Long term effects of reproductive history on female and male mortality in a rural area of Senegal

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Abstract

Population ageing in sub-Saharan Africa raises new concerns about adult mortality structures and differentials, but little is known in this region due to lack of data. Concerning the relation between fertility and mortality, interest has focused on maternal mortality rather than on long term effects, which are complex. This study examines the relation between fertility and mortality of older adults in a local area. We focus on Mlomp in rural Senegal, whose population has been followed up for twenty years. Differential mortality among men and women is analyzed on the basis of their reproductive history characteristics. Contrary to women, male mortality does not depend on the number of children. In a patriarchal system where women leave their family of origin to live with their husband's relatives after marriage, having sons is more beneficial for old women. The strong socioeconomic effects revealed by the study argue in favor of local patterns.

Introduction

Population ageing in sub-Saharan Africa raises new concerns about adult mortality. The high level of maternal mortality and the emergence of HIV/AIDS has led to interest in adult mortality, however mortality structures and differentials at adult and older ages remain difficult to estimate in developing countries, due to lack of data. Fertility is high in Africa, as well as maternal mortality which is a tragic effect of fertility on mortality. Here, we are interested in the relation between past reproductive history and old adult mortality.

The relation between fertility and health is complex. During the reproductive ages, pregnancies and deliveries are risks for women health, depending on the age, the duration spent since the last pregnancy and the total number of the children (Rutstein 2000 ; Unicef *et al*. 2002). However, indirect effects of reproductive events are difficult to estimate, apart from maternal maternity (Khlat and Ronsmans 2000 ; Ronsmans *et al*. 2001). At older ages, the reproductive history has impact on causes of death with less frequent breast cancer among women who have children, but more cardiovascular diseases and higher risks of diabetes among those who had many deliveries (Kelsey *et al*. 1993 ; Ness *et al*. 1994; Lawlor *et al*., 2003). Maternal depletion syndrome would contribute to alter the health of women who had repeated pregnancies (Winkvist *et al*. 1992) but its effect is not proved on mortality (Menken *et al*. 2003). Prior to the reproductive period, some selection health effects contribute to the capacity of women to give birth. Studying long term effects of fertility on health leads also to some biases with exclusion of all women who died during this period, especially when maternal mortality is high. For both parents, childrearing is known to have an indirect effect on "healthier behaviors" (Kravdal 1996). On the contrary, having children may lead to stress or a decrease of the socioeconomic level (D'Elio *et al*. 1997; Evenson et Simon 2005). When children grow up and get older, they may have a protective effect on their parent's health in providing social and economic support (Wolff, 1994); this effect may also differ according to the sex of the children (Rahman 2000) which could also have a physiological impact (Harrell *et al*., 2008).

Therefore, for women, having many pregnancies may result or produce some opposite effects on mortality, some which can be positive (healthier at the beginning, protection against some diseases, support of children, etc.) and others negative (stress, major risks of certain diseases, reduction of the health capital, etc.). For men, biological factors don't contribute so much and differentials can mainly be explained by socioeconomic factors. In this way, Lisa Hurt *et al*.

show that in Matlab, in rural Bangladesh, after age 45, parity appears not to have a significant effect on female mortality but the higher the number of children of the women, the lower the mortality of their husband (2004). Regarding studies on populations living in developed countries, many of them lead to the conclusion that nulliparous and high parity women as well as those who started early to have children know higher mortality in contrast with those who have children at old ages, which could be more robust (Smith *et al*., 2002). However, some studies show different patterns (Grundy et Kravdal, 2008). To discern a pattern in developing countries on the impact of fertility on female mortality after the reproductive period appears to be much more difficult, the relation would correspond to local patterns (Hurt *et al*. 2006). Comparing men and women in such analysis could contribute to distinguish some social effects from biological factors which are confounding in a study focused only on women.

In developing countries, Demographic Surveillance Systems (DSS), though not representative at national level, contribute to a better understanding of population levels and trends, notably in relation to adult mortality and fertility, thanks to accurate measurement. In Mlomp, in rural Senegal, the population has been monitored for twenty years. Differential mortality among men and women is analyzed on the basis of their reproductive history characteristics completed by socioeconomic covariates.

Data and Method

The demographic surveillance system of Mlomp

The Mlomp DSS started in 1985 with an initial census listing the inhabitants of the area and recording information on the union and reproductive histories of adult women. The demographic events (births, deaths, migrations and unions) are recorded annually. The union and reproductive histories are asked for all immigrants who have had at least one union. Furthermore, for deceased persons, detailed information about symptoms and diseases prior to death are obtained from a close relative through verbal autopsies. On the basis of these reports, in addition to medical information from health institutions, physicians establish the cause of death whenever possible (Pison *et al*. 2002). This DSS now provides more than 20 years of demographic data, notably on mortality and fertility.

Data reliability

Regarding demographic data reliability, the dates of the events that occurred during the surveillance are correctly registered. Although, there are classical bias resulting of

retrospective information in Africa. A special effort was made to prevent the classic problem of bias in age determination of the persons registered during the initial census using different information sources (dispensary and maternity registers, marriage years, identity cards…), but the age of the very old population may be of poor quality.

A reproductive history is registered for each woman followed by the surveillance system, one part is retrospective information reported at the initial census in 1985 or after an immigration in Mlomp. With the information registered by the health services since the 1960s, we assume a relatively good registration of the past reproductive histories for rural Africa, but older the event, lower the reliability. Then, for women who have pregnancies after their census' date, the prospective follow-up with the registration of pregnancies, deliveries and births, complete the retrospective data. For men, all their live born children registered through the reproductive histories of their partners are considered. In this way, we suppose that for a man, all his partners are known.

Study setting

Mlomp is located in South-West Senegal, in the region of Ziguinchor (also known as Casamance). At the end of 2004, the population totaled 8,000 persons. The population is rural. Most people belong to the Jola ethnic group. They are animist or Catholic. Rice cultivation is the main local economic activity during the rainy season, with seasonal migrations: men migrate during the dry season (mainly for fishing or harvesting palm wine); young women migrate before marrying in urban areas (mostly as domestic servants).

In Mlomp, the total fertility rate was 4.2 children per woman over the period 1985–2004. This level is relatively low compared with more than 6 in rural Senegal in 2000-2004 (Ndiaye and Ayad 2006). Women in Mlomp have their first child quite late for a rural area of Sub-Saharan Africa (average age 23) and births are spaced. This first birth occurs most often before marriage, which generally occurs between ages 25 and 30, and not necessary with the father of the first child. Although monogamous, people can have several unions over the lifetime with consensual unions while single and possibility of remarriage after divorce or widowhood. Therefore, women and men may have children from different partners.

Over 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. The difference between males and females is large: life expectancy was 57 years for men and 65 years for women. In Mlomp, the local health care system 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). For a live born child, the probability of dying before age five was 0.100 in 1985-2004, compared with more than 0.160 in rural Senegal as a whole over 1995–2004 (Ndiaye and Ayad 2006). Among adults, the probability of dying between ages 15 and 60 was near 0.310 for men and 0.165 for women for the observed period (Duthé and Pison, 2008). In Mlomp, female mortality is much lower than male mortality. On the one hand, mortality due to injuries is high among men (Pison *et al*., 2005). On the other hand, maternal mortality was estimated at 268 per 100,000 live births[1] in 1985–2004, a lower level than observed in the two other rural sites in Senegal and habitually in rural Africa (Pison *et al*. 2000). Furthermore, AIDS is not a major cause of death in this area[2].

Method

Mortality levels are estimate through duration models on the period 1985-2004. Then, we estimate the differences in mortality using a Cox proportional hazards model (Cox et Oakes, 1984). This model estimates hazard ratios according to the relationship :

$$h(t,z) = h_0(t) \cdot \exp(z \cdot \beta + \tilde{z}(t) \cdot \gamma)$$

where t is the duration, $h_0(t)$ is the baseline hazard function, z is a set of fixed covariates (z_1, z_2, z_3, …) and $\tilde{z}(t)$ a set of time-varying covariates. The Cox model requires no assumptions concerning the distribution of the hazards, thus $h_0(t)$ is an unknown function which is not parameterized, but the model assumes that the hazard ratio is proportional over time. For testing the model, we use a statistical test based on Schoenfeld residuals. It remains valid to test the specification of the model even in presence of time-varying covariates (Grambsch and Therneau 1994; Hosmer *et al*. 2008).

The study of mortality differentials after the reproductive history suppose to measure mortality in defined age group. 45 is the usual age for considering the end of reproductive history of women. However, if women become pregnant over this age they are then taken into account one year after the last delivery to avoid potential direct factors of the pregnancy on mortality. For the oldest subjects, mortality level and reproductive characteristics are less reliable and mortality risks are considered only until 60. Because men are older than women when they have their children, male mortality risks are considered in the age group 50-65.

[1] 95% CI =[111–528].

[2] The incidence in Mlomp was estimated at 0.8 per thousand adults and per year in 1990–95 (Diop *et al*. 2000).

Men who have children over 50 are included in the population analyzed at the birth date of the last live born child of their partner.

Differential mortality among men and women is analyzed on the basis of their reproductive history characteristics: number of live births, age at first and last deliveries. To discern certain social and gender effects, the sex of the children and if they are still alive at age 5[3] (for those born before 2000) are also taken into account. Female characteristics are applied to men, except mean interval which appears not influent for them in our opinion. We also introduced the birth year. Obviously, other socioeconomic characteristics have to be introduced to study differentials in mortality (Wunsch et al., 1996): marital status has a well-known strong impact on mortality level in developed countries (Lillard and Panis 1996) which seems to be universal (Rahman 1993), and we assume that the number of partners may also have an impact on mortality as a proxy of past conjugal stability. Finally, the presence of latrines in the household is used as a socioeconomic covariate[4] but information has been collected in 2004 and is thus not available for former households[5].

On average, women have had 6.7 live births during the reproductive life period (Table 1). Among them, 1.5 of live new born infants died before age 5. Women were on average 22.6 years old at first delivery and 39.5 at last one with a mean births interval of 2.5 years. Men have had more children than women, and they were on average more than 6 years older than women at first birth and last delivery of their partners[6].

Results

Female mortality differentials

Table 2 shows results for females. Controlling all the other covariates and regarding reproductive history characteristics, in the first model, the number of live births is strongly significant: the higher the number of live born infants, the lower the risks for women. In this model, we can see that the older the women at first birth, the lower the risks. Sex of the live born infants and their vital status at age 5 has been introduced in the second model. In this way, the number of live born infants has been replaced by the number of surviving boys and

[3] In most cases, information about the vital status at age 5 of women's children is available, after this age it depends on the follow up of those children in the DSS. Moreover, mortality risks significantly decreases after age 5 and the probability to reach adult age remains high.
[4] Presence of latrines in the household is also an environmental health factor, especially regarding infant and child health (Rutstein, 2000).
[5] Because of moving, migration or death of all its members, an households may be removed from the follow up.
[6] In this population, age differences between males and females are larger than in whole adult population.

girls at age 5 and deceased children under 5. The number of boys as the number of deceased children have the same significant impact on mortality risks, similar to the global number of live births: thereby, having had deceased children does not appear as a proxy of lower health context as we could expect. Conversely, the absence of significance for number of surviving girls at age 5 also is surprising and will be discussed in the following section. In the last model, age at first birth has been substituted by age at last birth: it is also significant. By contrast with an identified risk on direct maternal mortality, older a woman is when she has her last child, lower the mortality risk after. Moreover, mean interval is significant in this model whereas it was not in the previous ones: longer the duration between two deliveries, higher the mortality risks. In this model, the strong impact of the age at last birth led to suppress impact of number of children.

In all models, there is no cohort effect. Furthermore, marital status has an impact on post-reproductive female mortality: unmarried women, but not widowed ones, are subject to mortality risks that are around three times as high as those of married women. This result is similar for the number of partners they had: the higher the number, the higher the risks. Besides, presence or absence of latrines does not have any impact on mortality, except for women who live in a household where the information could not be collected. In most cases, information is missing because of a removal of the household resulting from an emigration and/or death of all its former members. In consequence, mortality observed in this type of households is clearly higher than mortality observed in the other ones.

Male mortality differentials

Results for males are presented in Table 3. For constructing male models, we had to exclude marital status which violates the test of proportional hazards we use, otherwise it has no impact on mortality risks (appendix 1). Regarding reproductive history characteristics, in all models, they do not have any impact. By way of contrast, whereas mortality risks increase with number of previous partners for women, those risks decrease for men and the effect is constant in all models. Such as in female models, mortality risks are very much higher among men who live in former households. But, there is also a significant effect of living on a household where there are no latrines.

Discussion

Between 45 and 60, being married and having had few partners are factors which protect women from a high mortality risk in Mlomp. On the contrary to many studies, the fact of

having had many children results in lower mortality after reproductive life but according to most of them, late fertility is linked with low post-reproductive mortality. Presumably, there is a "healthy pregnancy effect" of having a child late in reproductive life with short intervals between pregnancies, possibly resulting from biological factors, these women being more robust, and behavioral factors. In the specific context of Mlomp where all women give birth at the maternity clinic and children are taken to the dispensary for immunization and other health care, this can benefit the mothers of infants. Last but not least, the gender difference between having boys, which has a protective effect in contrast to having girls, which has no significance, leads us to assume a strong social effect which thwarts inverse physiological factors. In a patriarchal system, women leave their family of origin to live with their husband's relatives after marriage. Thus adult sons are assumed to remain with their parents when they get older. Having sons is more beneficial for older women. By contrast, male mortality does not depend on the number of children. Moreover, contrary to women, the more partners men have, the lower their risks of mortality. Result regarding presence of latrines in the household suggests that male mortality is strongly dependant on economic factors.

Admittedly, this study presents different limitations. The first one is the reliability of the mortality and fertility data we already exposed in the method section. For this reason, we did not study mortality of oldest people. But, the reliability of reproductive events which are from retrospective information remains questionable. Thanks to health services information, a large part of this information could be checked. In this way, we found a protective effect of having deceased children which could be due to better information collected for women who used health services than the others. Another limitation concerns socioeconomic characteristics, which are not well-defined in our models, since the surveillance system has been meanly focused on demographic and health data, assuming the population is quite homogeneous. Then, we used an information about presence of latrines in households which has been collected in 2002. Our results show the strong link which exists between mortality and former households. However, we also have seen an effect for males that leads us to conclude to the existence of socioeconomic differentials. Finally, because we excluded oldest persons in our analysis, this does not highlight possible longer term effects since certain diseases occur late in life. With respect to this point, analysis of the causes of death could also contribute to explain mortality level differentials, but the small number of deaths in the population studied here does not permit to do such analysis. In addition, the assessment of causes of death of elderly is problematic (Duthé and Pison, 2008).

In Mlomp, socioeconomic status seems to be the only significant determinant of male mortality. For women, we discern an healthy pregnant effect and a social effect of parity on post-reproductive mortality. Despite evidence of physiological effects of having children late, this study argues in favor of local patterns. This has to be confirmed by carrying out a comparative study based on DSS data with different population regarding demographic levels of fertility and maternal mortality, but also socioeconomic and gender characteristics.

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Table 1. Covariates description

	Females	Males	Type of covariate	Time-varying covariate
Number of live births (mean)	6.9	7.4	Continuous	No
Number of deceased children before age 5 (mean)	1.5	1.6	Continuous	No
Number of surviving boys at age 5 (mean)	2.7	2.8	Continuous	No
Number of surviving girls at age 5 (mean)	2.7	3.0	Continuous	No
Age at first delivery (mean in years)	22.6	28.9	Continuous	No
Age at last delivery (mean in years)	39.5	45.9	Continuous	No
Mean births interval (in years)	2.5	-	Continuous	No
Birth year (mean)	1941	1931	Continuous	No
Marital status*				
Married	79%	76%	Discrete	Yes
widowed	7%	7%		
Other (divorced, single or unknown)	14%	21%		
Number of partners	1.5	1.4	Discrete	No
Latrines in the household in 2002 (13% of missing values)	46%		Discrete	No

Note: * Proportion presented here are marital statuses at the end of the reproductive life.

Table 2. Post reproductive female mortality differentials, Mlomp 1985-2004

Cox proportional hazards models (Prob>chi2 =0.0000)	Model 1 Hazard Ratio	Model 2 Hazard Ratio	Model 3 Hazard Ratio
Number of live births	0.82***		
Number of surviving boys at age 5		0.76***	0.90
Number of surviving girls at age 5		0.96	1.13
Number of deceased children under 5		0.76**	0.87
Age at first birth	0.91***	0.91***	
Age at last birth			0.92***
Mean interval	1.08	1.09	1.17**
Birth year	1.03	1.02	1.02
Married (ref.)			
Unmarried	2.63**	3.09**	2.53*
Widowed	1.39	1.36	1.42
Number of partners	1.36**	1.35*	1.45**
Latrines in the household (ref.)			
No latrines in the household	1.14	1.17	1.20
Missing information	2.71**	2.52**	2.32*
Test of proportion hazards	*96%*	*82%*	*82%*

Note: Analysis are done on 854 women and 40 deaths (time at risk= 6698.6 years).
*** p<0.01; ** p<0.05; * p<0.10.

Table 3. Post reproductive male mortality differentials, Mlomp 1985-2004

Cox proportional hazards models (Prob>chi2 =0.0000)	Model 1 Hazard Ratio	Model 2 Hazard Ratio	Model 3 Hazard Ratio
Number of live births	1.04		
Number of surviving boys at age 5		1.09	1.09
Number of surviving girls at age 5		1.02	1.00
Number of deceased children under 5		1.04	1.03
Age at first birth	1.01	1.01	
Age at last birth			1.00
Birth year	1.02	1.02	1.02
Number of partners	0.66**	0.67**	0.66**
Latrines in the household (ref.)			
No latrines in the household	1.83***	1.86***	1.86***
Missing information	4.97***	5.10***	5.21***
Test of proportion hazards	*70%*	*80%*	*84%*

Note: Analysis are done on 862 men and 120 deaths (time at risk= 6729.9 years).
*** p<1%; ** p<5%; * p<10%.

Appendix 1. Post reproductive male mortality differentials, Mlomp 1985-2004

Cox proportional hazards models (Prob>chi2 =0.0000)	Model A Hazard Ratio	Model B Hazard Ratio	Model C Hazard Ratio
Number of live births	1.06		
Number of surviving boys at age 5		1.11*	1.10
Number of surviving girls at age 5		1.03	1.01
Number of deceased children under 5		1.04	1.04
Age at first birth	1.01	1.01	
Age at last birth			1.00
Birth year	1.02	1.02	1.02
Married (ref.)			
Unmarried	1.30	1.32	1.31
Widowed	1.08	1.06	0.99
Number of partners	0.65**	0.66**	0.65**
Latrines in the household (ref.)			
No latrines in the household	1.83***	1.85***	1.86***
Missing information	4.70***	4.83***	4.98***
Test for proportion hazards	*5%*	*11%*	*12%*

Note: Analysis are done on 862 men and 120 deaths (time at risk= 6729.9 years).
*** p<1%; ** p<5%; * p<10%.