Demographic Research a free, expedited, online journal
of peer-reviewed research and commentary
in the population sciences published by the
Max Planck Institute for Demographic Research
Konrad-Zuse Str. 1, D-18057 Rostock · GERMANY
www.demographic-research.org

DEMOGRAPHIC RESEARCH

VOLUME 19, ARTICLE 37, PAGES 1419-1448
PUBLISHED 01 AUGUST 2008
http://www.demographic-research.org/Volumes/Vol19/37/
DOI: 10.4054/DemRes.2008.19.37

Research Article

Adult mortality in a rural area of Senegal: Non-communicable diseases have a large impact in Mlomp

Géraldine Duthé

Gilles Pison

Table of Contents

Demographic Research: Volume 19, Article 37
research article

Adult mortality in a rural area of Senegal: Non-communicable diseases have a large impact in Mlomp

Géraldine Duthé[1]
Gilles Pison[2]

Abstract

This study provides original estimates of adult mortality in Mlomp, a rural population of Senegal which has been monitored for twenty years. Causes of death are assessed through verbal autopsies which are completed by medical information. Between ages 15 and 60, male mortality is much higher than female mortality. Globally, AIDS mortality does not have the tragic impact observed in other regions of Africa, and maternal mortality is relatively low for a rural area, unlike injuries which are common among men. In Mlomp, non-communicable diseases, especially cancers, are predominant. In addition to behavioural factors, infectious diseases may contribute to this situation.

[1] Institut national d'études démographiques (INED), 133, bd Davout 75980 Paris Cedex 20, France.
E-mail: geraldine.duthe@ined.fr.
[2] Institut national d'études démographiques (INED), 133, bd Davout 75980 Paris Cedex 20, France.
E-mail: pison@ined.fr.

1. Introduction

1.1 Health transition in less developed countries

According to the epidemiologic transition theory, progress in medicine and health care reduces the level of mortality and changes its structure (Omran 1971): the mean age at death increases progressively, and the major infectious and parasitic diseases, which are the main causes of death when mortality is very high, give way to a variety of 'man-made and degenerative diseases' linked both to day-to-day behaviours that present a risk for individuals, and to the biological ageing process. This long-term and ongoing mortality decline is generally qualified as the 'health transition' as the result of progress in health care, but also of social and economic development (Lerner 1973; Preston and Nelson 1974; Caldwell et al. 1990).

Over the long term, the changes follow an identifiable pattern, though certain specific developments may be observed (Frenk et al. 1991; Vallin and Meslé 2004). Yet mortality trends in less developed countries are not identical to those observed in industrialized countries, and mortality in sub-Saharan Africa hasn't decreased since the end of the 1980s and remains high: life expectancy at birth is estimated at 50 years over the period 2005-10, a similar level than twenty years ago (United Nations 2006).

Recent decades have seen the emergence of infectious diseases, the HIV/AIDS pandemic first and foremost, but also the resurgence of other infectious problems such as drug-resistant strains of malaria and tuberculosis closely associated with HIV/AIDS. Furthermore, several cancers are known to be of infectious origin: hepatitis B and C are risk factors for developing a liver cancer, human papilloma virus for cervical cancer, etc. (Prost 2000; Khlat and Le Cœur 2002). The incidence of cancers is not only linked to longer life expectancy but also to infectious diseases. In addition, behaviours such as smoking or alcohol consumption are observed in Southern countries too, increasing risks of injuries, cancers, and cardiovascular diseases (WHO 2002).

Hence, the man-made diseases and diseases linked to ageing which are characteristic of the developed countries also contribute to adult mortality in poor countries (WHO 2003). This is occurring in conjunction with the persistence of infectious and parasitic diseases. Consequently, infectious and parasitic diseases affect children as well as adults, while non-communicable diseases affect adults.

The emergence of AIDS has led to renewed interest in adult mortality, especially given that adults aged between 15 and 60 form the productive and the reproductive group, and are responsible for the welfare of the younger and the older groups (Feachem et al. 1992). This age group represents more than 50 per cent of the population of sub-Saharan Africa (United Nations 2006). But the mortality levels, structures and trends are difficult to estimate due to a lack of reliable data.

1.2 Estimating adult mortality in sub-Saharan Africa

There are several methods for estimating adult mortality. As a general rule, deaths are counted from the vital records and mortality is calculated with respect to the estimated population given by the population census. On the one hand, censuses may be spaced many years apart and the ages reported by individuals are usually inaccurate. On the other hand, though obligatory, vital registration does not function effectively in sub-Saharan Africa due to a lack of resources, and adult deaths are rarely registered in this region of the world, in rural areas (Hill 1999).

For these reasons, indirect techniques have been developed, using information such as the survival of parents, the sibling histories, or the occurrence of deaths in the household collected through population censuses or representative national surveys[3] (Preston and Bennett 1983; Timæus 1993; Hill 1977; 1999). But the accuracy of the estimates is difficult to assess (Timæus and Jasseh 2004).

The most common method estimates adult mortality from infant mortality level and model life tables (Brass and Coale 1968; Coale et al. 1983). Yet most model life tables have been constructed using data from Northern countries (Duchêne 2005) and those drawn up for the less developed countries by the United Nations do not encompass regions where data are insufficient, as is the case in sub-Saharan Africa (United Nations 1982).

Concerning causes of death, information is even more fragmentary, since few deaths are recorded in clinics or hospitals. Many people die at home, especially in rural Africa where access to health care is limited. In Burkina Faso, an estimated one death in twelve is registered by the health services (Baya 2004). Only four sub-Saharan African countries provide usable death registration information for 2001: Mauritius, the Seychelles, South Africa, and Zimbabwe (Mathers et al. 2006). There is little data for this region relating to adult mortality levels and causes of death.

1.3 What we know about adult mortality in sub-Saharan Africa

Whether based on unreliable data or on models, estimates of adult mortality in sub-Saharan Africa are subject to serious bias (Hill 1999; United Nations 2002). We nevertheless know that adult mortality is higher in sub-Saharan Africa than in the rest of the world. Murray et al. (2003) have developed a modified logit life table system based on Brass's model taking HIV/AIDS mortality into account. They estimate probabilities of dying between ages 15 and 60 in this region at around 0.518 for males and 0.437 for

[3] such as the Demographic and Health Surveys (DHS).

females in 2000, much higher than in 1990 (respectively 0.386 and 0.265) (Lopez et al. 2006).

The international "Global Burden of Disease and Risk Factors" project aims to study health and mortality across the world (Murray and Lopez 1996; 1997). To give an overall picture of the mortality structure, three broad groups of causes of death were defined (Murray et al. 1992): the first group comprises communicable and reproductive diseases[4] which, from the experience of industrialized countries, can be considered as avoidable; the second group comprises the non-communicable diseases (neoplasms, cardiovascular diseases, chronic respiratory diseases, nervous system disorders, etc.); and the last one groups injuries. In 2001, adult mortality from communicable and reproductive diseases appears to be much higher in sub-Saharan Africa than elsewhere in the world (Mathers et al. 2006). According to the estimates, HIV/AIDS accounts for around 40 per cent of male adult mortality and 45 per cent of female adult mortality: it has a tragic impact on mortality, further aggravated by the prevalence of tuberculosis. They are major components of mortality, alongside maternal mortality for women. Injuries form the second broad group of causes of death among men, with a large share of violent deaths. Non-communicable diseases represent less than 20 per cent for both sexes, with a predominance of cardiovascular diseases (Table 1).

However, this international picture conceals regional variations, since HIV/AIDS and many tropical diseases such as malaria do not affect all African countries to the same extent. Violent deaths are often a major component of mortality, but part of them correspond to specific contexts, such as local or regional conflicts. Furthermore, the difference between rural and urban areas, in terms of living conditions and health care, suggests that adult mortality in rural areas may also differs from urban ones. In this context, demographic surveillance systems, though not representative at national level, contribute to a better understanding of population levels and trends, notably in relation to adult mortality, thanks to accurate measurement, while providing informative data on causes of death (Kaufman et al. 1997; Pison 2005).

[4] Communicable and reproductive diseases include infectious and parasitic diseases, maternal causes, perinatal causes, meningitis, acute respiratory infections and nutritional deficiencies.

Table 1: Distribution of deaths by group of causes and sex (per cent), and mortality rate (per thousand) between ages 15 and 60 in sub-Saharan Africa in 2001

Causes of death	Male	Female
Communicable and reproductive diseases	60.7	77.1
HIV/AIDS	38.4	45.1
Tuberculosis	8.3	3.7
Maternal conditions	-	12.9
Respiratory infections	3.2	5.1
Other causes	10.8	10.3
Non-communicable diseases	18.5	17.7
Neoplasms	3.8	4.2
Cardiovascular diseases	6.9	7.1
Respiratory diseases	2.2	1.5
Digestive diseases	2.5	1.6
Genito-urinary diseases	0.7	0.9
Other causes	2.4	2.4
Injuries	20.8	5.2
Unintentional injuries	9.2	3.2
Intentional injuries	11.6	2.0
Total	100.0	100.0
Mortality rate (per thousand)	12.0	10.7

Source: Mathers *et al*. 2001 (author's compilation).

1.4 The demographic surveillance system of Mlomp

In 1985, a demographic surveillance system (DSS) was set up in Mlomp, a group of villages located in South-West Senegal (Pison et al. 2002). An initial census was conducted, listing the inhabitants of the area and recording information on the union and reproductive histories of adult women. Ever since, each compound has been visited once a year, usually between January and February. On every visit, the list of the people present during the previous visit is checked, and information is collected concerning the births, weddings, migration and deaths that occurred in the meantime. Furthermore, for persons who have died, detailed information about symptoms and disease prior to death are obtained from a close relative through verbal autopsies (VAs). On the basis of these reports, along with medical information provided by local health institutions, physicians establish the cause of the death whenever possible. This DSS now provides more than 20 years of data on adult mortality and causes of death.

Community consent comes from traditional districts chiefs and the mayor of the rural community of Mlomp. Medical information is obtained through the nurse who works in the local health services with the consent of the physician in charge of the department's health system. Each year, all these institutional and traditional actors are met by the person in charge of the annual survey who also provide them with feedback on the demographic information obtained: number of inhabitants, fertility and mortality indicators, map of the village, demographic trends, etc. Public meetings are also organized for this purpose.

2. Population of Mlomp

2.1 Location of Mlomp, resources and village characteristics

The Mlomp study area is located in the Ziguinchor region of Senegal (Map 1). This region is also known as Casamance and independence movements, which have existed since 1947, have led to ongoing political conflicts since 1982, with sporadic violent incidents leading to deaths as we will see.

In Mlomp, the climate is subtropical with alternating dry and rainy seasons. Rice cultivation is the main local economic activity during the rainy season (from June to October). Rice fields surround the inhabited area. People live in houses grouped in family concessions based on a patriarchal system. The houses are built with adobe walls; roofs are made of corrugated iron or straw (respectively 65 and 35 per cent in 2004). The water is drawn from collective wells and there is no electricity. At the beginning of the 2000s, half of all households did not have latrines.

Map 1: Location of Mlomp and the two other DSS sites in rural Senegal (Bandafassi and Niakhar)

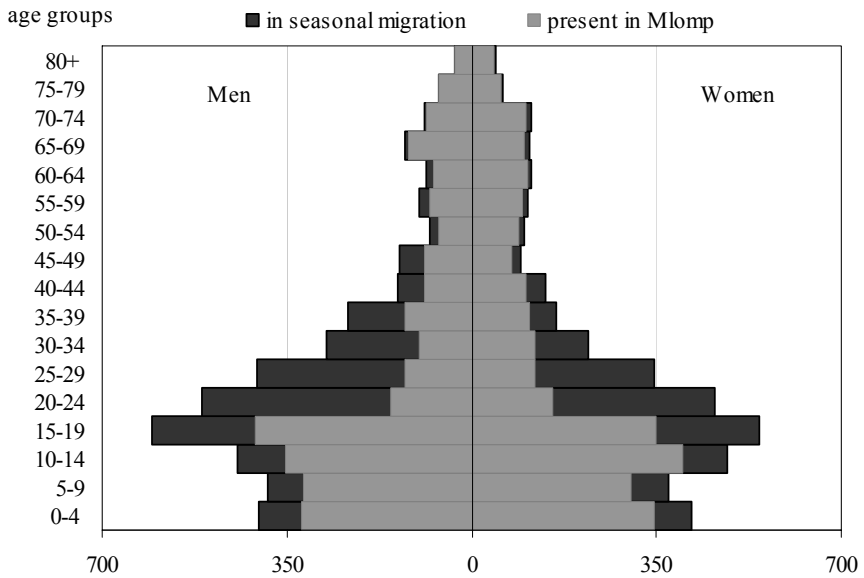
2.2 Population characteristics

On 1 January 2005, the population totalled 8,008 persons, of whom 92 per cent belong to the Jola ethnic group and are animist or Catholic. In Mlomp, most of the children go to school, including girls[5].

[5] In 2000, half of women aged 15–49 and 80 per cent of young ones (aged 15–19) had spent at least one year at primary school, whereas the proportion was less than 20 per cent in rural Senegal in 2005 (Ndiaye et Ayad, 2006).

During the dry season, a period of low agricultural activity in the local area, the majority of male adults migrate to earn money through palm wine harvesting or fishing. Women, before their marriage, work in urban areas as domestic servants for a few years. Hence, on 1 January 2005, one third of the persons followed by the DSS were not physically present in Mlomp and the proportion was 70 per cent for young people aged between 20 and 25 and still close to 50 per cent for men aged between 35 and 39 (Figure 1). As the DSS follows up the *de jure* population, demographic events are also collected on seasonal migrants who are residents[6].

Figure 1: Population in Mlomp DSS on 1 January 2005, by sex, age group and presence in the village at this date



Source: Mlomp database.

[6] Residents are persons who have been declared as members of the household at the initial census, children born to resident mothers during the follow-up, or immigrants. Are considered as emigrants the persons who have been absent for two successive years without coming back for a minimum of one month. At the annual survey, inhabitants in Mlomp are interviewed for themselves but also for their relatives in seasonal migration who are members of the same household. The respondants are vey well informed about their relative-s in migration who keep relation with them. Demographic events concerning these seasonal migrants are rarely omitted.

The sex and age structure of the population reflects past and present migration flows which vary according to sex and age. Other factors also have an influence: fertility was low during the Second World War because many young men were enlisted in the French army. Large-scale emigration also took place after the War. As a result, there were relatively few adults aged 40-65 in 2005. Many young children born in urban areas are fostered to relatives living in Mlomp, so there are many young people aged between 10 and 20. Fertility has decreased recently, which explains also why there are fewer young children by comparison.

2.3 Fertility and mortality

In Mlomp, fertility is relatively low and the total fertility rate was 4.2 children per woman during the period 1985–2004, compared with 6.4 in rural Senegal in 2002–2004 (Ndiaye and Ayad 2006). Women in Mlomp have their first child quite late for a rural area of sub-Saharan Africa: at age 23 on average. This first birth occurs most often in consensual unions before marriage which generally takes place late, between ages 25 and 30. Before - and also after - marriage, births are spaced because of many factors: migration of young women, non-cohabitation of non-married partners, use of contraception (17% women aged 15-49 in 2000), breastfeeding (median duration of 19 months), post-partum abstinence and separation due to seasonal migration (Pison et al. 2001).

During the period 1985–2004, life expectancy at birth in Mlomp was 61 years for both sexes. That is high for a rural area of sub-Saharan Africa[7]. Child mortality in Mlomp was relatively low: for a live born infant, the probability of dying before age five was 0.100 during the period 1985–2004, compared with more than 0.160 in rural Senegal as a whole over 1995–2004 (Ndiaye and Ayad 2006). This is particularly due to the local health care system which has been functioning since the early 1960s, with a dispensary and a maternity clinic. All women give birth at the maternity clinic, and children are fully immunized (Pison et al. 1993).

[7] Apart from rural sites in South Africa, life expectancy in Mlomp is the highest level observed among rural DSS sites in sub-Saharan Africa, the lowest is observed in Bandim (Guinea Bissau) with less than 40 years (INDEPTH Network 2002; Pison 2005).

3. Measurement issues and adult mortality data reliability

3.1 Mortality level

Regarding the data reliability, the dates of births and deaths that occur during the surveillance are registered carefully. A special effort was made to prevent the classic bias in age determination of the persons registered during the initial census using different sources of information as dispensary and maternity registers, marriage years, and identity cards (Pison et al. 2002). As a consequence, nearly all birthdates after 1985 are accurate, as well as birthdates of persons born during the 1960s and the 1970s up to 1985, thanks to health service registers; for those born before 1960, exact birthdates are known for some of them, and for the others, declarations have been crosschecked and corrected. The adult dates of birth are much more reliable than in most African surveys. The age of the very old population (80 years or more) remains of poor quality however.

A tragic event had a significant impact on the mortality level in Mlomp. The region is geographically separated from the rest of the country by Gambia. People from Casamance used to go to the capital of Senegal – Dakar – by ferryboat from Ziguinchor. This was the simplest and the cheapest mode of transport, but the ferryboat named the 'Joola' sank in September 2002, and nearly two thousand persons, mostly from Casamance, were drowned. During the following annual survey in Mlomp, 55 deaths in the wreck were registered, but 20 of them concerned persons who had come to Mlomp for the first time during the previous rainy season. This traumatic event probably led inhabitants to declare all the persons they knew who died in the disaster. These 20 persons were excluded from our analysis to avoid over-representing this event on mortality (Duthé 2006).

3.2 Causes of death

In Mlomp, causes of death are assessed through verbal autopsies and medical information provided by local health services. The VA method is based on the assumption that most causes of death can be identified by distinct sets of symptoms that can be recognized, remembered and reported by people with no medical training. The interviewer questions a close relative of the deceased and records the circumstances of the death, the initial symptoms, their duration and the affected organs. Physicians are then asked to interpret the information obtained and to determine the probable causes of death. Deaths can thus be classified by cause on the basis of reported information (Fauveau 2006). Classifying causes of death is not simple because death is usually the result of a complex process (WHO 1975) and the VA method cannot replace an autopsy

of the body. This method leads to some bias which may result in wrong diagnosis. Such bias may occur at different stages: the questionnaire used, the interview, the diagnosis, or the classification (Soleman et al. 2006).

From 1985 to 2003, the VA interviews[8] were performed by one male interviewer, except those relating to newborn children and women of reproductive age, which were conducted by a female interviewer to respect gender taboos. These interviewers were from Mlomp, a fact that facilitates a good understanding in terms of language, but also in terms of social and cultural aspects. They have no medical training but they are involved in the local health system as mediators. A relation of trust is essential to minimize the emotional distress which can be caused by a poorly conducted interview (Chandramohan et al. 2005). The time elapsed between the death and the interview is six months on average. The maximum is one year, and at minimum, the interviewer respects the period of mourning. The interviewed person is the closest relative of the deceased able to answer questions about symptoms during the illness. The significance of the VA is explained to the relatives and verbal consent obtained from the interviewed person.

In Mlomp, the questionnaire has not changed since 1985. It is the same for every death, but one part is specific to newborn children and women who were pregnant in the year preceding their death. After confirming the information on identities of the deceased person and the interviewee, the interviewer asks about the deceased person's cause of death, if the interviewee has any knowledge of it, and asks him/her to freely talk about and describe the illness and the health care received. The questionnaire also includes a list of symptoms[9] which are detailed in other questions if they have been noticed by the interviewee. Answers mostly take the form of fixed responses.

Until 2003, only one physician was required to diagnose the causes of death. This is not recommended in the standard VA method, and normally two or three physicians are involved in determining the causes of death, with a comparison of their diagnoses. But, in Mlomp, local health institutions provide precious medical data, a rare occurrence in rural areas. As all women give birth at the maternity clinic and children are taken monthly to the dispensary for growth monitoring and immunization, medical information completes many VAs of newborn children, young children and pregnant women. Furthermore, information on blood pressure, presence of a chronic disease,

[8] On average for the 20 year-period, there were fewer than 80 deaths a year.

[9] Fever, diarrhoea/dysentery, dehydration signs, vomiting, convulsions and other neurological signs, trouble breathing, cough, pimples, wound, burn, abscess, bleeding, oedema, distended stomach, urinary and stools problems, eyes problems, pains (for a death after age two), general signs, chronic disease. For a death related to a newborn child or a 12-49 years old woman: information on the previous and last or current pregnancies if there are, last delivery conditions and newborn child health.

medicines taken, results of laboratory tests, complete also the VA of adults if the deceased made use of dispensary services, which is common[10].

The method has been slightly changed recently in order to harmonize the methods used for all three DSS sites in rural Senegal: Niakhar, Bandafassi, and Mlomp. Since 2004, a new interviewer[11] has come to Mlomp during the annual survey and two physicians are involved in determining the causes of death (and a third one in case of disagreement).

Causes of death are classified according to the ninth International Classification of Diseases (WHO 1975), and only the underlying cause is registered. We assume that there is no intra-observer variation during the period 1985–2003 because the protocol remained unchanged. The change in 2003 may modify the results of the VAs for the last year of the period, but we suppose that medical information provided by the health services minimizes this bias.

3.3 Distribution of ill-defined causes

The adult mortality structure, more complex than that of children, is generally difficult to study with this method (Chandramohan et al. 1994; 1998). But in Mlomp, medical information increases the reliability of the diagnosis when a precise cause is defined and minimizes the risk of misclassification. For certain deaths, the causes are ill-defined however. These deaths may be related to general symptoms (fever, coma…) or relative to an anatomical system (digestive tract, respiratory tract…). Some deaths are characterized by senility (at old ages) and, in the absence of any information[12], cause of death is unknown. Between ages 15 and 60, a quarter of the 363 deaths which occurred during the period 1985–2004 have ill-defined causes, but the proportion is 18 per cent among the 15–39 age group: 4 per cent are characterized by general symptoms, 6 per cent by particular symptoms and 9 per cent of deaths have an unknown cause. Between the ages 40 and 60, the proportion of deaths from ill-defined causes is much higher, with 11 per cent of deaths which are classified in specific symptoms and 13 per cent for which the cause is unknown. But the ill-defined causes are very frequent among deaths occurred in the oldest age group (Table 2).

[10] Since the beginning of the follow-up, the nurse who works in the local health service writes all deaths she notices in a register and reports, if there are, additional medical information and possible diagnosis. On average on the period, more than 70% of all adult deaths (15-59) have been registered in this death register.
[11] This interviewer is also from Mlomp.
[12] For deaths which occurred during migration or without the presence of a relative living in Mlomp who is able to answer the VA.

Table 2: Deaths from ill-defined causes after age 15 (per cent) and number of deaths, by age group in Mlomp (1985-2004)

	15–39	40–59	60 and over
Proportion of deaths from ill-defined causes (per cent)	18.4	28.6	39.3
General symptoms (fever, coma, convulsions…)	4.0	4.2	7.8
Other symptoms (related to a specific organ)	5.7	11.1	9.4
Senility, old age	-	-	8.5
Unknown cause	8.6	13.2	13.6
Number of deaths from ill-defined causes	32	54	286
Total number of deaths	174	189	727

Source: Mlomp database.

To analyze the causes of death among adults, ill-defined causes must be taken into account. The simplest method consists in redistributing them across all the other causes, proportionally by sex and age group. In this way, the distribution of the defined causes is not modified, on the assumption that there is no correlation between the real cause and the ill-defined death. In the international project "Global Burden of Diseases and Risk Factors", deaths from general ill-defined causes were distributed pro-rata across the two first broad groups of causes, communicable and non-communicable diseases, excluding the third one, injuries which are easier to diagnose than the other causes of death (Mathers et al. 2006). In Mlomp, we process separately two categories of ill-defined deaths: on the one hand, deaths for which the cause is unknown are deaths for which there is no information and we assume that they may be due to any cause, even injuries, except in the particular case of deaths due to the sinking of the 'Joola'; on the other hand, we consider that the other ill-defined causes which are characterized by symptoms, either general or specific, cannot be injuries that are correctly registered when there is sufficient information. In this way, deaths of unknown cause are distributed proportionately across all causes except deaths due to the sinking of the 'Joola', whereas the other ill-defined causes are distributed proportionally across all causes excluding all injury deaths[13].

[13] See appendix 1 for the calculation.

4. Adult mortality in Mlomp (1985–2004)

4.1 Much higher mortality among men than women

In Mlomp, the probability of dying between ages 15 and 60 is near 0.310 for men and 0.167 for women. The adult mortality level in Mlomp can be compared with the two other DSS sites in rural Senegal – Niakhar and Bandafassi – which are located in other regions (Map 1) and characterized by different populations and living conditions: the probability of dying before age 60 for adults older than 15 is 0.291 for men and 0.236 for women in the first, 0.300 and 0.285 in the second (Table 3). In Mlomp, male mortality is slightly higher than in the two other DSS sites of Senegal, but female mortality is much lower. Analysis of the causes of death helps to understand why do we have so important differences between men and women.

Table 3: Probability of dying between ages 15 and 60, by sex in the three DSS sites in rural Senegal

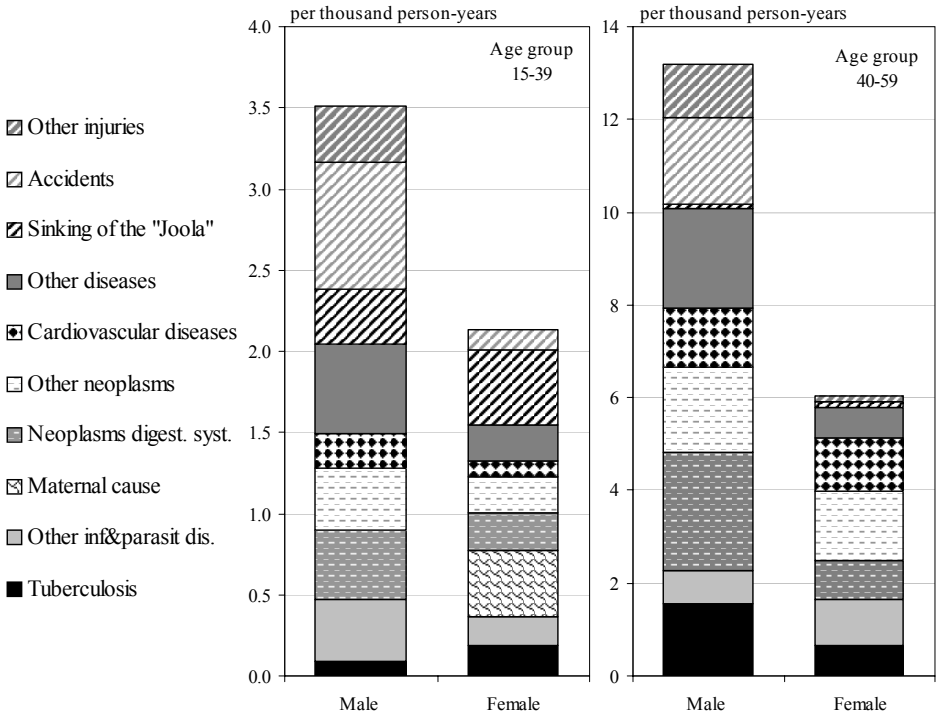
${}_{45}q_{15}$	Male	Female
Mlomp[(1)] 1985–2004	0.309	0.167
95% CI	0.276–0.345	0.140–0.199
Number of deaths	245	118
Other DSS sites in rural Senegal		
Niakhar[(2)] 1985–2004	0.291	0.236
Bandafassi[(3)] 1986–2000	0.300	0.285

Sources: [(1)] Mlomp database; [(2)] Lévi *et al*. 2004; [(3)] Guyavarch 2003.

4.2 Distribution of causes of death

Taking the ill-defined causes into account in the distribution as explained above in section 3.3, we can attempt to provide mortality rates by group of causes, by sex and age group among adults in Mlomp (Figure 2).

Figure 2: Mortality rate by group of causes with redistribution of deaths from ill-defined causes, between ages 15 and 60, by sex and age group (Mlomp, 1985-2004)



Source: Mlomp database.

Accidents represent the largest share of male mortality between ages 15 and 40 (0.79 out of 3.51 deaths per thousand person-years). Added to the deaths due to the sinking of the 'Joola' and other injuries, they total 1.47 deaths per thousand person-years. This level is high for rural Senegal (Pison et al. 2005). Among injuries and poisoning, women have mostly been victims of the sinking of the 'Joola' (0.46) for a total female mortality rate of 2.14 per thousand person-years. The second main cause is maternal deaths, which represent 20 per cent of the mortality rate. Neoplasms, constitute 20 per cent of the deaths in this age group for both women and men. Infectious and parasitic diseases also contribute to mortality of young adults.

Few cases of tuberculosis (TB) are diagnosed before age 40, but this disease is becoming more common between ages 40 and 60, especially among men, for whom the

TB mortality rate is 1.56 per thousand person-years. Injuries and poisoning represent 23 per cent of male mortality. Neoplasms are the group of causes which accounts for the largest proportion of mortality, followed by cardiovascular diseases.

Because of the small numbers, we grouped causes of death in the whole 15–59 age group. Let us consider the grouping into three categories used by Murray et al. (1992).

4.3 Three broad groups of causes

Communicable and reproductive diseases account for 17 per cent of male mortality and 35 per cent of female mortality in Mlomp (Table 4). For females, one third of these deaths are maternal deaths. However, maternal mortality was estimated at 268 per 100,000 live births[14] in 1985–2004, a lower level than observed in the two other rural sites in Senegal (Niakhar and Bandafassi), and habitually in rural Africa (Pison et al. 2000). In this group, tuberculosis is predominant for both sexes. In most cases, tuberculosis is not associated with AIDS, whose prevalence is relatively low in Mlomp, as in the whole of Senegal (UNAIDS 2006). The incidence in Mlomp was estimated at 0.8 per thousand adults and per year in 1990–95 (Diop et al. 2000) and according to the diagnoses, 8 adults between ages 15 and 60 died of AIDS[15] during the period 1985–2004, mainly women. For female mortality between ages 15 and 60, maternal deaths, tuberculosis and AIDS explain 80 per cent of the communicable and reproductive mortality, but only 28 per cent of the total mortality.

Non-communicable diseases are the most common broad group. Cancers constitute more than half of this group: they are mostly malignant neoplasms of the digestive system, primarily liver cancer which affects men. Cardiovascular diseases are also common, with cardiopathies, cardiac insufficiencies, and cerebrovascular diseases. In addition, the weight of the digestive and genitourinary diseases is by no means marginal.

Injuries represent one third of male mortality and 16 per cent of female mortality, mostly due to the sinking of the 'Joola'. There were 13 recorded victims of the conflict in Casamance among men. For the rest, the working activities of men who are harvesting palm wine and fishing are a major cause of injuries: deaths by drowning concern only young men and falls from palm tree are most common among men older than 40. For women, though the proportion is small, domestic activities also present risks of dying from falling into wells.

[14] $_{95\%}$ CI =[111–528].

[15] In total, 16 AIDS deaths have been diagnosed: two before age 15, eight between ages 15 and 60 and six after 60.

Table 4: Distribution of deaths by broad group of causes and sex (per cent), and mortality rate (per thousand person-years) between ages 15 and 60 with redistribution of deaths from ill-defined causes, in Mlomp (1985–2004)

Causes of death	Male	Female
Communicable and reproductive diseases	17.1	35.3
HIV/AIDS	1.1	7.3
Tuberculosis	7.4	9.7
Maternal conditions	-	11.0
Respiratory infectious	1.1	1.2
Other causes	7.4	6.1
Non-communicable diseases	50.7	48.7
Neoplasms	27.9	28.0
Cardiovascular diseases	8.0	11.0
Respiratory diseases	0.0	0.0
Digestive diseases	5.1	4.9
Genito-urinary diseases	5.7	2.4
Other causes	4.0	2.4
Injuries	32.2	16.0
Sinking of the 'Joola'	4.9	11.9
Other unintentional injuries	18.1	3.1
Intentional injuries	9.3	1.0
Total	100.0	100.0
Number of deaths	245	118
Person-years	42410.107	37695.735
Mortality rate (per thousand person-years)	5.78	3.13

Source: Mlomp database.

5. Discussion

5.1 Adult mortality level

Mortality is quite different for men and women, for two reasons: first, exceptionally low female mortality due to a relatively low level of maternal mortality for a rural area; second, a surprisingly high male mortality in comparison. This "excess" mortality of men appears to be due to accidents and neoplasms.

According to WHO national estimates for 2004, probabilities of dying between ages 15 and 60 are 0.368 for males and 0.288 for females in Senegal (WHO 2006a and

Mathers et al. 2001). We could compare national estimates to local results from DSS sites, but further analyses are necessary to study more precisely all the different sources (local and national) which involve a variety of methods and results, as we can see here (Table 3; Table 5).

Table 5: Probability of dying between ages 15 and 60 by sex in Senegal

Year	Source and method	$_{45}q_{15}$	
		Male	Female
1988	Deaths in the year prior to the National Census [(1)]	0.295	0.271
1999	Under-5 mortality level and modified Brass logit system [(2)]	0.362	0.308
2004	Under-5 mortality level and modified Brass logit system [(3)]	0.368	0.288

Sources: [(1)] Pison *et al.* 1995 ; [(2)] Lopez *et al.* 2002 ; [(3)] WHO 2006a and Mathers *et al.* 2001.

5.2 Specific causes of death

Concerning specific causes of death, the measurement of maternal mortality in the three sites in rural Senegal in 1985–98 had shown an overestimation of the national rate issued by WHO in 1995 (Pison 2001). According to WHO, the maternal mortality rate for Senegal is estimated at 690 per 100,000 live births in 2000, down from 1,200 in 1995, a figure that wasn't realistic (WHO et al. 2004). In the same way, measuring the local impact of HIV/AIDS epidemic can be useful. In Mlomp, the AIDS mortality rate is estimated at 0.16 per thousand and per year[16] for the entire population during 1985–2004. In Senegal, UNAIDS estimates that in 2005, AIDS killed 5,200 people among a population of 11,658 thousand inhabitants, giving a mortality rate of around 0.42 per thousand, but with a large uncertainty interval [0.14–0.73] (UNAIDS 2006). Similarly, we estimate that TB mortality rate for all ages in Mlomp is 0.57 per thousand and per year in 1985–2004, which is close to the WHO countrywide estimation of 0.52 per thousand in 2004 (WHO 2006b). But such contributions for evaluating the impact of tuberculosis and AIDS on mortality remain uncertain due to the presence of many ill-defined deaths. For this reason, they must be supported by comparative studies in all the DSS sites in Senegal, and by accurate and recent data on the prevalence of HIV/AIDS in the population.

[16] With redistribution of deaths from ill-defined causes at all ages.

5.3 Broad groups of causes

Comparing the estimate distribution of broad causes of death in Mlomp with the distribution estimated for sub-Saharan Africa (Table 1; Table 4), communicable and reproductive diseases contribute less to adult mortality in Mlomp. Thus, they may be less prevalent in local areas than the international picture shows, mostly because the HIV/AIDS epidemic is relatively limited in Senegal. But also because maternal mortality can be reduced, even in rural areas, with accessible health services and lower fertility rates. In addition, respiratory infections, which are a major group in this class, appear to be less prevalent in Mlomp. This is also true for the respiratory diseases classified among non-communicable diseases. By contrast, one third of the total mortality rate could be due to cancers, a much higher proportion than for sub-Saharan Africa as a whole.

We can also compare the distribution of causes of death in Mlomp with that of a developed country at a period when the adult mortality level was similar to that of Mlomp today: in France in 1947, the probability of dying between ages 15 and 60 was 0.254 among men and 0.169 among women. Tuberculosis represented 24 and 21 percent respectively of male and female adult mortality (Appendix 2). This result suggests that communicable diseases were also common in the past in developed countries among adults despite the absence of HIV/AIDS. Concerning non-communicable diseases, the two other main causes were cardiovascular diseases and cancers in France, instead cancers only in Mlomp, according to our estimates. Therefore, a proportion of deaths from neoplasms could be considered as 'avoidable mortality', and likewise for communicable and reproductive diseases.

5.4 Ascertaining causes of death

In Mlomp, causes of death are ascertained using a combination of the classical VA method and medical information. This method is particular to this site and is expected to provide more accurate diagnosis than simple verbal autopsies, but it has not been quantitatively assessed yet. For this purpose, new consolidated protocols now being disseminated by WHO could be useful (WHO, 2007).

In Mlomp for the 20-year period 1985-2004, analyses of adult mortality are based on a low number of deaths (n=363) due to the small size of the study population. Therefore, mortality rates are influenced by events such as the sinking of the 'Joola' in 2002. This small total number is a major limitation for measuring the weight of specific causes of death.

Despite the contribution of medical information to the method, a quarter of adult deaths remain ill-defined. Hence, the redistribution to estimate the weights of groups of causes of death we have applied here, may lead to over- or under- estimations. Among communicable diseases, the substantial proportion of tuberculosis deaths reveals a major public health problem. However, we can also assume some overestimation of the disease in Mlomp. Thanks to medical information, tuberculosis, like most chronic diseases, with clear symptoms and long duration, are easily recognized by the nurse who works at the dispensary and also by the close relatives who answer the VAs. Respiratory symptoms, on the other hand, are less easy to discern, and digestive disorders can be due to different diseases such as cirrhosis or cancer.

Another problem is to distinguish between the direct cause and the underlying cause. Half of the men who died by drowning were epileptic, but there was no information about a possible fit which could be the underlying cause of death. As epilepsy is rarely reported as the underlying cause of death, its weight in mortality appears to be under-estimated.

6. Conclusion

Behavioural factors account for a large share of the differences between adult men and women in Mlomp: in particular, alcohol consumption, a major risk factor in liver diseases, is common among male adults. It is also known to increase the frequency of injuries (Kjellstrom et al. 1992; Ezzati et al. 2002), which are strongly linked to day-to-day behaviours, and with high-risk male activities (harvesting palm wine, fishing).

The three broad groups of causes are connected if we consider the morbidity aspect: infectious diseases are involved in the development of non-communicable ones, such as intestinal infections and the development of neoplasms of the digestive system or cirrhoses. The example of epilepsy shows that an injury can occur because of a chronic disease. Hypertension – which is a risk factor for a chronic disease – and diabetes increase the risk of cardiovascular disease. The morbidity of adults in less developed countries is even less well documented than mortality. The study of morbidity and the prevalence of chronic diseases and infections is a vital step in understanding the processes that lead to death.

In Mlomp, HIV prevalence is low compared to other African areas and adult mortality is half due to non-communicable diseases. Even if the first group of communicable and reproductive diseases part is lower than the estimated international situation, many infections can lead to fatal non-communicable diseases. In this way, the adults suffer of a variety of health problems that is urgent to consider for a successful health transition in developing countries.

7. Acknowledgements

We are grateful for the many helpful comments that we have received, especially from all the readers of the previous versions, the anonymous reviewers, France Meslé, Magali Barbieri and Catriona Dutreuilh for her support in the translation of the English version. We also gratefully acknowledge the support for this research through Institut national d'études démographiques (INED) and the French Ministry of Research (PAL+ project). We would like to thank the other members of the Mlomp Project who have contributed to the data collection, the management of the database and the determination of the causes of death, especially Emmanuelle Guyavarch, Catherine Enel, Adama Sow Sambou, Paul Senghor, Rosine Diedhiou, Agnès Diatta, Raphael Laurent, Alexis Gabadinho, Henriette Delenne (Soeur Marie-Joëlle), Mamadou Cissé, Jean-François Trape, Felix Kabou, Arame Mbengue Gaye and Aldiouma Diallo.

References

Baya, B. (2004). *Population et maladies infectieuses au Burkina Faso [Population and infectious diseases in Burkina Faso]*. Second seminar of the IUSSP Scientific Committee on Emerging Health Threats HIV, Resurgent Infections, and Population Change in Africa, Ouagadougou, Burkina Faso, February 12-14 2004.

Brass, W. and Coale, A.J. (1968). Methods of analysis and estimation. In: Brass, W., Coale, A.J., Demeny, P., Heisel, D.F., Lorimer, F., Romaniuk, A. and Van de Walle, E. (eds.). *The demography of tropical Africa*. Princeton: Princeton University Press, 88-139.

Caldwell, J.C., Findley, S., Caldwell, P., Santow, G.M., Cosford, W.H., Braid, J. and Broers-Freeman, D. (eds.). (1990). *What we know about health transition: The cultural, social and behavioural determinants of health; The proceedings of an International Workshop*, *Canberra, May 1989*. Canberra: Health Transition Centre. (Health transition series; 2).

Chandramohan, D., Maude, G. H., Rodrigues, L.C. and Hayes, R.J. (1994). Verbal autopsies for adult deaths: Issues in their development and validation. *International Journal of Epidemiology* 23: 213-222.

Chandramohan, D., Maude, G.H., Rodrigues, L.C. and Hayes, R.J. (1998). Verbal autopsies for adult death: Their development and validation in a multicentre study. *Tropical Medicine and International Health* 3: 436-446.

Chandramohan, D., Soleman, N., Shibuya, K. and Porter, J. (2005). Ethical issues in the application of verbal autopsies in mortality surveillance systems. *Tropical Medicine and International Health* 10(11): 1087-1089.

Coale, A.J., Demeny, P. and Vaughan, B. (1983). *Regional model life tables and stable populations.* 2nd ed. Princeton: Princeton University Press.

Diop, O.M., Pison, G., Diouf, I., Enel, C. and Lagarde, E. (2000). Incidence of HIV-1 and HIV-2 infections in a rural community in southern Senegal. *AIDS* 14(11): 1671-1672.

Duchêne, J. (2005). Model life tables. In: Caselli, G., Vallin, J. and Wunsch G. (eds.). *Demography: Analysis and Synthesis. Volume 4*. London: Academic Press.

Duthé, G. (2006). La transition sanitaire à Mlomp. Évolution de la mortalité à Mlomp depuis 1985 et influence du paludisme chimiorésistant [Health transition in rural

Senegal. Mortality trends in Mlomp since 1985, and impact of chloroquine resistance of malaria], PhD thesis. Paris: Muséum national d'histoire naturelle.

Ezzatti, M., Lopez, A.D., Rodgers, A., Vander Hoorn, S., Murray, C.J.L. and the Comparative Risk Assessment Collaborating Group. (2002). Selected major risk factors and global and regional burden of disease. *The Lancet* 360: 1347-1360.

Fauveau, V. (2006). Assessing probable causes of death without death registration or certificates: a new science?. *Bulletin of the WHO* 84(3): 246-247.

Feachem, R.G.A., Phillips, M.A. & Bulatao, R. (1992). Introducing adult health. In: Feachem, R.G.A., Kjellstrom, T., Murray, C.J.L., Over, M. and Phillips, M.A. (eds.). *The health of adults in the developing world*. New York: Oxford University Press: 1-22.

Frenk, J., Bobadilla, J.L., Stern, C., Frejka, T. and Lozano, R. (1991). Elements for a theory of the health transition. *Health Transition Review* 1: 21-38.

Guyavarch, E. (2003). Démographie et santé de la reproduction en Afrique subsaharienne. Analyse des évolutions en cours. Une étude de cas: l'observatoire de population de Bandafassi (Sénégal) [Demography and reproductive health in sub-Saharan Africa. Analysis of evolution in progress. A case study: the demographic surveillance system of Bandafassi (Senegal)], PhD thesis. Paris: Muséum national d'histoire naturelle.

Hill, K.H. (1977). Estimating adult mortality levels from information on widowhood. *Population Studies* 31(1): 75-84.

Hill, K.H. (1999). The measurement of adult mortality: an assessment of data availability, data quality and estimation methods. In: Chamie, J. and Cliquet, R. (eds.). *Health and mortality issues of global concern: Proceedings of the Symposium on Health and Mortality, Brussels, 19-22 November 1997*. Brussels: CBGS, Population and Family Study Centre, Flemish Scientific Institute: 72-83.

INDEPTH Network (ed.). (2002). *Population and health in developing countries. Volume 1: Population, health, and survival at INDEPTH sites*. Ottawa: International Development Research Centre. (Population and health in developing countries; 1).

Kaufman, J.S., Asuzu, M.C., Rotimi, C.N., Johnson, O.O., Owoaje, E.E. and Cooper, R.S. (1997). The absence of adult mortality data for sub-Saharan Africa: a practical solution. *Bulletin of the WHO* 75(5): 389-395.

Khlat, M. and Le Cœur, S. (2002). La santé: Anciennes et nouvelles maladies [Health: Old and new diseases]. In: Chasteland, J.-C. and Chesnais, J.C. (eds.). *La population du monde. Géants démographiques et défis internationaux*. Paris: Ined, 497-525.

Kjellstrom, T., Koplan, J.P. and Rothenberg, R.B. (1992). Current and future determinants of adult ill-health. In: Feachem, R.G.A., Kjellstrom, T., Murray, C.J.L., Over, M. and Phillips, M.A. (eds.). *The health of adults in the developing world*. New York: Oxford University Press: 209-259.

Lerner, M. (1973). *Modernization and health: A model of the health transition*. Annual Meeting of the American Public Health Association (APHA), San Francisco, November 1973.

Lévi, P., Adjamagbo, A. and Passchier, M. (2004). Presentation of the main sociodemographic indicators in Niakhar (Senegal) [electronic resource]. Dakar: IRD. http://www.ird.sn/activites/niakhar/.

Lopez, A.D., Salomon, J., Ahmad, O., Murray, C.J.L. and Mafat, D. (2002). *Life tables for 191 countries: Data, methods and results.* Geneva: WHO. (GPE discussion paper series; 9).

Lopez, A.D., Begg, S. and Bos, E. (2006). Demographic and epidemiological characteristics of major regions, 1990-2001. In: Lopez, A.D., Mathers, C.D., Ezzati, M., Jamison, D.T. and Murray, C.J.L. (eds.). *Global burden of disease and risk factors*. New York: Oxford University Press: 17-44.

Mathers, C.D., Vos, T., Lopez, A.D., Salomon, J. and Ezzati, M. (eds.). (2001). *National burden of disease studies: A practical guide. Edition 2.0. Global Program on Evidence for Health Policy*. Geneva: WHO.

Mathers, C.D., Lopez, A.D. and Murray, C.J.L. (2006). The burden of disease and mortality by condition: Data, methods, and results for 2001. In: Lopez, A.D., Mathers, C.D., Ezzati, M., Jamison, D.T. and Murray, C.J.L. (eds.). *Global burden of disease and risk factors*. New York: Oxford University Press: 45-240.

Meslé, F. and Vallin, J. (2005). Causes of death in France since 1925 [electronic resource]. Paris: Ined. http://www.ined.fr/bdd/causfra/.

Murray, C.J.L., Yang, G. and Qiao, X. (1992). Adult mortality: levels, patterns and causes. In: Feachem, R.G.A., Kjellstrom, T., Murray, C.J.L., Over, M. and Phillips, M.A. (eds.). *The health of adults in the developing world*. New York: Oxford University Press: 23-111.

Murray, C.J.L. and Lopez, A.D. (eds.). (1996). *The global burden of disease*: *A comprehensive assessment of mortality and disability from diseases, injuries, and risk factors in 1990 and projected to 2020*. Cambridge: Harvard University Press.

Murray, C.J.L. and Lopez, A.D. (1997). Mortality by cause for eight regions of the world: Global burden of disease study, *The Lancet* 349(9061): 1269-1276.

Murray, C.J.L., Ferguson, B.D., Lopez, A.D., Guillot, M., Salomon, J.A. and Ahmad O.B. (2003). Modified logit life tables system: Principles, empirical validation, and application. *Population Studies* 57(2): 165-182.

Ndiaye, S. & Ayad, M. (2006). *Enquête démographique et de santé au Sénégal 2005* [Demographic and Health Survey in Senegal 2005]. Calverton, Maryland: CRDH (Senegal) and ORC Macro.

Omran, A. (1971). The epidemiologic transition: a theory of the epidemiology of population change. *Milbank Memorial Fund Quarterly* 29(4): 509-538.

Pison, G. (2001). Assessing maternal mortality in developing countries. *Population & Sociétés* 372: 1-4.

Pison, G. (2005). Population observatories as sources of information on mortality in developing countries. *Demographic Research* 13: 301-334.

Pison, G., Trape, J.-F., Lefebvre L. and Enel, C. (1993). Rapid decline in child mortality in a rural area of Senegal. *International Journal of Epidemiology* 22(1): 72-80.

Pison, G., Hill, K.H., Cohen, B. and Foote, K.A. (1995). *Population dynamics of Senegal*. Washington, DC: National Academy Press.

Pison, G., Kodio B., Guyavarch, E. and Étard J.-F. (2000). La mortalité maternelle en milieu rural au Sénégal [Maternal mortality in rural Senegal]. *Population*, 55(6): 1003-1018.

Pison, G., Gabadinho, A. and Enel, C. (2001). Mlomp, Sénégal: Niveaux et tendances démographiques 1985-2000 [Mlomp, Senegal: Demographic levels and trends 1985-2000]. Paris: Ined (Document de travail [Working paper]; 103).

Pison, G., Wade, A., Gabadinho, A. and Enel, C. (2002). Mlomp DSS, Senegal. In: Indepth network (ed). *Population and health in developing countries. Volume 1: Population, health, and survival at INDEPTH sites*. Ottawa: International Development Research Centre: 271-278.

Pison, G., Duthé, G., Guyavarch E., Marra, A and Chippaux J.-P. (2005). *Violent mortality in Senegal: levels and causes in three rural areas*. XXV IUSSP International Population Conference, Tours (France), July 18-23 2005.

Preston, S.H. and Bennett, N.G. (1983). A census-based method for estimating adult mortality. *Population Studies* 37(1): 91-104.

Preston, S.H. and Nelson, V.E. (1974). Structure and change in causes of death: an international summary. *Population Studies* 28(1): 19-51.

Prost, A. (2000). L'Afrique n'est pas un cas particulier : Retour des grand fléaux, émergence de maladies nouvelles [Africa is not a particular case : Return of large plagues, emergence of new diseases]. *Afrique contemporaine* 195: 15-23.

Soleman, N., Chandramohan, D. and Shibuya, K. (2006). Verbal autopsy: Current practices and challenges. *Bulletin of the WHO* 84(3): 239-245.

Timæus, I.M. (1993). Adult mortality, *in* K.A. Foote, K.H. Hill & L.G. Martin (eds.). *Demographic Change in sub-Saharan Africa*. Washington, D.C.: National Academy Press.

Timæus, I.M. and Jasseh, M. (2004). Adult mortality in sub-Saharan Africa: Evidence from Demographic and health surveys. *Demography* 41(4): 757-772.

UNAIDS. (2006). Report on the global AIDS epidemic. Geneva: UNAIDS.

United Nations. (1982). *Model life tables for developing countries*. New York: Population Division, Department of Economic and Social Affairs of United Nations.

United Nations. (2002). *Methods for estimating adult mortality*. New York: Population Division, Department of Economic and Social Affairs of United Nations.

United Nations. (2006). *World population prospects: The 2005 revision*. New York: Population Division, Department of Economic and Social Affairs of United Nations. (http://esa.un.org/unpp/).

Vallin, J. and Meslé, F. (2004). *Convergences and divergences in mortality: A new approach to health transition*. Second seminar of the IUSSP Scientific Committee on Emerging Health Threats HIV, Resurgent Infections, and Population Change in Africa, Ouagadougou, Burkina Faso, February 12-14 2004.

WHO. (1975). *International classification of diseases: The ninth revision (ICD-9)*. Geneva: WHO.

WHO. (2002). *The world health report 2002: Reducing risks, promoting healthy life*. Geneva: WHO.

WHO. (2003). *The world health report 2003: Shaping the future*. Geneva: WHO.

WHO. (2006a). *The world health report 2006: Working together for health*. Geneva: WHO.

WHO.(2006b). *Global tuberculosis control: Surveillance, planning, financing*. Geneva: WHO.

WHO. (2007). *Verbal autopsy standards: Ascertaining and attributing cause of death*. Geneva: WHO.

WHO, UNICEF, UNFPA. (2004). *Maternal mortality in 2000: Estimates developed by WHO, UNICEF, UNFPA*. Geneva: WHO.

Appendix 1: Mortality rate by group of causes (per thousand person-years) with redistribution of deaths from ill-defined causes, and distribution (per cent), by sex and age group, in Mlomp (1985–2004)

	Male				Female			
	Mortality rate			Distr.	Mortality rate			Distr.
Group of causes of death	Crude	Redistribution of ill-defined causes			Crude	Redistribution of ill-defined causes		
Age group 15–39								
Tuberculosis	0.06	0.07	0.09	2.4	0.14	0.17	0.18	8.5
Other infectious&parasitic diseases	0.28	0.31	0.38	10.9	0.14	0.17	0.18	8.5
Maternal causes	0.00	0.00	0.00	0.0	0.32	0.37	0.41	19.2
Neoplams of the digestive system	0.31	0.34	0.43	12.1	0.18	0.21	0.23	10.7
Other neoplasms	0.28	0.31	0.38	10.9	0.18	0.21	0.23	10.7
Cardiovascular diseases	0.15	0.17	0.21	6.1	0.07	0.08	0.09	4.3
Other diseases	0.40	0.44	0.55	15.8	0.18	0.21	0.23	10.7
Sinking of the 'Joola'	0.34	0.34	0.34	9.6	0.46	0.46	0.46	21.7
Accidents	0.71	0.79	0.79	22.4	0.11	0.12	0.12	5.8
Other injuries	0.31	0.34	0.34	9.7	0.00	0.00	0.00	0.0
Symptoms	0.40	0.40			0.14	0.14		
Unknown	0.28				0.21			
Total		3.51		100.0		2.14		100.0
95% CI		[2.92–4.22]				[1.66–2.75]		
Number of deaths		*114*				*60*		
Person- years		*32477.212*				*28078.377*		
Age group 40–59								
Tuberculosis	1.11	1.28	1.56	11.8	0.42	0.53	0.66	11.0
Other infectious&parasitic diseases	0.50	0.58	0.71	5.4	0.62	0.80	0.99	16.5
Maternal causes	0.00	0.00	0.00	0.0	0.00	0.00	0.00	0.0
Neoplams of the digestive system	1.81	2.09	2.55	19.3	0.52	0.66	0.83	13.7
Other neoplasms	1.31	1.51	1.84	14.0	0.94	1.20	1.49	24.7
Cardiovascular diseases	0.91	1.05	1.28	9.7	0.73	0.93	1.16	19.2
Other diseases	1.51	1.74	2.13	16.1	0.42	0.53	0.66	11.0
Sinking of the 'Joola'	0.10	0.10	0.10	0.8	0.10	0.10	0.10	1.7
Accidents	1.61	1.86	1.86	14.1	0.00	0.00	0.00	0.0
Other injuries	1.01	1.16	1.16	8.8	0.10	0.13	0.13	2.2
Symptoms	1.81	1.81			1.14	1.14		
Unknown	1.51				1.04			
Total		13.19		100.0		6.03		100.0
95% CI		[11.11–15.65]				[4.66–7.80]		
Number of deaths		*131*				*58*		
Person- years		*9932.895*				*9617.358*		

Source: Mlomp database.

Appendix 2: Distribution of deaths by group of causes and sex (per cent) and mortality rate (per thousand) between ages 15 and 60, in France in 1947

Causes of death	Male	Female
Communicable and reproductive diseases	29.8	29.3
HIV/AIDS	-	-
Tuberculosis	23.6	20.6
Maternal conditions	-	1.6
Respiratory infectious	2.8	2.4
Other causes	3.4	4.7
Non-communicable diseases	52.3	64.1
Neoplasms	15.9	23.5
Cardiovascular diseases	21.3	25.5
Respiratory diseases	3.4	2.3
Digestive diseases	5.9	5.5
Genitourinary diseases	3.1	4.1
Other causes	2.7	3.2
Injuries	17.9	6.6
Unintentional injuries	14.0	4.6
Intentional injuries	3.8	2.0
Total	100.0	100.0
Mortality rate (per thousand)	5.7	3.9

Source: Meslé and Vallin, 2005 (author's compilation).