MORTALITY IN AFRICA: AN INTRODUCTORY OVERVIEW

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Introdução

The study of mortality (and survivorship) is an elemental component for the assessment and understanding of the wellbeing of a society. The knowledge of mortality levels, mortality causes and mortality differentials contributes to the understanding of the population dynamics, its weaknesses and development trends. The striking feature of a developed society is whether people live long and healthy lives. Furthermore, once mortality rates are in great measure linked with morbidity rates, it is expected that a country with high mortality rates will also have high morbidity rates, hence with a much lower wellness. Therefore, in diagnosing the population infirmities it is possible to identify ways of improving its well being.

Mortality levels in Sub-Saharan countries are staggeringly high (UNICEF, 2007):

- **1 in 16 women in average die of maternal causes, but in Angola the corresponding figure is 1 in 7 women;**
- **1 in 5.9 children in average do not reach 5 years old, but in Sierra Leone only 1 in 3.5 children reach that age;**
- **46 years is the average number of years a person born today expects to live, but in Swaziland the analogous figure is 31 years;**

These values are considerably worse than the world averages and incomparably worse than in industrialized countries.

Indeed, the study of mortality aims to know, first of all, how many years, in average, a person lives and how many persons die in a certain period, at different ages. It also aims to identify the causes of death and to recognize

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which groups of the population are more vulnerable. The answers to these questions will allow determining what can be done to prevent early deaths and increase people's life-span. They will allow the formulation of targeted policies conducing to a steady improvement of the population well being and the increase of its development pace. That's why mortality levels are a crucial issue in the eight UN Millennium Development Goals2 (MDGs). That's the case of Goal 4 - reduction of child mortality and Goal 5 - reduction of maternal mortality. In addition, Goal 6 – combat HIV/AIDS, malaria and other illnesses is also related with mortality.

Nevertheless, data on mortality in sub-Sahara Africa is still incipient and for most African countries, only in the last few decades basic mortality indicators have been estimated. In addition, data on causes of death is not very accurate, as Kenneth Hill (2006) reported:

"Death has always been an overriding concern: two of the eight Millennium Development Goals express targets in terms of mortality and one out of three components of the Human Development Index is a mortality measure. It is therefore surprising that so little is known about the levels and causes of death in developing countries. In Africa, only two countries report causes of death for 50% or more of their deaths."

Hence, writing about mortality in Africa is of great importance but, due to the scarcity of data, it is a daunting challenge. Nevertheless, due to its importance it should be attempted, as its importance overrides the difficulties in doing it. What follows aims to present an overview, or, more precisely a snapshot of what is known about mortality levels and issues hence related in sub-Saharan Africa.

As a first overview on mortality in sub-Saharan Africa, this article will tackle this issue mostly from a quantitative perspective. Mention to medical and socio-economic issues will be done, but the objective is to present the mortality levels and main issues in the region hence related.

2 In September 2000, at the United Nations Millennium Summit, World leaders agreed to set a time-bound and measurable goals and targets for combating poverty, hunger, disease, illiteracy, environmental degradation and discrimination against women

All sources of data presented here have been published in journals or included in International Organizations reports.

1. The measurement of mortality

1.1 Data sources

Global health progress and people's survivorship trends require the systematic gathering of data so that morbidity and mortality levels and trends are accurately scrutinized. However, as above mentioned, this is not the case of most sub-Saharan countries. Indeed, the International Institute for Vital Registration and Statistics (1988) reported that the great majority of sub-Saharan countries do not have registration systems producing usable vital statistics. Data gathering is a rather costly activity, thus a compromise between quantity and quality of data has to be made.

In order to estimate the mortality levels of a certain population during a given time period, the basic information needed are the number of persons of the population during that period and the number of deaths that occurred during that period. Because the number of persons is continually changing, demographers consider the number of persons in a given period as the mid-point between the number of persons at the beginning of the period and the number of persons at the end of that period. A well organized civil registration is needed to obtain these figures. While it seems that this registration system is a straightforward process, it is costly and entails a level of government organization that most African countries cannot afford. Particularly complex it is the data gathering on causes of death of all population, that in addition to an efficient registration throughout the country, also requires the participation of medical personnel.

In the last decades, population censuses have been conducted in most countries with a reasonable frequency and quality, producing acceptable information on population figures. However, death's statistics on these censuses rely solely on people's reports on past deaths, with questionably

accuracy. In addition, seldom there is any mention to causes of death on these censuses, as proper statistics on the cause of death requires the presence of medical personnel for the registration of deaths' details.

Other important sources of data are the demographic and health household surveys, using large samples representative of the whole population. These surveys have, among many others, detailed questions on births and deaths and its quality can be considered good. However, because deaths are a relatively rare event, the death rates provided are significant only at national level, and sometimes also at regional level. Since mortality rates tend to vary considerably from one region to another, these surveys provide good estimates but incomplete.

More recently, in order to obtain information on causes of death, a pilot experience has been set up in a number of sub-Saharan countries, called Demographic Surveillance Systems, where verbal autopsies (VA) are used to assign causes of death in a given region. This process involves interviewing family members about circumstances leading to death, and symptoms signs during the illness that preceded death, with close involvement of medical personnel on the sites (Adjuik et al, 2006). These Surveillance Systems do not represent statistically all country, as the sites are not numerous neither constitute a random sample. They nevertheless give an amount of very important data, at a reasonable cost.

In summary, data on mortality levels and mortality causes in the region exist but it is still incipient. Nevertheless, in the recent decades, governments and international organizations are making great efforts have in gathering information and estimating the basic mortality indicators. Putting together all existing data it is possible have a rather accurate picture of the situation.

1.2 Overview of main mortality indicators

The measurement of demographic indicators is simple but somewhat tricky, because the population is continuously changing due to births, deaths and migration. In general, indicators refer to a fixed period, often

a year, and the mid-period population is used as the base rate. The procedures used to calculate the various indicators below presented will not be presented here.

The main mortality indicators are the following:
- Crude mortality rate and age-specific mortality rates
- Expectancy of life (at birth and at other ages)
- Infant and under five mortality rates
- Maternal mortality

The **crude death rate** is the quotient of the total number of deaths occurred during a year by the mid-year population. **Age specific mortality rates** are similar concepts, but they refer to a certain age group: it is the quotient between the number of deaths of persons within a certain age group by the total number of persons of that age group, during a certain period.

Comparing the mortality levels of two population groups, for instance two countries, using only the crude death rate, can be somewhat misleading as this indicator depends greatly on the age-structure of the population. If a population is 'old', meaning that have a high proportion of older people, it may have the same crude mortality rate than a population that is 'young', but with very different levels of mortality in the sense that in the first country, people live much longer than in the second one. So, to clearly understand the levels of mortality, one has to combine the crude death rate with the age specific death rates.

The graphic of the age-specific mortality rates is a U-shaped line as mortality rates at very young and very old ages are much higher than at other ages. The left side is higher or lower depending on the level mortality rates at early ages. In developed countries, the left part of the 'U' is almost inexistent while in less developed countries the shape is much closer to an 'U". However, the soaring death rates due to AIDS are changing this pattern in some countries, as there are significantly higher mortality rates in early adulthood. The age-specific mortality rates, not only define a more complete mortality pattern of the mortality levels, but it is also the base to calculate the expectancy of life (see below).

The great importance of the crude mortality rate is to calculate the annual natural population growth rate. Indeed, this last rate is the difference between the crude birth rate (definition similar to the crude death rate, but considers births instead of deaths) and the crude mortality rate in a given year. Nevertheless, a single mortality indicator would be desirable for easy comparison.

The **expectancy of life at birth (e_0)** is the number of years the persons born in that year can expect to live, if at each age they will experiment the same age specific mortality rates as observed in the year they were born. Similarly, the **expectancy of life at a given age *x* (e_x)** is the number of years the persons aged *x* years can expect to live on average, if at each age afterwards they will experiment the same age specific mortality rates as observed in the year they were aged *x* years old.

The expectancy of life indicators are 'fiction' definitions, as the age specific mortality rates tend to change over time. However, the expectancy of life at birth is a single indicator and it is the most important for comparison of mortality levels between different populations. As the definition states, the expectancy of life is calculated based on age-specific mortality rates, but these rates require accurate yearly statistics per age on the total population and deaths, which only the more developed countries produce. Scholars and demographers at United Nations developed model life-tables for different mortality structures which have been used for the estimation of the expectancy of life in less developed countries.

The **Infant Mortality Rate (IMR)** is the number of deaths under age 1 in the year divided by the number of live births in that year.

Normally this rate is indicated as the number of infant deaths in one thousand live births. Actually, this indicator is not a 'rate' but a 'ratio' as the numerator is not a subset of the denominator. The virtue of this indicator is that it can be calculated from census or survey data while the age-specific mortality rates need a complete and accurate births and deaths registration. However, if mortality rates are relatively stable, the

infant mortality rate is a good proxy of age-specific mortality rate between exact ages 0 and 1.

The **under-five mortality rate** is the probability of dying between birth and exactly five years of age, expressed per 1,000 live births

The **maternal mortality ratio** is the number of women who die each year from causes related with pregnancy and delivery per 100,000 live births.

Because this rate depends on the number of children and does not provide a proportion of woman who dies by maternal causes, another indicator is often used.

The **life time maternal risk of dying** is the probability of a woman to die due to maternal causes.

All these mortality indicators are very important indicators for the understanding and measurement of a society wellness. Indeed, the striking feature of a developed society is whether people live long and healthy lives. As mentioned above, mortality rates are very much linked with morbidity rates, and thus a country with high mortality rates will also have high morbidity rates. Of particular importance among the different mortality indicators, is the infant mortality rate. It depends on the parent's education, on their capability to provide enough food and on the country's health system accessibility to the majority of people. It is the group of people where the mortality rates are staggeringly high and its influence on the value of the expectancy of life is enormous.

On Figure 1, the relationship of the expectancy of life and the mortality rates can be observed. Indeed, the graph on the left side is the expectancy of life at different ages for three sub-Saharan countries.

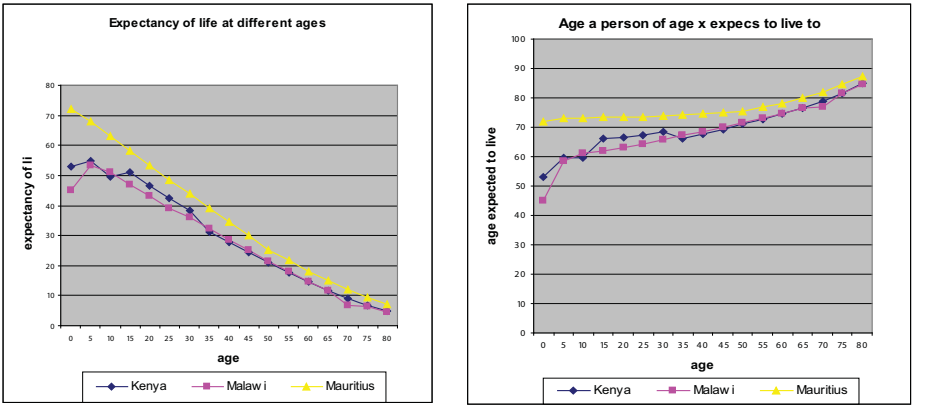

Figure 1. Expectancy of life at different ages in Kenya, Malawi and Mauritius
Source: data from UN Statistical Yearbook, 2006

As can be noticed, while there is a huge difference of e_0 between Mauritius and Malawi (respectively 72 and 45 years), the difference of e_x for x bigger than 15 years is much smaller. In other words, in a country with high levels of mortality at early ages, once a person reaches youth, he/she can expect to live almost the number of years as a person in another country with a much higher expectancy of life at birth. Or, it can be said the age a person is expected to live to increases considerably after surviving the first years, as can be observed on the graph on the left part of Figure 1. Nevertheless, AIDS mortality rates are changing considerably this pattern. Countries with high prevalence of AIDS for some decades, are already experiencing a mortality pattern different of the one just mentioned. This is due to the fact that the increase of mortality rates due to AIDS is affecting mainly young adult ages, as will be analyzed below.

2. Mortality rates in Africa

The knowledge of sub-Saharan population dynamics in the past is very scarce, almost nil. Based on historical colonial documents, some researchers come up with some figures for some specific populations, but credible figures on mortality in the past for the region simply do not exist. However, there are some references about the high mortality levels in the past. McDaniel and Preston (1994), using data from the American authorities showed that the mortality levels of the freed slaves returning to Liberia in the beginning of 1800's is the highest mortality level of a sizeable population ever recorded. In Newitt (1995)'s *History of Mozambique,* reported that that one in three children died during the first half of the twentieth century. In summary, although these and other indications suggest high mortality levels, they are scattered and thus not conclusive of the situation in the past. For most sub-Saharan Countries, only on the recent decades, estimates of mortality levels have been done.

2.1 Present values

As mentioned above, the weakness of the vital registration in most African countries prevents the estimation of accurate mortality levels, particularly rates related with causes of death. However, most of the above mentioned rates are calculated in almost all sub-Saharan countries. On Table 1 it is presented the average mortality rates for sub-Saharan and other regions of the world.

Table 1. Average mortality rates for sub-Saharan and other regions of the world

	Life expectancy at birth	Infant mortality rate per 1,000 live births	Under five mortality rate per 1,000 live births	Maternal mortality ratio per 100,000 live births	Life time risk maternal death, one in:
Sub-Saharan Africa	**46**	**101**	**169**	**940**	**16**
World Average	**68**	**52**	**76**	**400**	**74**
Industrialized countries	79	5	6	13	4000
Central Europe	67	32	38	64	770

Middle East &North Africa	68	44	56	220	100
South Asia	63	67	92	560	43
East Asia and Pacific	71	29	36	110	360
Latin America & Carib.	72	26	31	190	160

Source: 'The state of the world's children 2006', UNICEF 2007

It is important to note that while these figures show a tremendous situation, they are averages for all the sub-Saharan Africa, which means that there are countries in a worse situation than the average. Indeed, there is a great variability among the countries in the region. On Table 2 it is presented the list of countries in the region with highest and lowest under five mortality rate. For instance, in Sierra Leone, 283 children aged under five out of 1,000 live births die per year. This means that around 1 in 3.5 children do not reach five years old. Indeed, the under five mortality rate in Sierra Leone is approximately 20-fold higher than Seychelles'.

Table 2. Countries in sub-Saharan Africa with highest and lowest under five mortality rate per 1,000 live births

Worst five Sub-Saharan Countries	**Value**	Best five Sub-Saharan Countries	**Value**
Sierra Leone	**283**	Seychelles	**14**
Angola	**260**	Mauritius	**15**
Niger	**259**	Cape Verde	**36**
Liberia	**235**	Namibia	**63**
Somalia	**225**	South Africa	**67**
Average in sub-Saharan Africa: **169**			

Source: 'The state of the world's children 2006', UNICEF 2007

Similarly, the country averages hide the differences between regions within a country. For instance in Mozambique, the IMR and the U5MR are respectively 124 and 178 per 1,000 live births. But the analysis of the corresponding values per province, show a dramatic disparity, as can be seen on Figure 2.

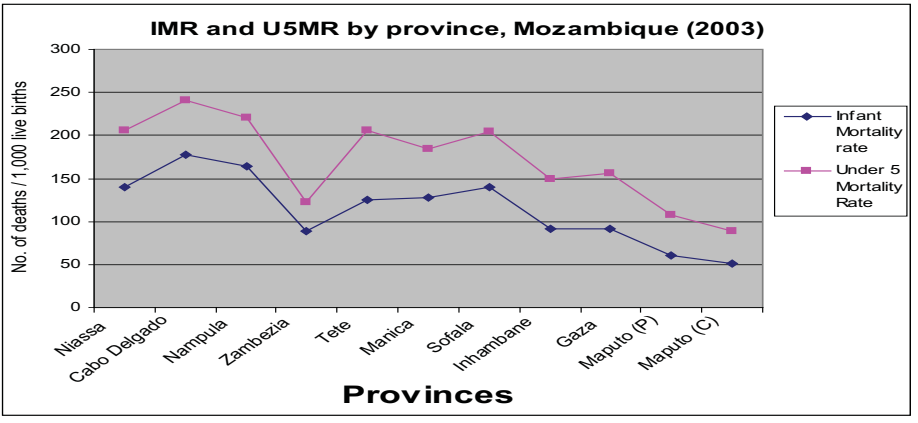

Figure 2. Infant and under five mortality rate in Mozambique
Source: data from "Mocambique – Inquerito Demografico e de Saude", 2003 (INE e MISAU, 2005)

While infant and child mortality rates have been decreasing for the last decades and the expectancy of life is increasing in general (it is not the case of countries with high prevalence rates of HIV/AIDS) in Sub-Saharan Africa, maternal mortality is not having the same improvements. A study by Keneth Hill (2007), showed that maternal deaths fell by less than 1% a year between 1990 and 2005.

The number of women dying by maternal causes varies dramatically worldwide from one in six in Sierra Leone to 1 in 47,000 in Ireland (UNICEF 2007). Maternal health is strongly linked to access to safe abortion, contraception and emergency obstetric care. It is studied that for each woman who dies of childbirth there are around fifteen other woman that suffers disability, often rather severe. In addition, if a mother is ill or dies, the baby is less likely to survive and her other children less likely to be healthy and educated (Starrs, 2007). On Table 3, the maternal mortality ratio and maternal life time risk of death averages in the different regions in the world are presented. In addition, the antenatal coverage and the percentage of births attended by a skilled medical professional can also be observed.

Table 3. Maternal mortality ratio and maternal life time risk of death averages in different regions in the world, antenatal coverage and the percentage of births attended by a skilled medical professional can also be observed.

Region	Antenatal care coverage %	Skilled attendant at birth %	Maternal mortality ratio (no. of deaths per 100,000 births)	Lifetime risk of maternal death, 1 in:
Sub-Saharan Africa	69	42	**940**	**16**
Middle East & North Africa	71	76	**220**	**100**
South Asia	54	36	**560**	**43**
East Asia and Pacific	87	86	**110**	**360**
Latin America & Caribbean	87	87	**190**	**160**
Central Europe	86	93	**64**	**770**
Industrialized Countries	na	99	**13**	**4000**

Source: UNICEF 2007

Similarly to the other rates, the high average levels of maternal mortality in Sub-Saharan Africa do not tell the whole story, indeed there are dramatic differences between the countries. On Table 4, the list of the sub-Saharan countries that have the maternal mortality ratio higher than this region average is presented.

Table 4: Maternal mortality ratio and maternal life time risk of death for countries with higher maternal mortality ratio higher than the average in sub Saharan Africa

Countries	(a)	(b)	(c)	(d)	Countries	(a)	(b)	(c)	(d)
Angola	66	45	**1700**	**7**	Mauritania	64	57	**1000**	**14**
Democratic Rep. Congo	68	61	**990**	**13**	Mozambique	85	48	**1000**	**14**
Central African Rep.	62	44	**1100**	**15**	Niger	41	16	**1600**	**7**
Chad	42	16	**1100**	**11**	Rwanda	92	31	**1400**	**10**
Guinea-Bissau	62	35	**1100**	**13**	Sierra Leone	68	42	**2000**	**6**
Kenya	88	42	**1000**	**19**	Somalia	32	25	**1100**	**10**
Malawi	94	61	**1800**	**7**	Tanzania	94	46	**1500**	**10**
Mali	57	41	**1200**	**10**	Zimbabwe	93	73	**1100**	**16**

(a) Antenatal care coverage
(c) Maternal mortality ration (no. of deaths per 100,000 births
(b) Skilled attendant at birth
(d Lifetime risk of maternal death, 1 in:

Source: UNICEF 2007

High levels of maternal mortality are linked with unsafe abortion, antenatal care, skilled birth attendance and emergency obstetric care. If maternal mortality is difficult to measure, the proportion of each of these causes is even less known. Nevertheless, it is common sense that maternal mortality reductions require a considerable increase and improvement of health care personnel and facilities. But these actions need to be preceded by a throughout situation analysis, to determine where the bottlenecks lie. Indeed, plotting the antenatal care coverage and the skilled birth attendant against maternal mortality ratio from the data on Table 4 (Figure 3), one can see that there is not a strong correlation between the two variables. That's the case, for instance, of Kenya, Rwanda, Zimbabwe and Tanzania, having very high coverage of antenatal care but very high maternal mortality ratios.

Although Egypt (Campbel et al, 2005) is not a sub-Saharan country, its experience in tackling maternal mortality is worth to mention. According to UNICEF (2007), the antenatal coverage is 69% of pregnant women and the percentage of births attended by a skilled health professional is also 69%. Nevertheless, they halved the maternal mortality ratio in just 10 years. They started the program by doing a detailed and comprehensive diagnosis of the situation, checking the accessibility and logistics of the health care facilities, the quality of providers and the availability of supplies (equipment, drugs, blood, anesthestics) all over the country. In addition they also checked on contraceptive prevalence and the supply of family planning services. Based on the results of this throughout study, they addressed the encountered problems and as a result maternal mortality declined drastically.

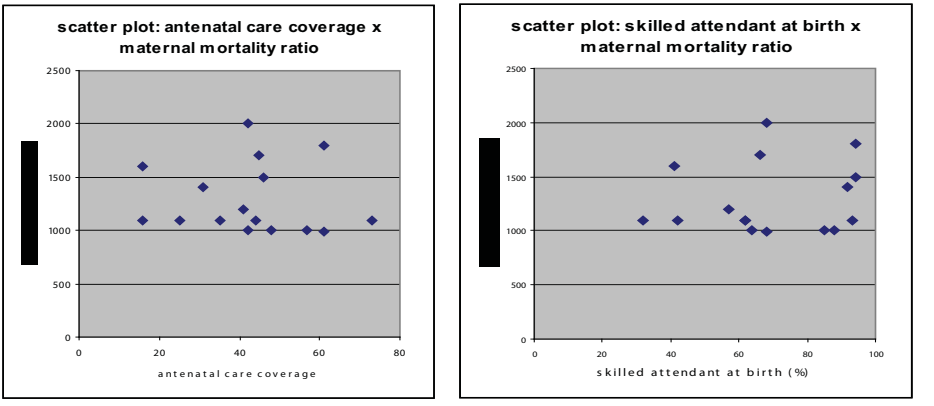

Figure 3: Scatter plots showing the relationship between antenatal care coverage and maternal mortality ratio (left graph) and skilled attendant at birth and maternal mortality ratio (right graph) for the countries with maternal mortality ratio higher than the sub-Saharan average

It is worth to point out the importance of family planning in reducing the maternal mortality levels. There is an obvious reason for this: the higher the number of children a woman has, the likelier she dies of maternal causes. Furthermore, the use of contraceptives prevents women to have children too young, too old, too short birth intervals and too many children, all proven causes for the increase of death by maternal causes (Marston & Cleland, 2004).

2.2 Values in the last decades

Notwithstanding mortality rates in sub-Saharan Africa are tremendous, on average they have been decreasing for the past decades. This is the case of the expectancy of life at birth, infant mortality rate and under five mortality rate. Maternal mortality rates are mostly unknown from that period.

This mortality decrease has not been continuous and there are countries where mortality levels increased recently. In a recent study, Garenne and Gakusi (2006), studied 32 countries for which there was data available for the period 1950-2000 and reported that:

- A quarter of the countries had monotonic declining mortality trends;
- Another quarter had long term declines, with some minor rises over short term periods;
- A third quarter had periods of major increases in mortality due to political or economic crises and in most of them mortality stopped to decrease;
- Finally, in the remainder countries mortality has risen in recent years, particularly due to HIV/AIDS.

Nevertheless, Garenne and Gakusi, concluded that during the second half of the twentieth century, under-five mortality rates declined an average of 1.8% per year on the 32 sub-Saharan countries observed. They said that the main causes of mortality increases were due to political instability, serious economic downturns, and emerging diseases. These authors, likewise many others, consider that these declines are in great measure due to the general child vaccinations that sub-Saharan countries started to implement immediately after their independence, with help from several international organizations.

In any case, it is interesting to see how sharply some mortality levels fell, in some selected countries. On Table 5, the estimates of the infant mortality rate of a handful countries are presented.

Table 5: IMR in selected countries, four or five decades ago and now

Country	Period	IMR (per 1,000 live births)	IMR nowadays (per 1,000 live births)
Burundi	1965	**150**	**114**
Tanzania	1956	**190**	
	1967	**167**	**78**
Niger	1959-60	**200**	**152**
Sudan	1955-56	**94**	**63**
Mozambique	1950	**212**	**104**
Kenya	1962	**132**	**79**
Angola	1940-50	**273**	**154**
Mali	1956-58	**344**	**121**

source: data taken from Jacques Vallin, 1976; Ansley Cale, 1966; UNICEF, 2007

Similarly, the trends on the expectancy of life at birth in three countries are presented. It is important to recall that a drastic reduction of high levels of IMR immediately makes the expectancy of life at birth considerably increased. Unfortunately, there are not many countries with known expectancy of life in the 1950's.

Table 6: e_0 selected countries, four or five decades ago and now

Country	Period	e_0	e_0 nowadays
South Africa			**47**
Asiatic	1945-47	**50**	
	1950-52	**55**	
Colored	1935-37	**41**	
	1945-47	**43**	
	1950-52	**46**	
Mauritius	1942-46	**33**	**72**
	1959-65	**37**	**39**
Central African Rep.	1959-65	**39**	**44**

source: data from Etienne Van de Vale and Hilary Page, 1969; George Stolnitz, 1965; Ansley Coale, 1966; UNICEF, 2007

2.3 Mortality levels of countries in other regions in the past

On Table 7, the values of the infant mortality rates in selected European and Asian countries on the early 70's and nowadays are presented. Interestingly, it can be seen that the IMR in Portugal three decades ago are almost the same as it is nowadays in Maputo City. In addition, it is the same or higher than some African countries nowadays.

Table 7: IMR in selected countries around the world

Country	IMR in 1970-73 (per 1,000 live births)	IMR nowadays (per 1,000 live births)
Poland	**29**	**7**
Portugal	**49**	**4**
Italy	**28**	**4**
Finland	**12**	**3**
China	**65**	**26**
Pakistan	**142**	**80**
Thailand	**75**	**18**
Sri Lanka	**46**	**12**
Indonesia	**137**	**30**

source: Jacques Vallin, 1976; UNICEF, 2007

On Figure 4, the infant mortality rates in Italy for little more than a century are plotted. Interestingly, only on the 40's-50's of the twentieth century did Italy IMR levels started to be lower than African average nowadays, which is 101 children deaths per 1,000 live births. So, in Sub-Saharan Africa existing information shows that improvements in infant mortality rates so far happened to a much higher pace than happened in Italy. Indeed, if we look at the sub-Saharan levels in the early fifties, i. e., around fifty years ago, and the nowadays values we can see a similarity of Italy rates changes in eighty-hundred years.

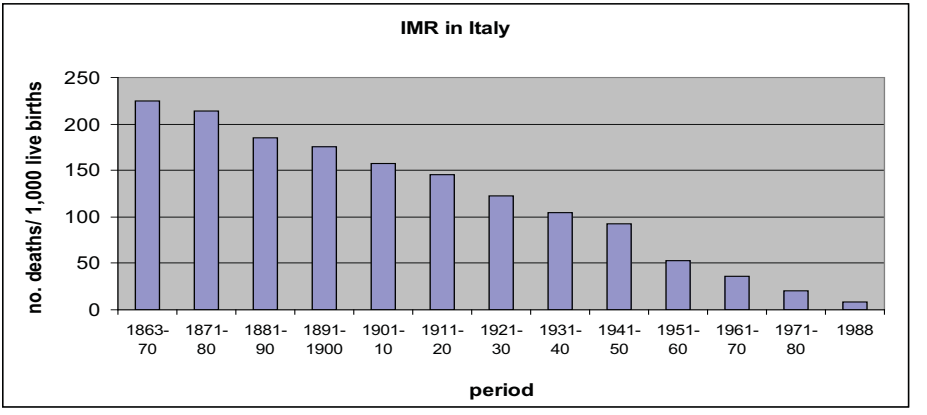

Figure 4: Infant mortality rates in Italy, 1863-1988
Source: Bacci, 1990

Also, experience from other countries shows that the values of the expectancy of life can change rapidly. On Table 8, the trends of the expectancy of life at birth in Chile and Venezuela are shown. Interestingly, these countries had, in the early 1940's, an expectancy of life at birth respectively 42 and 47 years, which is very close to the expectancy of life in sub-Saharan Africa that is 46 years in 2006. So, in just 60 years these countries improved the life expectancy enormously: Chile has almost the same expectancy of life nowadays than the industrialized countries, respectively 78 and 79; Venezuela is rapidly reaching the industrialized countries with an expectancy of life at birth at 73 years.

Table 8: trends of the expectancy of life at birth in Chile and Venezuela

Country	Period	e_0
Chile	1940	42
	1952	52
	2004	**78**
Venezuela	1942	47
	1952	57
	2004	**73**

source: data from Stolnitz, UNICEF

3. Causes of death

3.1 Main causes of death in Africa

In order to estimate the main causes of death the participation of the health personnel at the time or immediately after the death is required in order to assess all the death circumstances. The objective of estimating the number of deaths per cause and per age, allows the answer to the following questions:

- What is the probability of dying per each cause at each age?
- How would the life table be changed if one cause is totally or partially removed?
- How much would the expectancy of life be increased if a cause of death disappeared?

There are demographic methods to answer these questions (see Bacci, 1990), but the results obtained using those methods are only approximate. Indeed, even in developed countries, it is not yet known whether a certain cause of death is eliminated the distribution of the remaining causes is still the same. In fact, persons who die of a certain cause that has been eliminated, might have had some specific characteristics to get that disease or to die from that disease. In other words, it is not certain that with the absence or decreasing of a cause of death the remaining causes of death will still have the same relative proportions among themselves. In addition, it is also not known if the removal of a certain cause of death was done by using medicines that might weaken the body and thus become more prone to other diseases.

Nevertheless, even taking into account these limitations, it is crucial to estimate the proportion of each cause of death. Using different methods and different data sources, WHO (2005) estimated the proportion of the different groups of causes of death for the different regions of the world, for children under five years old. On Table 9 it is presented the estimated distribution of causes of death for children under five years of age and on Figure 5 a pie chart of this distribution is shown (it is important to notice that the values for Africa include all northern Africa countries and not only sub-Saharan Africa).

Table 8: Trends of the expectancy of life at birth in Chile and Venezuela

Cause	All member states (%)	Africa (%
HIV/AIDS	3	6
Diarrhoeal diseases	17	16
Measles	4	5
Malaria	8	18
Acute respiratory infections	19	21
Neonatal causes	37	26
Injuries	3	5
Others	10	5

source: data from WHO, 2005

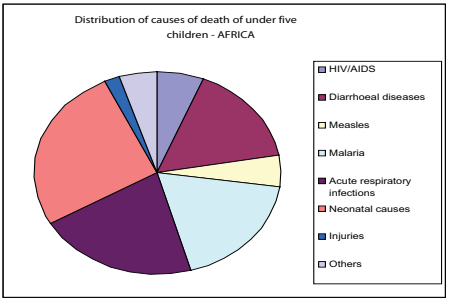

Figure 5: Distribution of causes of death for children under five years of age.

As can be seen, aside the neonatal causes, the main causes of death are acute respiratory infections, malaria and diarrhoeal diseases. These last three causes account for 55% of all under-five deaths. Because northern African countries are less malaria and HIV/AIDS prone countries, their inclusion on the overall statistics may not give the real distribution of the causes of death for sub-Saharan countries.

Indeed, Adjuik et al (2006) report that the mortality estimates from the sub-Saharan sentinel sites are, on the whole, similar to the WHO estimates, but the sentinel sites recorded a lower contribution of diarrhoeal diseases and a higher contribution of malaria. In addition, they concluded that the AIDS cause of death rate in South Africa is higher than the WHO estimates. According to the authors, the main reason for the difference might be attributed to the slightly different time frame of the data gathering. Indeed, the WHO estimates refer to an earlier period and it is more recently that HIV/AIDS significantly increased and malaria became resistant to existing drugs. While the sentinel sites study can not be extrapolated to all region as the sample is not a random and representative sample, it does point for some trends.

Malaria has been under scrutiny for some time as a leading cause of death in sub-Saharan Africa and more recently a number of interesting studies have been done. Dobson (2006) estimated that almost a million children aged under five die per year of this disease. Ayaga and Binka (2005), studying the malaria endemic region of northern Gana, concluded that as of 1995, if malaria had been eliminated in that year, life expectancy would have increased by as much as 6 years. Romagosa et al. for three years (Jan 2001-Dec 2003) studied the maternal death in Maputo (Mozambique) and concluded that the overall crude maternal mortality rate was 995/100 000 live births. In addition, they found that malaria was the most frequent cause of maternal death, accounting for 23%, of all deaths, with peaks during the rainy seasons. While this result cannot be extrapolated to all maternal deaths in the city and even less to all maternal deaths in the country, it nevertheless points out for the important role of malaria on maternal deaths.

As already mentioned, AIDS role on mortality levels is changing its traditional pattern. In addition, it is becoming the leading cause of death in some countries. That's the case of South Africa, where death rates from natural causes for women aged 25-34 years increased five-fold between 1997 and 2004, and for males aged 33-44 more than doubled (UNAIDS 2006).

As a final note on this section, Byce et al (2005), analyzing WHO estimates on the causes of death for children under five years old, concluded that 94% of global deaths attributable to malaria occur in the Africa region. However, the noteworthy conclusion of their study is that undernutrition, while does not directly causes many deaths, is the underlying cause of all deaths of children aged under five years.

From the results just mentioned, there is no single formula for the reduction of child deaths that can be applied across countries; it needs to be based on their geographical location, income level, and epidemiological profile. The one thing that is undoubtfully common to all countries is the need to gather data and analyze it properly. In addition, it is important to point out that a large proportion of child deaths can be prevented with relatively simple measures. Findings from large scale surveys showed that fewer than 5% of children in regions of Africa with high prevalence of malaria are using insecticides treated nets to prevent malaria.

4. Mortality differentials

The analysis of mortality variations by socio-economic, environmental and demographic characteristics of a population is one of the most interesting issues in the mortality study, but also one of the most difficult ones to tackle. The characteristics to be considered can be varied, from biophysiological and environmental to economic, social and life style. Within each characteristic, subgroups can be considered in order to more fully understand the mortality levels' variations between characteristics.

The sources of data are registration, censuses and surveys. Nevertheless, a trade-off compromise needs to done: the larger the number of individuals, the more costly the information gathering is and thus the fewer questions to be asked, and not much information can be gathered about the individual's characteristics. Nevertheless, the most difficult issue to circumvent is the interpretation of the differentials. A very interesting study made by Valin and Beham (1980), compared the probability of death before one year old (a proxy to infant mortality rate) with the moth-

er's number of schooling years in a few Latin American countries. They showed that while the probability of death decreases with the increase of the number of school years, these differentials are much more accentuated in some countries than in others (see Figure 6).

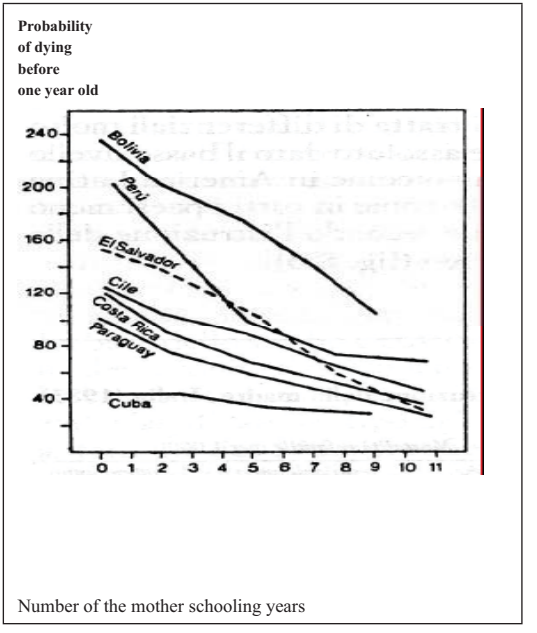

Figure 6: Probability of dying before one year old, per number of schooling years of the mother in seven Latin American countries

source: copied from Bacci, 1990

These results suggest that there is not only one important characteristic to be considered. Indeed, not only some other individual characteristics (mother's age, revenue, etc) may also have impact on the probability of death of the infant, but also community level variables should be considered. This is the case of the availability, accessibility and quality of health centers, the social education carried out on the communities on how to take care of a baby, etc.

Multivariate regression models are a very useful and often applied to analyze the relationship between child mortality and characteristics of the

household. In addition, more recently, multilevel models have also been applied. These models allow for the simultaneous analysis of individual characteristics of the household and community variables that may explain some extra variability that the usual regression analysis does not allow.

In sub-Saharan Africa, most mortality differentials' studies done so far, concern infant and child mortality differentials. Indeed, infant and child mortality is one of most important mortality issues to study and for which there is a reasonable quantity and quality of data. In general, the studies analyze the relationship of infant or child mortality with different socio-economic variables of the persons belonging to the household (see Preston, 1975; Hobcraft et al., 1984; Hill, 1985; World Bank, 1993). Most indicators of socio-economic status used are income per capita, education (mother, father), urban/rural residence, work status and household assets. In all studies, a significant relationship between socio-economic status and the child's survival probability was found. However, the effect of a specific variable varies from country to country and with the period of the survey/census. In some studies the mother's educational level was the leading factor, while in others the leading factor is the income per capita. In addition as it is in the case of Latin America just mentioned, the same factor can make a much different effect. And it can also happen that a factor is important in one country or population group but it is not valid for other population groups. This is the case, for instance of the income per capita. Indeed, there is threshold in income per capita above which income does not any difference for the children's survival. So, in a country were the majority of the households are above this threshold, the income per capita will not be a very important factor for the survivorship of children.

The studies just mentioned analyze the probability of death of a child related to certain characteristics at the household level and the unit of observation is a child. Aggregate studies are also very informative. Amouzou and Hill examined under-five mortality trends in sub-Saharan Africa, and the association between socio-economic status (indicated by average per capita income, women illiteracy rate, percentage of people living in

urban areas) and the under five mortality rates between 1960 and 2000. In this study the unit of observation is a given country at a given period and used random effect cross-sectional time series models to take into account the interactions between the socio-economic variables. They concluded that there is a consistent negative relationship between under five mortality rates and per capita income, but a given income implies lower U5MR as one moves towards the present. They also concluded that U5MR is positively associated with illiteracy rate and negatively associated with percentage of persons living in urban areas. Interestingly, the effects of urbanization and illiteracy have diminished recently while the per capita income effect increased in this period.

While it is important to consider individual characteristics for the analysis of the differentials, aggregate studies are also important.

An interesting issue that recently is coming up is the effect of ethnicity on child mortality. Brokerhoff & Hewett (1998) analyzed data from several sub-Saharan countries that conducted health and demographic surveys and found very large differentials in child mortality between ethnic groups. They also reported that these differentials were associated with differences in socio-economic status. While the socio-economic differences may have historical explanations, the authors raised the concern that a political component may also be responsible for these differences. While they could not be conclusive about the political effect on child mortality, they urged that attention to politics in child health, related with ethnic groups, should be paid, when researching child health on developing countries.

5. AIDS

Knowledge of mortality linked with HIV/AIDS in sub-Saharan Africa is still incipient. It is a recent disease, the time lags between the infection, the onset of the disease and the death are largely variable, and there is a scarcity of data. So far, the estimation of the number of people infected with HIV in most countries is based on samples of women visiting pre-na-

tal clinics. In addition, if a specific test is not done, one cannot conclude whether a certain death was due to HIV/AIDS or not. Indeed, a person can die of pneumonia but it happened because the person was infected with HIV. Nevertheless, great efforts on estimating the rates of infected people and the mortality rates due to AIDS have been done and the situation looks tremendously bleak.

Recently, a few countries conducted special population surveys to determine the prevalence, according to the UNAIDS Global AIDS Epidemic report (UNAIDS, 2006). This report points out that even though HIV prevalence rates have stabilized in sub-Saharan Africa, the actual number of people infected continues to grow because of population growth. Applying the same prevalence rate to a growing population will result in increasing numbers of people with HIV (see Figure 7). Similarly to the mortality rates, the averages of HIV prevalence in Sub-Saharan Africa, hide the truly catastrophic situation of some countries. For example in Lesotho it is estimated that around 22% of adults aged 15-49 years old are infected with HIV (UNAIDS, 2006).

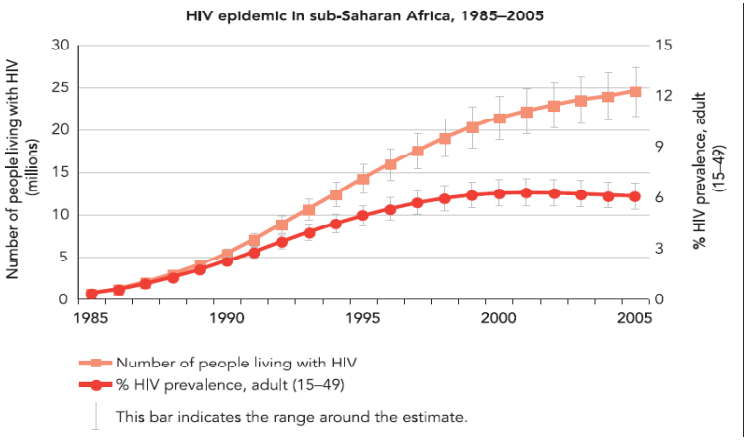

Figure 7: Estimates of the number of people living with HIV and the prevalence rate among adults (15-49 years old) in sub-Saharan Africa

source: data from United Nations Population Division, World Population Prospects: the 2004 Revision, database; graph taken from UNAIDS 2006

Mortality due to AIDS is changing the normal mortality pattern: many more prime age adults are dying than before. In addition, infant and under-five mortality rates are increasing in countries with very high HIV/AIDS prevalence, due to the mother-child HIV transmission and to the fact that parents are very ill or dead. Both mortality increases, in children and young adults, are having a strong impact on the expectancy of life at birth. On Figure 8, a graph showing the trends on life expectancy at birth from 1970 to 2010, in five high HIV prevalence countries is presented. The dramatic increase on expectancy of life from 1970 to 1990 has been drastically thwarted by HIV/AIDS mortality and the number of years a person born today can expect to live is even lower than it was on 1970.

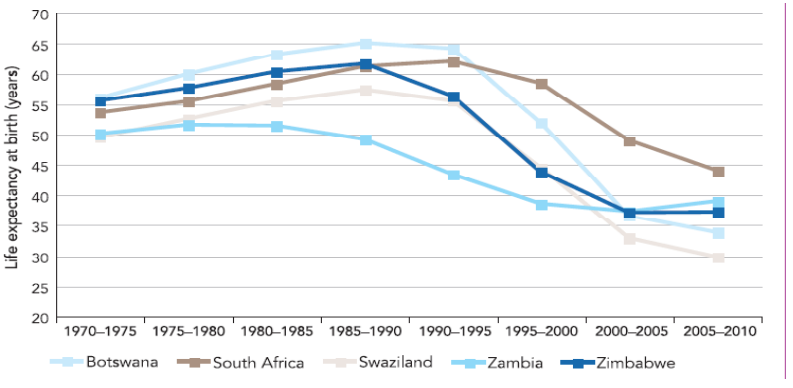

Figure 8: Impact of AIDS on life expectancy in five African Countries, 1970-2010

source: data from United Nations Population Division, World Population Prospects: the 2004 Revision, database; graph taken from UNAIDS 2006

In sub-Saharan Africa approximately 9% of children under the age of 15 have lost at least one parent to AIDS.

6. Large scale mortality events

Not rarely, large scale mortality events occurs in a relatively short period of time due to natural or man-made disasters. In sub-Saharan Africa the conflicts are the main cause of dramatic mortality increase in short

periods. It is very difficult to determine accurately the number of deaths caused by the conflict for a number of reasons:

- whole families who die;
- lack of good registration systems and the existing ones are often disrupted or destroyed;
- large population movements, not monitored;
- surveys cannot have a sample basis;
- unsafe environments for data gathering operations.

Nevertheless, sometimes the scale of mortality is so tremendous, that all efforts should be done to have at least a rough estimate. This is the case of the breaking of war in the Eastern part of the Democratic Republic of Congo, around 1998. The International Rescue Committee, IRC (2000) conducted a household survey to estimate the number of direct and indirect casualties of the conflict. A total 1,011 households were interviewed and IRC reported that 1.7 million excess deaths occurred during 22 months since the outbreak of the fight. In addition, IRC concluded that a large number of children younger than two years old were missing from the demographic profile. Also, in the interviewed families, 3% of full term births resulted in maternal deaths, which means a maternal mortality ratio of 3,000 per 100,000 live births. The excess of deaths were due to violence and to diseases resulting from the forced displacement and economic hardships.

Conclusions

What has been presented so far is simply an introductory overview of mortality in Africa. Some important conclusions can be made:

- There is a terrible lack of data. It is important to invest more on data gathering both for indicators' monitoring and for policy oriented actions. Data gathering is costly, but there is an extreme need to invest seriously on it, as efficiency of the programs to tackle mortality will depend in great measure on a proper situation analysis and quality of the information gathered;
- Mortality rates are staggeringly high, but they are an improvement

when compared with mortality rates some decades ago. Experience in other less developed regions and even in some developed countries, show that mortality levels can be reduced in relatively short period of time.

• AIDS is a devastating pandemic in some countries that urge all efforts to curb the disease and treat the infected persons. In addition, in the ones were prevalence rates are still relatively low, attention should be paid and prevention programs implemented so that the disease is not further spread out.

• There is a large variability between the countries. While it is advisable to grasp the situation at aggregate level, there is a strong need to study properly the situation in each country and in each region within the countries. The solutions should be targeted in order to have more cost-efficient programs.

Urgent and large scale actions are needed to curb the soaring mortality rates. While most countries in the region are committed to these activities, they cannot afford to tackle such a large scale problem without external investment. Declines in morbidity and mortality not only prolong healthy life but also generally increase labor productivity and increase investment on human capital. Nevertheless, a final note needs to be done: while it is highly and unquestionably desirable to sharply decrease the mortality rates in sub-Saharan Africa, it is fundamental that population problems are tackled as a whole. Indeed, a rapid decrease in mortality rates will have a side effect of increasing the population growth rate. Therefore, it is crucial to accompany the decreases in mortality with decreases in fertility. In doing so, a more balanced and healthy population development will take place.

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