Recent Trends in Older Adult Mortality in Sub-Saharan Africa : an Analysis of the Modal Age at Death in Late Life

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Abstract

This study aims to highlight recent trends in older adult mortality in sub-Saharan African countries looking at the patterns of modal age at death in late life (M), which is considered as a specific indicator of longevity. Using secondary 5-year aggregated information about child (${}_5q_0$) and adult mortality (${}_{45}q_{15}$) from the United Nations World Population Prospects, the analysis will cover forty-four countries from 1990 to 2014. Using indirect model life table systems indexed by child and adult mortality, the first objective of this paper is to know whether M has changed in the recent decades in these countries. The second objective seeks to know whether M is shifting and compressing as in developed countries.

Key words

Older adults, mortality, modal age at death, sub-Saharan Africa

Introduction

In mortality studies, the modal age at death in late life appears to be a relevant indicator for studying longevity. Defined as the age at which the maximum number of old-age deaths occured in a synthetic cohort of individuals experiencing similar mortality conditions, this indicator is less sensitive to any improvement on the health of children and young adults compared to life expectancy at birth or median age at death (Canudas-Romo, 2008, 2010; Horiuchi, Ouellette, Cheung, & Robine, 2013; Ouellette, Robine, Bourbeau, & Desjardins, 2012). In developed world characterized by aging populations, many studies are devoted to the analysis of this indicator and its evolution over time and space (Canudas-Romo, 2008, 2010; Diaconu, Ouellette, Camarda, & Bourbeau, 2016; Missov, Lenart, Nemeth, Canudas-Romo, & Vaupel, 2015; Ouellette & Bourbeau, 2011; Ouellette, Bourbeau, & Camarda, 2013). As for traditional analysis on older adult mortality, research on M are also virtually non-existent in sub-Saharan Africa. The purpose of this work is to improve the state of knowledge about mortality of the elderly in this region of the world.

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Infectious diseases are almost endemic in sub-Saharan countries and affect all segments of the population, including the elderly. (Hontelez et al., 2011; Negin & Cumming, 2010; Wallrauch, Bärnighausen, & Newell, 2010). In combination with age-related alterations and the high risks of developing chronic diseases, these older people faced a double burden of diseases that could have an effect on their longevity. However, poor vital statistics registration and poor data quality, particularly at older ages, make it difficult to estimate mortality and related indicators. Since the 1950s, the emergence of indirect systems for generating life tables aimed to address this issue (Hu & Yu, 2014). However, these approaches had many limitations, including the non-representativity of the sample of life tables used to build them, their inability to take into account the effect of devastating epidemics such as HIV on the structure of age-specific mortality, together with their unique parametric nature and their little flexibility (Murray, Ahmad, Lopez, & Salomon, 2000). Recently, indirect systems for modeling life tables from at least two parameters have been developed (Murray et al., 2003; Sharrow, Clark, & Raftery, 2014; Wilmoth, Zureick, Canudas-Romo, Inoue, & Sawyer, 2012). These models offer a window to improve the quality of the estimated life tables and an opportunity to study M in sub-Saharan african countries.

This study aims to highlight recent trends in older adult mortality in sub-Saharan African countries looking at the patterns of modal age at death in late life (M), which is considered as a specific indicator of longevity. Specifically, two main research questions underlies this paper. The first is to know the ages at which older adult deaths are concentrated over time in sub-Saharan African countries. The second question seeks to know whether sub-Saharan African countries behave differently in terms of mortality at older ages compared to developed countries.

Data

In the absence complete vital statistic systems in the region, we are using secondary information that are produced, well-established and documented by the United Nations and other international agencies. Three major information were needed to derive full abridged life tables for the purpose of this study. The first is the level of child mortality (${}_5q_0$), the level of adult mortality (${}_{45}q_{15}$) and the HIV prevalence for each period concerned. The child mortality is generally underestimated in censuses (Masquelier et al., 2016; Merdad, Hill, & Levin, 2016). Even in surveys, it is the case, but the estimates from demographic and health surveys (DHS) seems to be more accurate than other surveys. To overcome this issue of underestimation and to be more confident in the inputs used, we used the United Nations Inter-agency Group of child Mortality Estimation (UN-IGME). These estimates were generated using a bayesian B-splines bias adjusted model with all the available data sources starting with the most recent data first, eliminating data sources with important non-sampling errors or omissions and taking into account populations severely affected by HIV and AIDS (United Nations Inter-agency Group for Child Mortality (UN IGME), 2017). As such,

the child mortality information from the UN Inter-agency group seems to be more reliable. The UN IGME has not yet extended its work to adult mortality. But information on it are available from the current United Nations World Population Prospects. They are drawn from different sources of information available for each country. Different methods well documented in the literature are then used to adjust them and estimates the levels and trends. The HIV information are collected for each country and corresponding period in the UNAIDS online database. Table 1 below provides a summary of the countries considered.

Table 1 : list of african countries considered in this study

Region	Countries	Number
Eastern	Burundi, Djibouti, Eritrea, Ethiopia, Kenya, Madagascar, Mozambique, Malawi, Rwanda, Somalia, South Sudan, United Republic of Tanzania, Zambia, Zimbabwe, Uganda	15
Middle	Angola, Central African Republic, Cameroon, Democratic Republic of the Congo, Congo, Gabon, Equatorial Guinea, Chad	08
Southern	Botswana, Lesotho, Namibia, Eswatini, South Africa	05
Western	Benin, Burkina Faso, Côte d'Ivoire, Cabo Verde, Ghana, Guinea, Gambia, Guinea-Bissau, Liberia, Mali, Mauritania, Niger, Nigeria, Senegal, Sierra Leone, Togo	16

Source: summary of the authors

Methods

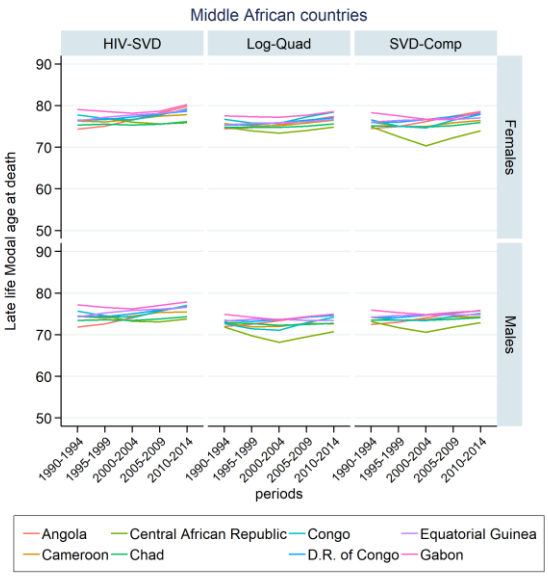
As stated by Clark (2016), the log-quadratic model (Wilmoth et al., 2012) is the state of the art mortality model relating child and adult mortality to generate age-specific pattern of mortality. This model used a singular value decomposition (SVD) as components for the regression of residuals by exploiting the curvilinear relationship between child mortality and older age mortality. Rather than using SVD factorization like components to model residuals or building the model on a particular functional form, the Sharrow-Clark age-specific model used SVD to factorize observed log mortality (Sharrow et al., 2014). The model allows taking into account covariates such as the region (African or non-African countries), the sex, HIV prevalence and adult mortality in a way to be possible to combine either life expectancy at birth or child mortality to the previous covariates. But, considering only HIV prevalence in a context of free access to antiretroviral treatments (ART) raises questions. Following on the work about this type of model, Clark proposed a more general SVD component model that attempts to minimize estimation errors when compared to the log-quadratic model, mainly at older ages (Clark, 2019). Given the difficulty of obtaining information on the prevalence by country and period of infected persons who are not using ART, the latter model does not take HIV into account as for the log-quadratic model. This could create distortions in the age distribution of mortality rates and by extension in the distribution of deaths for countries

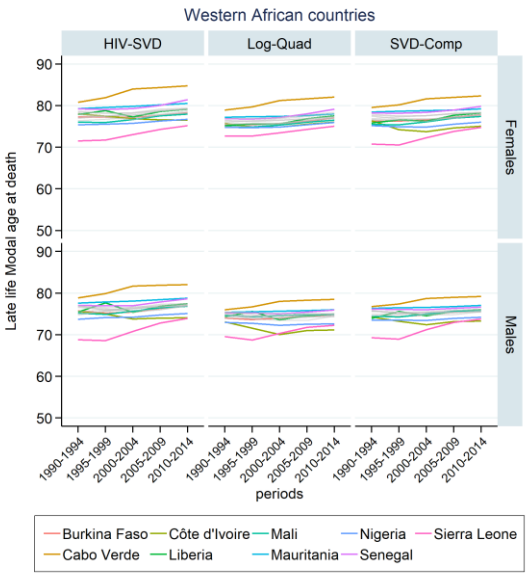
severely affected by HIV. However, these distortions would be less significant beyond the age of 50 as tested with South Africa (Clark, 2019). In this work, we are testing the three modelling approaches.

Based on the fact that the estimated modal age at death $\widehat{M}$ is the maximum of life table deaths distribution at older ages, and assuming these deaths to follow a poisson distribution, the package *MortalitySmooth* (Camarda, 2012) is used as a non-parametric P-splines approach to refine ages at death with decimal-point precision and smooth the mortality curve. Insofar life tables are not derived directly from raw data, we used the functions ${}_nd_x$ and ${}_nL_x$ of the estimated life tables as proxy of observed death counts and person-years lived to smooth forces of mortality and estimate M. We only consider the mode above age 50.

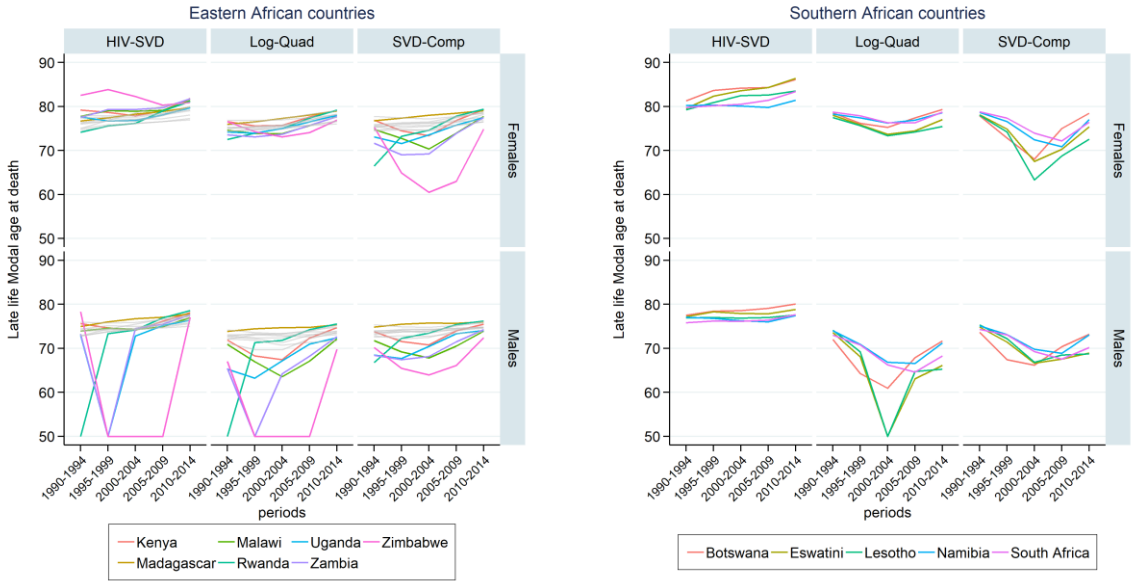
Expected findings

As expected, it is noted that the modal age at death beyond 50 years is generally higher for females regardless of the model used. However, against all expectations, the levels estimated with the Sharrow-Clark model calibrated with HIV are higher than the others. This could be explained by the fact that HIV prevalence alone is not sufficient to take into account the effect of HIV in the model. When trends for Middle and Western African countries are examined, they are almost identical as these regions have not been significantly affected by the HIV health crisis, although the effect is slightly felt with troughs in the mid-2000s in log-quadratic and SVDComp models in particular.





For Eastern and Southern African countries, trends are quite different with significant lows corresponding to periods when HIV was devastating populations and not under control. HIV was so high in some countries in these regions that the distribution of deaths was sometimes unimodal and monotonic with a concentration of adult deaths before age 50, leading thus to a value of 50 years as the modal age at death from age 50. This explains the U-shaped shapes observed in the trends with the HIV and Log-quadratic models, while the SVDComp model leads to more undistorted trends that reflect the HIV crisis in these two regions.



The SVD-Comp model seems to better capture the old-age modal age at death, even in contexts lacking good vital statistic systems. In general, M has not changed much in recent decades. There was even a slowdown and decline in the early 2000s followed by a recovery in recent years. Further analyses will address the dispersion of the age at death distribution above M in order to check the shifting and compression hypothesis.

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