reported with less accuracy. Thus, considerable caution should be employed when quoting cause of death results.

Discussion

There are several issues related to the survey results that require further exploration or explanation than what is conveyed by simple mortality rates. The IRC conducted over two-dozen mortality surveys of health zones within the DRC in 2000 and 2001, and many facets of these results complement or contrast with past results. For simplicity's sake, the discussion of related issues will be limited to five topics: violence as the linchpin to excessive mortality in the eastern DRC, births and spontaneous abortions, mortality in the east vs. the west, the apparent decrease in mortality, and the staggering death toll of the war.

Violence as the Catalyst for Excess Mortality

In previous surveys, the overall mortality rate was strongly associated with the violence-specific mortality rate: areas with the most violence tended to have the highest non-violent mortality as well.[3] Within these areas, parts of health zones with the poorest security tended to have the highest death rates.[6,7] In one population (Kalonge 1/99 – 4/00), as violence increased over time, death from infectious disease increased correspondingly.[6] The link between death from violence and death from

infectious diseases and other non-violent causes of death was assumed to be a consequence of the displacement and economic and social disorder that accompanied outbreaks of violence. The results from the 2002 survey hint that this relationship may be more complex.

This year's survey found that the overall mortality decreased in the eastern DRC compared to previous years. The estimated rate of 3.5 deaths/1000/mo. in 2002 in the east contrasts with the previously estimated rate of 5.4 deaths/1000/mo. during August 1998 to April 2001.[3] While many factors may be acting to bias the results from 2002 downward, similar biases existed in past surveys as well. Many changes occurred between the two survey periods that we believe contributed to the reduction in mortality. A peace accord that stopped hostilities along the front between the Kinshasa-based government forces and their allies and the Rwandan and Ugandan troops and their Congolese rebel allies was signed in early 2001. Additionally, 5500 UN observers arrived and undertook operations during the intervening period, and the amount of humanitarian assistance and workers increased dramatically.

Most strikingly, the rate of violent deaths recorded in these surveys is approximately one-tenth the rate seen in previous years (0.056 violent deaths/1000/mo. compared to 0.55 in the 2001 surveys and 0.63 in the 2000 surveys). Indeed, the rate of violence in the two study areas most affected by violence in 2001, and revisited by chance in 2002, diminished by 96 percent. It is very likely that the decrease in violence rates is a primary cause of the decrease in CMR in the eastern DRC.

Only one place showed an increase in mortality from previously documented rates, Kisangani Ville. According to IRC data, Kisangani Ville experienced the most death from violence of any of the 20 health zones visited by the study teams in 2002. Five violent deaths were reported among interviewed households. According to the family members, all five victims were shot by Rwandan soldiers. By contrast, in 1999, there was one violent death reported among the 80 households interviewed in Kisangani Ville, and none in the 160 households interviewed from other parts of the city.

There are three health zones within the urban area of Kisangani: Kisangani Ville; the more northern and less urban area of Kabondo; and Lubunga, the area on the south shore of the Congo River. In 2000, the IRC, in conjunction with MSF-Holland, recorded the mortality in all three sections of the city from January 1999 to March 2000. In addition, the mortality in Lubunga was recorded by the IRC between January and August 2002 as part of its evaluation of its ongoing health program there. The mortality in Kabondo was measured by the IRC in November 2002 as a follow-up to this survey in order to understand the high mortality found in Kisangani Ville. Figure 5 shows the mortality in these three areas. Of note is the dramatic increase in mortality in Kisangani Ville compared to the other two areas of the city.

Kisangani Ville has been pledged medical support by UNICEF and WHO, but does not receive the level of clinic support provided by MSF in Kabondo or the IRC in Lubunga. It is not likely that this difference alone accounts for all of the elevated mortality in Kisangani Ville.

In early 2002, tensions arose between Rwandan soldiers and locals in Kisangani. This tension culminated in May with the killing of at least 200 Congolese, according to the BBC.[8] The point estimate of the rate of violent death from the IRC survey (.261% among 244,000 people) would imply

637 violent deaths [95% CI: 5 - 1830]. The IRC's staff in Kisangani reported that this violence was predominantly limited to Kisangani Ville. Unlike past episodes of violence recorded in IRC surveys, the residents of Kisangani Ville are known to have remained home and the economy of Kisangani did not shut down. In fact, two weeks later, a U.N. report indicated that the shops were reopened and that the schools were operating despite a tense atmosphere. Figure 6 shows the deaths by month among interviewed households in Kisangani Ville. Figure 7 shows the number of deaths in the other surveyed areas of the eastern DRC.

The excess death rate seen in Kisangani occurred proportionally less among children <5 years than in any of the other 19 health zones surveyed. This finding, while proving little, is consistent with the idea that the elevated mortality in Kisangani was not driven by disease transmission dynamics or access to health care, both of which would disproportionately impact children.

Given that little or no economic recovery occurred between the time of the IRC's last surveys (April 2001) and 2002, the apparent reduction in mortality in the eastern DRC in those areas surveyed may have been largely triggered by the subsiding of hostilities in those areas. The data from Kisangani indicates that, at least there, the link between elevated mortality and violence may be related more to individual or social stress than to physical displacement and economic disruption. The death rate in Kisangani Ville during the first four months of 2002 (3.9/1000/mo.) was markedly less than during May – September 2002 (7.1/1000/mo.) This trend was not observed in the other areas surveyed. Further study is needed to understand what role stress plays in excess mortality in violent settings, and thus what interventions are most needed to prevent such mortality.

Births and Pregnancy Loss

The crude birth rate among the population in the eastern DRC is statistically significantly lower than the rate in the west (p<.001). This difference is not surprising, given the stress and nutritional hardship experienced in the areas of armed conflict in the east. What is interesting is that there does not seem to be a reverse relationship between birth rates and mortality. Figure 8 shows a scatter plot for the rate of births vs. the rate of mortality for the 20 populations surveyed. Other than perhaps a trend toward low birth rates in the areas of lowest mortality, there seems to be a steady rate of about 40 births per 1000 people per year over a wide range of mortality rates. This contrasts markedly with the reported rates of fetus loss in Figure 9, which shows a strong trend toward more frequent fetus loss in the areas of highest mortality. Such a trend is consistent with the results indicating that pregnancies are three times more likely to end in a spontaneous abortion or stillbirth in the east than in the west.

It would appear that pregnancy loss is far more sensitive to the hardship associated with the eastern DRC over the past year than either mortality or CBR. Because pregnancy loss is relatively difficult to detect and record, it is not likely that it can be used as a monitoring tool for documenting human hardship. Rather, further investigation is needed to understand the possible physical (e.g. malaria-related or nutrition-related) or psychological factors which are inducing this pregnancy loss.

East vs. West

The IRC conducted surveys to gain insight into the mortality experience of the five eastern provinces of the DRC in 2000 and 2001. While the IRC only acknowledges the existence of one DRC

politically, most of these provinces remain out of the direct control of the Kinshasa-based government. Thus, to facilitate comparisons with survey results from past years, a sample of 10 health zones was taken in the areas of the five eastern provinces not controlled by the Kinshasa-based government, and a separate sample of 10 health zones was taken in the six western provinces predominantly controlled by the Kinshasa-based government. With one exception (South Lodja), the eastern sample can be thought of as the rebel-held areas and the western sample as the Kinshasa-based government-controlled areas. This simplification ignores that fact that Aketi in the east and Gbadolite in the west are controlled by a third political power. Because Aketi can be accessed only from the east and transport to Gbadolite can be arranged only in Kinshasa, these two "Bemba" held health zones do not detract from the general conclusions regarding differences between the east and the west.

By virtually all measures, the population's health appears worse in the east than in the west. The crude mortality rate, birth rate and other factors that contrast the east and the west are shown in Table 4.

Table 4: Contrast in health events in the samples of the eastern vs. western health zones

Indicator	East	West
CMR: deaths/1000/mo.	3.5 (95% CI = 2.2 - 4.9)	2.0 (95% CI = 1.5 - 2.6)
<5 MR: deaths/1000/mo.	9.0 (95% CI = 4.0 – 14.0)	4.4 (95% CI = 3.2 - 5.7)
% newborns dead by 12 mo.	21.0%	11.6%
Births/1000/mo.	44 (95% CI = 38 – 50)	52 (95% CI= 43 – 60)
% pregnancies lost	21.0%	7.0%
% population <5	16.3%	19.4%
Average HH growth rate	0.00%	1.58%
Measles-related deaths	21 of 443 (4.7%)	4 of 246 (1.6%)
HIV-reported deaths	10 of 443 (2.3%)	0 of 246 (0%)
Violence-related deaths	7 of 443 (1.6%)	0 of 246 (0%)

In specific health zones of the east, particularly dire circumstances were recorded. For example, in Kalemie, 66% of children die before reaching 2 years of age. This fraction was 59% in Mweso, and 53% in Pweto. Thus, while conditions are generally poor in the east, clearly there are areas with acute needs that are not being met.

The ongoing conflict in the east explains the relatively poor health condition of the population in comparison with the west. Yet the health conditions in the west are relatively poor compared to Africa generally. The crude mortality measured by this survey in the western DRC in 2002 is the same as that reported for Sierra Leone in 2001, which had the highest mortality for any country in the world that year, according to UNICEF.[10]

Under stable conditions, rural African populations tend to experience far more births than deaths, and thus are continually growing. During past surveys in the eastern DRC, the chief health zone doctors (Medecin Chef de Zone, or MCZ) in Katana and Kisangani reported that in stable times, including the early 1990s, the rate of population growth was 3%, while the local MCZ reported a rate of 2% in Lusambo. Most health professionals in the DRC assume a 3% annual growth rate while planning vaccination campaigns. The concept of average household growth rate, as

captured in this survey, does not account for immigration or emigration, and therefore may only be a proxy for population growth. The low population growth rate of 1.6% in the western DRC indicates that the west may have also suffered from economic or other consequences of the war.

The attribution of 10 deaths to HIV in the east and none in the west should not be taken as an indication of the relative prevalence of HIV in the two areas. The reluctance of people to report HIV-related deaths and the knowledge of how HIV manifests itself in the late stages of the illness may differ between the eastern and western parts of the country.

Decrease in Mortality Rates

This survey indicates that the rate of mortality has decreased in 2002 compared to the previous three years. Assuming that the previously reported results for 2000 and 2001 were correct, several pieces of evidence (although not entirely independent) imply that conditions in the eastern DRC have improved. These include:

- The CMR measured in 2002 in the eastern DRC was 3.5/1000/mo. vs. an estimated 5.4/1000/mo. previously reported for the period August 1999 to April 2001.
- Four locations visited in this survey had been surveyed previously by the IRC (Katana, Kisangani, Kalima, and Kalemie). Three of the four had a marked decrease in mortality. Two places, Kalima and South Lodja, had been surveyed previously by Medical Emergency Relief, (MERLIN), a British-based NGO. The 2002 IRC estimate reported herein is lower than the two previous MERLIN estimates.
- It is not likely that the areas excluded due to insecurity could explain the decrease in the CMR measured in this survey. The CMR would need to have been 8.9/1000/mo. for the 5 million people who were excluded from the 2002 survey for the overall CMR in the east to be as high as was previously estimated. While the northeastern area of Orientale Province, Ituri, has seen periodic fighting and population displacements in recent months, the area is believed to have approximately 2 million residents at present. These 2 million inaccessible residents would need to have a CMR of 22/1000/mo. (double the worst places previously surveyed by the IRC), and the rest of the inaccessible would need to have an average mortality of 5.4/1000/mo. for the overall mortality in the eastern DRC to be as high as previously estimated. The three areas with the highest mortality rates previously reported by the IRC (Moba: CMR=12.1, 1/99 – 5/00; Kalemie: CMR=10.8, 1/00 – 3/01; and Kalonge: CMR=11.0, 11/99 – 4/00) all involved confrontations with thousands of soldiers and massive population displacements over periods lasting several months. No such violence has been documented in the eastern DRC in recent months. This level of warfare is not known to have occurred since the May 14, 2002, outbreak of violence in Kisangani, which lasted only several days.
- The previous IRC surveys systematically under-sampled the insecure areas, although not with the formality used in this survey. Thus, previous estimates of the CMR in the eastern DRC are believed to have been conservative, supporting the likelihood that the present estimated CMR of 3.5/1000/mo. is an improvement.
- Violence previously has been linked statistically to the overall CMR. The results from the 2002 survey indicate a dramatic decrease in the rate of violence in the eastern DRC.
- In 2000, when the IRC undertook its first round of mortality surveys, very few of the eastern health zones were deemed safe enough to visit. War raged openly across northern Katanga, Maniema Province and Ituri, as well as much of North and South Kivu. The fact that two-

thirds of the health zones in the eastern DRC were listed as accessible in 2002, and that in 9 of 10 selections this proved true, implies that there has been an improvement in security, which is consistent with lower mortality rates.

Estimated Deaths Attributable to the War

The IRC previously estimated that 2.5 million deaths occurred in the eastern DRC between August 1998 and April 2001 above and beyond the million that would have occurred under stable circumstances.[3] A sensitivity analysis examining the range of plausible assumptions about the baseline mortality rate, the extrapolations undertaken, and the time it took for the effects of the war to influence mortality, could only produce a range of imprecision spanning 2.1 to 3.1 million excess deaths. Now that conflict appears to be subsiding, it is valuable to reexamine the number of deaths associated with the war. In order to do so, several assumptions need to be made:

1) The number of excess deaths between August 1998 and April 2001 was approximately 2.5 million, as previously reported by the IRC.
2) Without war, the expected baseline mortality rate would have been 1.5/1000/mo.
3) The 5 million people who were not accessible during the 2002 survey experienced the same mortality during 2002 as the 9.3 million people included in the eastern sampling. This indicates that 343,000 excess deaths occurred in the east in 2002.
4) The rate of decrease in mortality was steady from the period of our last assessment (ending April 2001) to the period covered by this survey (2002). That is, the decrease from 76,000 deaths per month to 28,600 deaths per month was linear over an eight-month period. Therefore, 418,400 excess deaths are assumed to have occurred between May and December 2001.

It is estimated that approximately 3.3 million excess deaths occurred between August 1998 and December 2002 in the five eastern provinces of the DRC. If the baseline mortality rate was actually 2.0 (the rate seen in the western DRC), this would decrease the excess death estimate to 3.0 million. As a worst "reasonable" case scenario, if the inaccessible areas in 2002 were assumed to be equal to the worst two areas surveyed in 2002 (CMR=6.2), and the mortality rates seen in Katanga in 2000 and 2001 applied to two-thirds of Katanga and all of Ituri (which was not surveyed in 2002 due to insecurity), the excess death toll would be 4.7 million.
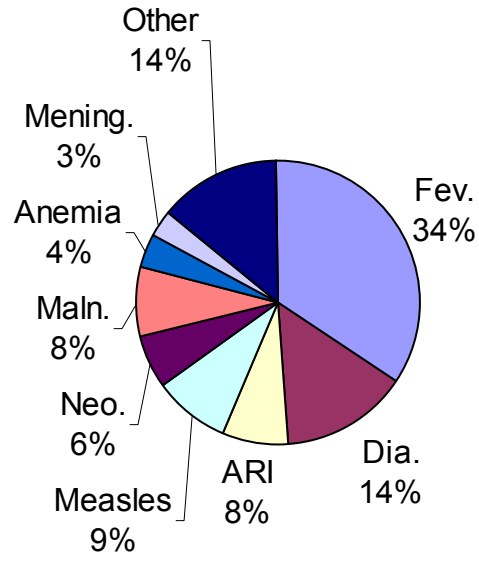
According to the last Zairean census, the population of the five eastern provinces in DRC was 19.9 million in mid-1996. The population was known to be growing at 3% per year. Without immigration or emigration, the population today should be 23,762,000. According to UNICEF's 2002 national vaccination-day estimates (which local authorities have considerable incentives to inflate), the population of the five eastern provinces is 20,893,000. While national vaccination-day figures are crude and unreliable and do not account for Congolese who have fled to safer areas of the west, they are consistent with the estimate that approximately 3 million people have perished in the eastern DRC due to this conflict above and beyond the expected number of deaths.

It is believed that the death toll from the war in the DRC has exceeded that of the Biafran conflict as the highest death toll ever attributed to a war in Africa, or indeed anywhere in the world since World War II.[11] The enormity of this breakdown of society in the DRC is difficult to imagine. What is even more extraordinary about this crisis is the relative lack of attention it has received compared to the last two African crises to involve over a million documented deaths: the Ethiopian famine of 1984 and the Biafran conflict, or even the war in Southern Sudan which has been less well documented. If this war has indeed subsided in its fourth year, political scientists and policy makers would benefit from examining what made it so deadly and what factors brought on its demise.

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6. Roberts L., Mortality in Eastern DRC: Results from Five Mortality Surveys. The International Rescue Committee, May 2000.
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9. Office for the Coordination of Humanitarian Affairs (OCHA), Integrated Regional Information Network (IRIN), Update, May 31, 2002.
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11. http://users.erols.com/mwhite28/warstat2.htm Twentieth Century Atlas, Death tolls accessed, 2/26/03.

Fig. 1: Cause of Death, East <5 years, N=198

Other 14%
Mening. 3%
Anemia 4%
Maln. 8%
Neo. 6%
Measles 9%
ARI 8%
Dia. 14%
Fev. 34%

Fig. 2: Cause of Death, West <5, N=104*

Other 9%
Mening. 7%
Anemia 4%
Maln. 3%
Neo. 15%
Measles 2%
ARI 5%
Dia. 7%
Fev. 48%
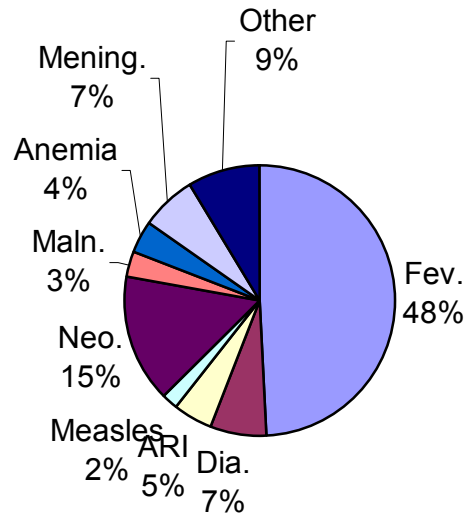
Fig: 3: Cause of death, East >4 years, N=231

Maternal 1%
HIV 4%
Fev. 24%
Other 43%
Dia. 10%
ARI 7%
Mening. 2%
Maln. 3%
Measles 2%
TB 4%
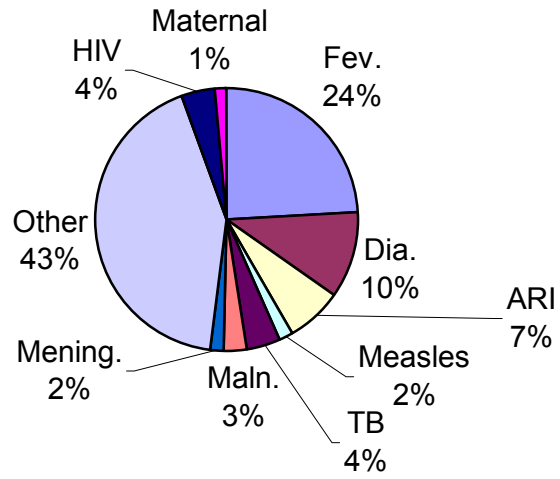
Fig. 4: Cause of death, West >4 years, N=121*

Typhoid 4%
Fev. 27%
Other 35%
Dia. 7%
ARI 5%
Mening. 3%
Maln. 5%
TB 12%
Measles 2%
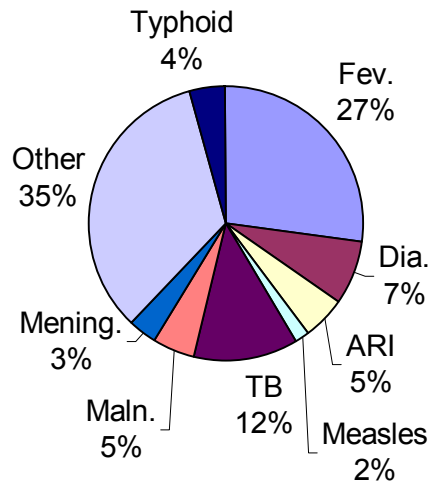
Figure 5: Mortality in 3 areas of Kisangani 1999 and 2002
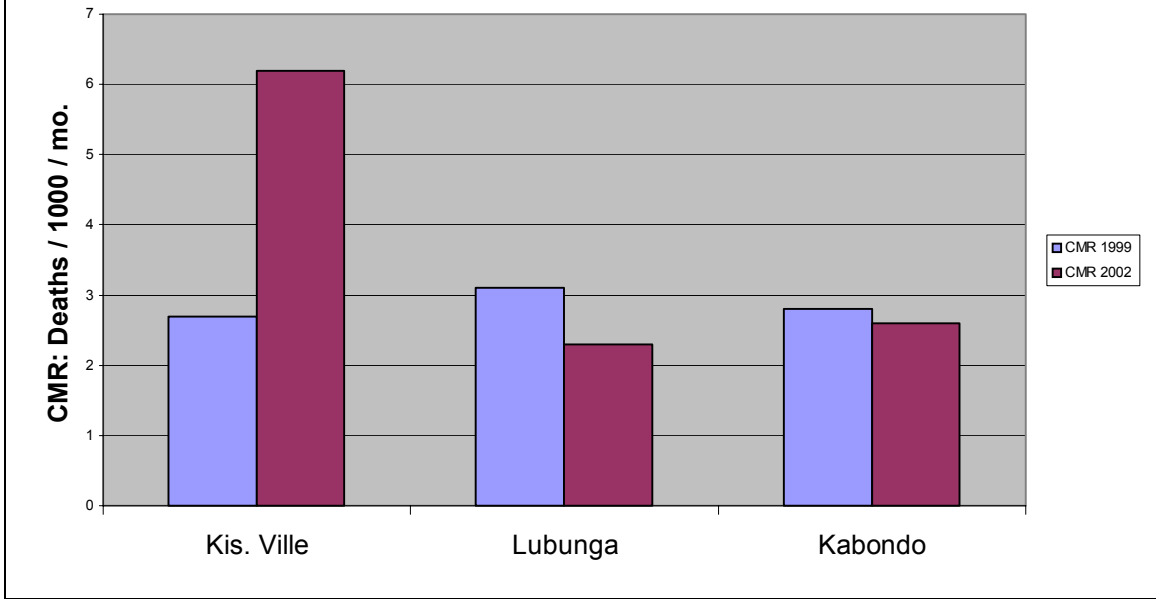
Figure 6: Deaths in Kisangani Ville, by Month, 2002
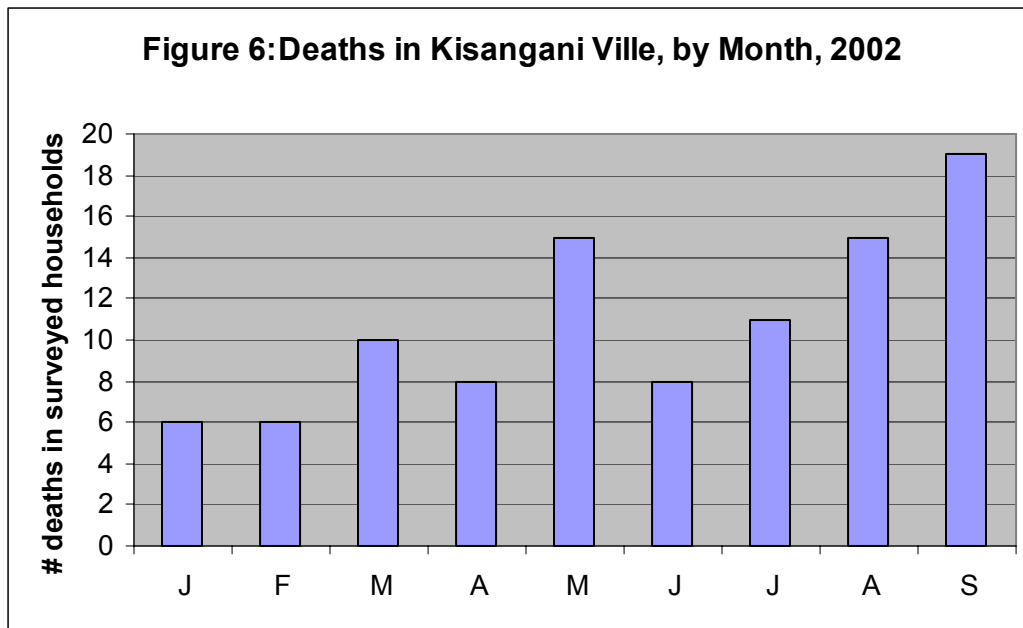
Figure 7: Deaths Elsewhere in Eastern DRC, excluding Kisangani, by Month, 2002
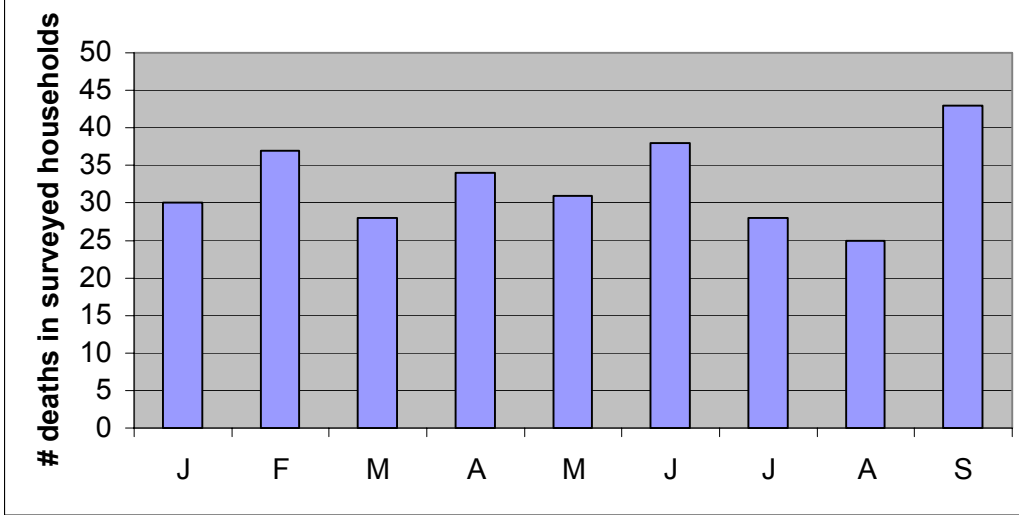
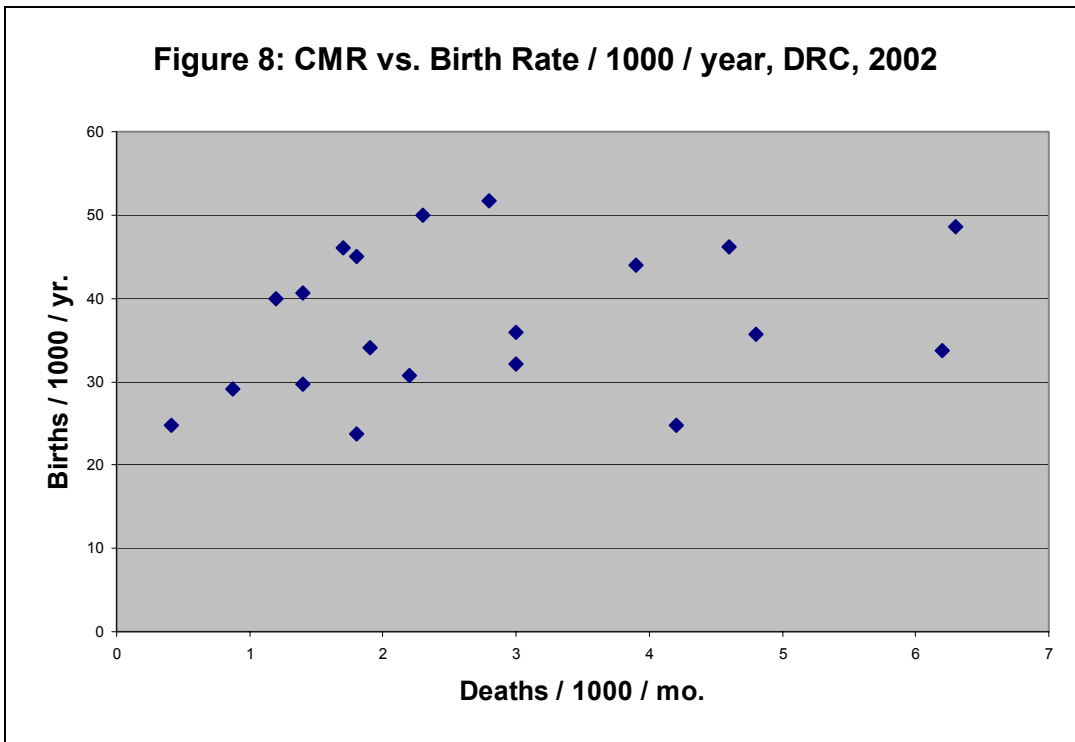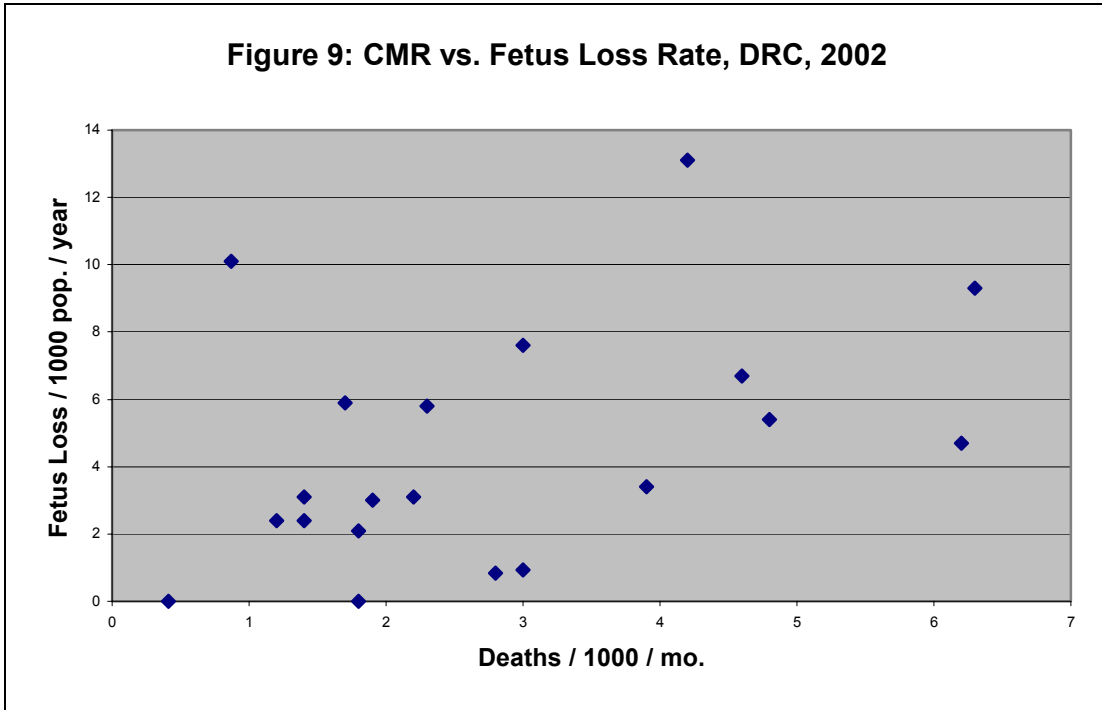**Figure 8: CMR vs. Birth Rate / 1000 / year, DRC, 2002**

Figure 9: CMR vs. Fetus Loss Rate, DRC, 2002

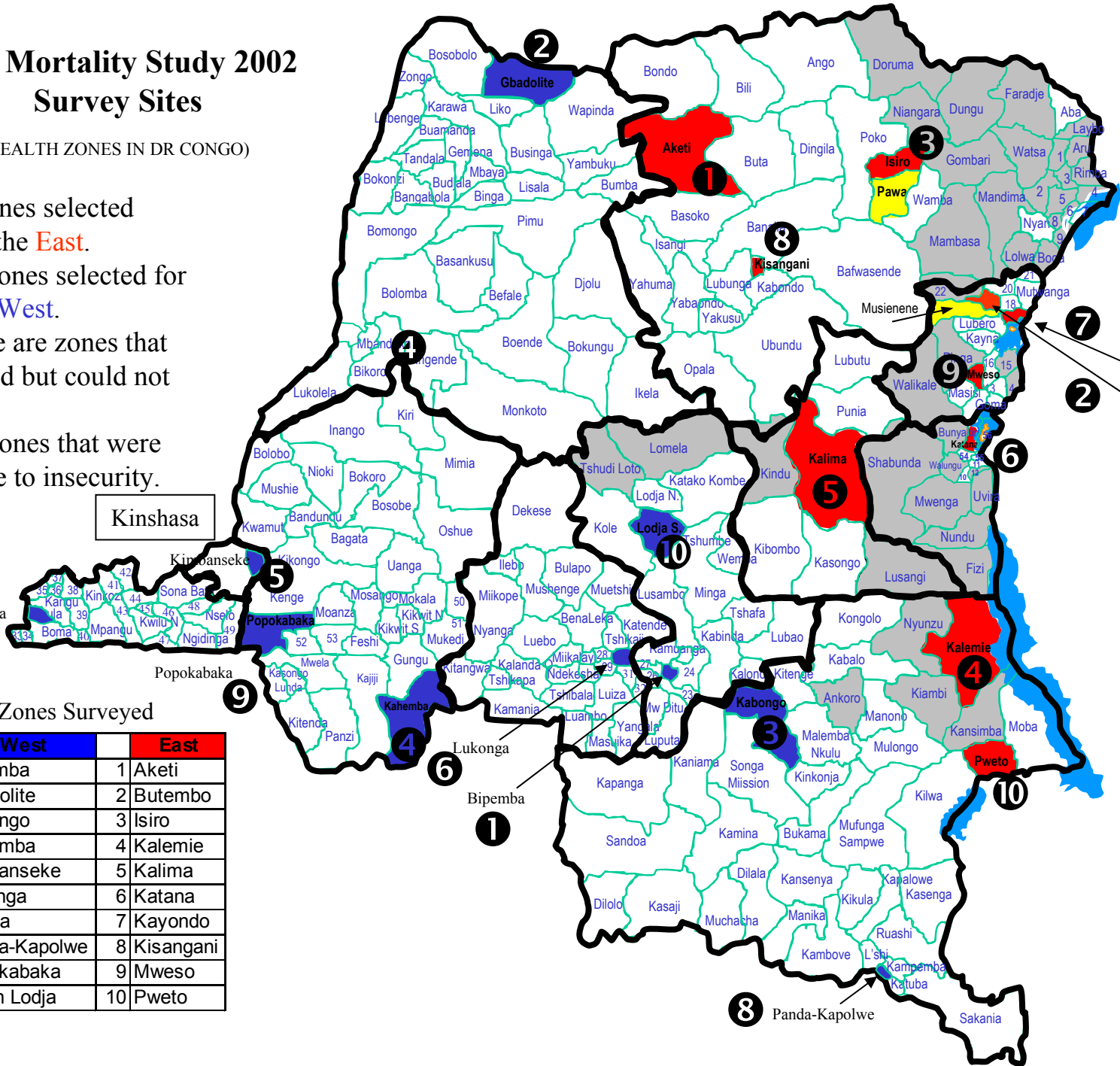# IRC Mortality Study 2002
Survey Sites

(HEALTH ZONES IN DR CONGO)

In red are zones selected for study in the East.
In blue are zones selected for study in the West.
In yellow are are zones that Were planned but could not Be visited.
In grey are zones that were excluded due to insecurity.

Kinshasa

Health Zones Surveyed

	West		East
1	Bipemba	1	Aketi
2	Gbadolite	2	Butembo
3	Kabongo	3	Isiro
4	Kahemba	4	Kalemie
5	Kimbanseke	5	Kalima
6	Lukonga	6	Katana
7	Lukula	7	Kayondo
8	Panda-Kapolwe	8	Kisangani
9	Popokabaka	9	Mweso
10	South Lodja	10	Pweto

1 Biringo
2 Mongwalu
3 Logo
4 Nyarambe
5 Fataki
6 Rethy
7 Drodro
8 Bunia
9 Tshomia
10 Kaziba
11 Nyangezi
12 Lemera
13 Kirotshe
14 Rwanguba
15 Rutshuru
16 Birambizo
17 Kayondo
18 Katwa
19 Butembo
20 Beni
21 Oicha
22 Manguredjipa
23 Ngandajika
24 Bibanga
25 Miabi
26 Tshilundu
27 Mbuji Mayi
28 Kananga
29 Bunkonde
30 Tshikula
31 Dibaya
32 Lubandaie
33 Kitona
34 Moanda
35 Kwuimba
36 Tshela
37 Kizu
38 Uaki
39 Seke Banza
40 Matadi
41 Kibunzi
42 Luozi
43 Kimpese
44 Gombe Matadi
45 Mbanza Ngungu
46 Kimpangu
47 Boko Kivulu
48 Kisantu
49 Kimvula
50 Idiofa
51 Ipamu
52 M. Manimba
53 Y. Bonga
54 Kabare
55 Bukavu
56 Idjwi