Estimating mortality from external causes using data from retrospective surveys: a validation study in Niakhar (Senegal)

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Short abstract

Mortality due to external causes (accidents, homicides or suicides) is poorly known in countries with limited registration of vital events and causes of death. Retrospective household-based surveys such as DHS increasingly collect siblings’ survival histories (SSH) in order to derive estimates of adult and pregnancy-related mortality. In some surveys, a few questions are also asked to identify violent deaths and this practice could be generalized to provide estimates of mortality from external causes. We conducted a validation study of SSH with such additional questions in Niakhar (Senegal), a locality where prospective data on adult mortality has been collected during demographic surveillance since 1962. We examine the sensitivity and specificity of SSH in recording adult deaths due to external causes. We then assess possible biases in SSH estimates of the proportion of adult deaths due to external causes.
Extended summary

Introduction

Mortality due to external causes (accident, homicide, suicide) has so far received little attention compared to other causes such as AIDS, malaria or tuberculosis, although it is thought to be rising rapidly in the developing world where most of these deaths are concentrated (Gosselin et al., 2009). Reports that WHO or IHME/GBD publish regularly on health and mortality in the world provide estimates of violent deaths for each region (Vos et al., 2015). For example, in Africa, violent mortality is estimated to have risen to 100 deaths per 100,000 people in 2012 (WHO, 2015). Violent deaths are estimated to account for about 10% of all deaths in the region, distributed as follows: road accidents (involving pedestrians, passengers and cyclists) account for about 2% of all deaths; war injuries and homicides combined account for about 1.5%, and suicides account for 0.7% of all deaths.

These figures, however, are very uncertain. As in all regions with limited registration of vital events and causes of death, they are based on models and assumptions based on few observations. Some external causes have been investigated extensively in local populations, for example suicide, homicide or war trauma in conflict regions (Depoortere et al., 2004; Nzongola-Ntalaja, 2004; Roberts et al., 2003). Traffic accidents have also been documented, particularly on hazardous roads (Lagarde, 2007; Sobngwi-Tambekou et al., 2008). But the resulting estimates are difficult to generalize to national populations, given that external causes are likely highly clustered at the local level. War traumas, for example, are specific to regions experiencing political unrest with armed conflicts, whereas road accidents are concentrated mainly in large urban areas or along highways.

Local studies such as those in health and demographic surveillance sites (HDSS) also provide data on causes of death (Pison, 2005). A comparison of 10 HDSS located in different countries in sub-Saharan Africa showed that in the 2000s mortality due to external causes varied tenfold depending on the site (from 20 to 180 annual deaths per 100,000 inhabitants) (Adjuik et al., 2006). The highest levels were observed in the Southern African sites (in South Africa and Mozambique), in part because of a high violent mortality in adults (Garrib et al., 2011). A comparison of 20 HDSS located in sub-Saharan Africa and in Asia also showed a tenfold variation with the highest levels observed in one site located in Southern African and the lowest in a site located in Indonesia (Streatfield et al., 2014).

In this study, we evaluate the potential of national retrospective household-based surveys such as the Demographic and Health Surveys (DHS) to provide estimates of violent mortality at the adult ages at the national level. These surveys collect siblings’ survival histories (SSH): respondents are asked to list all their maternal siblings by birth order and report their survival status, their age, and, if deceased, their age at death, and date of death. These data are used to derive adult mortality estimates (Reniers et al., 2011). If the respondent declared that his/her sister had died at reproductive ages (e.g., 15-49 years), interviewers ask also if she died while
pregnant, during delivery or within 42 days of her last birth; these data are used to estimate maternal mortality (Graham et al., 1989).

SSH could also provide estimates of mortality from external causes if a few questions about the circumstances of a siblings’ death were added to the questionnaire. It is indeed expected that 1) respondents recall such circumstances well, 2) they are not affected by social desirability biases in reporting some of these circumstances, and 3) knowledge of these circumstances permits accurately classifying a death as due to external/violent causes.

We conducted a validation study of SSH with such additional questions on violent deaths in Niakhar (Senegal), a locality where prospective data on adult mortality has been collected during demographic surveillance since 1962. Using the information from this HDSS as a reference data set, we examine whether SSH yield unbiased estimates of the proportion of adult deaths due to external causes and of the adult mortality due to these causes in this population.

Population, Data and Methods

Study site

The Niakhar health and demographic surveillance site (HDSS) is located 120 km southeast of Dakar, Senegal’s capital. The population covered by the HDSS lives in 30 villages comprising ≈44,000 inhabitants as of 1 January 2013. Most of the population belongs to the Sereer ethnic group, with Wolof, Toucouleur, and Laobe minorities. The main language is Sereer but many people also speak Wolof, the most common language in Senegal. The main religious groups in the area are Muslim (≈80%) and Christian (≈20%). Households in Niakhar live traditionally on one food crop (millet) and one cash crop (groundnuts). They also raise a few cattle. The climate is typical of the sub-Saharan. The three largest villages in the area include health facilities, weekly markets, daily buses to Dakar, and several shops. The educational level is low: 50% of men and 75% of women in the HDSS population have never attended primary school. High levels of mobility, both permanent and temporary, also characterize the area. A large proportion of Niakhar residents move to Dakar, where they seek employment. Over the period 1985-2004, life expectancy at birth for both sexes was 54 years on average in the area, the proportion of deaths due to external causes was 1.6%, and mortality rate from external causes, 30.7 annual deaths per 100,000 inhabitants (45.3 for males and 18.0 for females) (Guyavarch et al., 2010). The most frequent external causes of death were in order of decreasing importance falls (from trees, roofs, etc.), suicide, road accidents and fire and burning. A more detailed description of the Niakhar HDSS is given elsewhere (Delaunay et al., 2013).

Reference data set

Activities of the Niakhar HDSS started in 1962 in eight villages of the Niakhar area and were later expanded to 30 villages in 1983. An initial baseline census was carried out in 1962,
followed by another census in 1983, when the study area was expanded. Since these censuses, data on demographic events (births, deaths, marriages and migrations) have been collected from household informants during household visits. Study interviewers use a printed roster of household residents and inquire about the vital status of each household member, as well as possible changes in marital status and births since the previous household visit. For each death, a detailed verbal autopsy (VA) questionnaire has been collected. VA interviews are usually conducted with close relatives of the deceased. After review of VA data by physicians, a probable cause of death is assigned to each recorded death using ICD-9 codes.

New household members (including in-migrants) are added to the roster. Each individual who ever resided in the study area since the start of the HDSS has been assigned a unique ID number. Migrants who move to another household of the HDSS study population are assigned a new residence and continue being part of the longitudinal follow-up under their same ID number. On the other hand, migrants who move permanently outside of the HDSS area (e.g., Dakar) are lost to follow-up: they are not tracked, and their relatives are not asked to report their vital status. As a result, it is not known whether they are still alive at any time after their migration. If a migrant returns to the HDSS area after some time outside, s/he is reassigned his/her previous ID number so as to avoid duplication of individuals in the HDSS dataset.

From 1962 to 1987, household visits were conducted yearly. From 1987 to 1997, they were conducted weekly because of requirements of vaccine trials. Between 1997 and 2007, they were conducted every 3 months, and between 2008 and 2013, every 4 months.

The Niakhar HDSS allows researchers to identify sibships (i.e., brothers and sisters having the same biological mother) among individuals who have ever resided in the HDSS population. The identification of sibships is possible because every population member is potentially linked to his/her biological mother through a mother ID number. The mother ID number is attributed either at the time of birth (if the mother gave birth in the HDSS area) or the first time an individual enters the HDSS population (i.e., initial census or after in-migration). We used these data to identify the sibships of potential respondents and measure the rate of omissions of siblings’ deaths in surveys collecting siblings’ survival histories (SSH) (see below). For some members of the HDSS population, the mother ID number may be missing because their biological mother may never have been a member of the HDSS population or because the information reported during household visits was not sufficient to establish a link between mother and child. Similarly, some sibships may be only partially identified if, for example, some of the siblings were born outside of the HDSS area.

**SSH data collection**

In 2013, we conducted in the Niakhar HDSS a retrospective validation study of a new SSH questionnaire, the siblings’ survival calendar (SSC), incorporating supplementary interviewing techniques to limit omissions of siblings and uses an event history calendar to improve reports of dates and ages (Helleringer et al., 2014).
We randomly assigned men and women aged 15–59 y to an interview with either the standard DHS questionnaire or the SSC. We compared SSHs collected in each group to prospective data on adult mortality collected in Niakhar to examine whether this SSC has the potential to collect more accurate SSHs than the questionnaire used in DHS.

In both questionnaires (standard DHS and SSC), three questions were added in case the respondent declared that his/her sibling had died. First, respondents were asked whether that sibling had died after being injured. If so, they were asked whether the injury was due to an accident, a suicide, a homicide, a war or a natural disaster. Finally, they were asked to list the circumstances that led to the injury, including for example, whether the injury was due to a collision with a motor vehicle, to a fall, or whether it involved poisoning or drowning.

**Sampling of respondents:**

Using the Niakhar HDSS dataset, we first selected a stratified sample of a) sibships in which one sibling (male or female) died between 15 and 59 years old since the beginning of the HDSS (n = 592), and b) other sibships, in which no adult deaths were recorded by the HDSS (n = 500). We randomly allocated the sampled sibships to the DHS or SSC groups, and we selected at random up to 2 surviving members of each sibship. Two members of the same sibship, when selected, were automatically assigned to the same study group. Respondents included both men and women aged 15-59 years old. We recruited 8 interviewers who had previously conducted one of the Senegal DHS. Interviewers were unaware of the composition of respondents’ sibships. In total, 609 respondents from the DHS group were interviewed vs. 580 from the SSC group.

**Validation sample:**

In this paper, we focus on sibships in which a man or a woman died at age 12 years or more. Some respondents belonged to a sibship in which no death at such ages was recorded by the HDSS in the past 15 years. SSH data on causes of death reported by these respondents cannot be validated because HDSS data on their sibships may be incomplete. For example, if the sibling (brother or sister) of a respondent moved out of the HDSS area and later died, his/her death would not be captured by HDSS, but would potentially be reported during SSH. Some of the respondents were excluded for this reason.

In a preceding study, we used the data collected in this controlled trial to evaluate the quality of the SSH information on pregnancy-related deaths and its improvement with the new questionnaire (SSC) (Helleringer et al., (in press)). In this study, we’ll use these data to evaluate the SSH information on violent deaths.

**Data analysis:**

**Violent deaths according to the HDSS:** First, we will measure the number of violent and non-violent deaths recorded by the HDSS in the past 15 years, and will describe differences in characteristics of violent vs. non-violent deaths. These characteristics will include the total
number of maternal siblings in the sibship of the deceased and his/her age at death according to the HDSS. Second, we will test for differences in sibship and respondent characteristics between the DHS vs SSC groups.

**Reporting errors in SSH:** Two types of reporting errors may bias SSH estimates of the proportion of violent deaths (PVD) among deaths of adult ages. Selective omissions happen when the likelihood of reporting a sibling’s death depends on his/her cause of death. For example, if respondents do not list 10% of their siblings whose death was PVD vs. 20% of their siblings whose death was not PVD, the PVD will be overestimated. Misclassifications occur when respondents correctly report that their sibling died at adult ages, but misstate the circumstances of his/her death. All else being equal, the PVD will be underestimated if violent deaths are reported as non-violent, but overestimated if non-violent deaths are reported as violent.

**Analytical framework:** We will estimate the sensitivity of SSH, i.e. the probability of correctly classifying the cause of a reported death among respondents in sibships with a violent death; and the specificity of SSH, i.e. the probability of correctly classifying the cause of a reported death among respondents in sibships with a non-violent death. If the total number of violent deaths is sufficiently high, we will compare the declarations in the SSH to the HDSS information for some sub-categories of external causes which are of particular interest (road accident, fall, drowning, homicide, suicide, etc.). Finally, we will assess the extent of bias in SSH estimates of the PVD using simple formulas, which we devised to investigate the classification of pregnancy-related deaths.

**Conclusion**

Our study will result in recommendations in data collection and analysis to improve our knowledge of the level and trends in mortality from external causes in countries with limited registration of vital events and causes of death.
References


