Using parental survival histories in low- and middle-income countries to estimate mortality over age 50: Assessing selection bias

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Introduction

As child mortality has declined in low- and middle-income countries (LMICs), more people are reaching older ages (Aboderin and Beard 2015; Kudo et al. 2015). Yet little is known about mortality above age 50 in these settings, where civil registration and vital statistics is lacking (AbouZahr et al. 2015). Surveys can be a good alternative to estimate mortality reliably, but the existing data collection instruments (full birth histories or sibling survival histories) are designed to measure premature mortality only, and do not cover deaths above age 60 (Hill and Trussell 1977; Moultrie et al. 2013). Some surveys employ the orphanhood method which examines parental survival among young children, using the age of respondent as a way to estimate the duration to the risk of dying (Timæus 2013). We propose building on this method, and asking adult respondents detailed information about the survival of their parents. Parental survival histories (PSH) build on four simple questions – vital status of biological parents, age of parent, or age at death, and the timing of death. This survey instrument could thus easily be integrated into common surveys such as the Demographic and Health Surveys (DHS). However, the reliability of PSH would depend on the extent of bias in the mortality estimates. We therefore aim to examine sample selection biases in mortality estimates for over 50 year olds.

Bias could arise due to correlation between the number of children eligible to the survey and parental survival. Some evidence suggests that having more children, especially boys, is lowers the risk of death of women aged 50-70 (Duthe et al. 2016). Such a correlation may occur when multiple children are able to care for their parents, contributing numerous resources, which can translate into improved parental health and survival. Alternatively, similar to death clustering within families noted among young children (van Dijk 2018), children may share higher risks of death with their parents. This could be due to more direct pathways like shared genetic traits, or more disperse mechanisms, like shared socioeconomic status and living conditions, especially where intergenerational mobility is low (Azomahou and Yitbarek 2020; Piraino 2015). Moreover, parental death could heighten the mortality risk of children even in adult ages, in places where down-stream intergenerational transfers are relied on, whether socio-psychological or economic. Indeed, socioeconomic status could play an important role too in defining the relationship between the number of children and parental mortality: more educated or economically advantaged parents tend to have fewer children (Kebede et al. 2021), but higher education and socio-economic status is also associated with lower risk of death (Malderen et al. 2019; Masquelier and Garbero 2017).

Methods

We employ longitudinal data from eleven Health and Demographic Surveillance Systems (HDSS) in Senegal, South Africa, Burkina Faso, Malawi and Bangladesh to assess the possible correlation between mortality rates above age 50 and the number of surviving children of “respondent age”, ie. older adults between ages 15 to 49, who are commonly interviewed in surveys. HDSS continuously record births, deaths and migration events, including the dates of these events, for all people within a geographically defined population following a baseline census. HDSS produce high quality data including older mortality estimates, but are limited to mostly rural locations and are not nationally representative. By employing data from multiple sites in six LMICs, we are able to assess sample bias in a range of settings, including sites with high HIV prevalence sites, different life expectancies and fertility levels.

HDSS data is recorded based on unique individual ID numbers, with mother and father IDs linking individuals to their parents. The parents are matched based on these IDs to all their children to create time-varying covariates of the number of surviving children. An important limitation to this analysis includes cases of missing parental IDs or incomplete parent-child links, which is more common for fathers. This happens for numerous reasons, including cases of child fostering, which is prevalent in sub-Saharan Africa (Grant and Yeatman 2012) , or where a parent in-migrates alone to the site and the child(ren) is not recorded in the HDSS (and vice versa), or where the father died before the birth of the child. To assess the extent of missing IDs, we a) compare to sites where full genealogical data was collected and have near complete data, such as in Bandafassi in Senegal, and b) impute missing IDs in sites where possible (as in Matlab in Bangladesh) based on matching mothers and fathers according to marriage records.

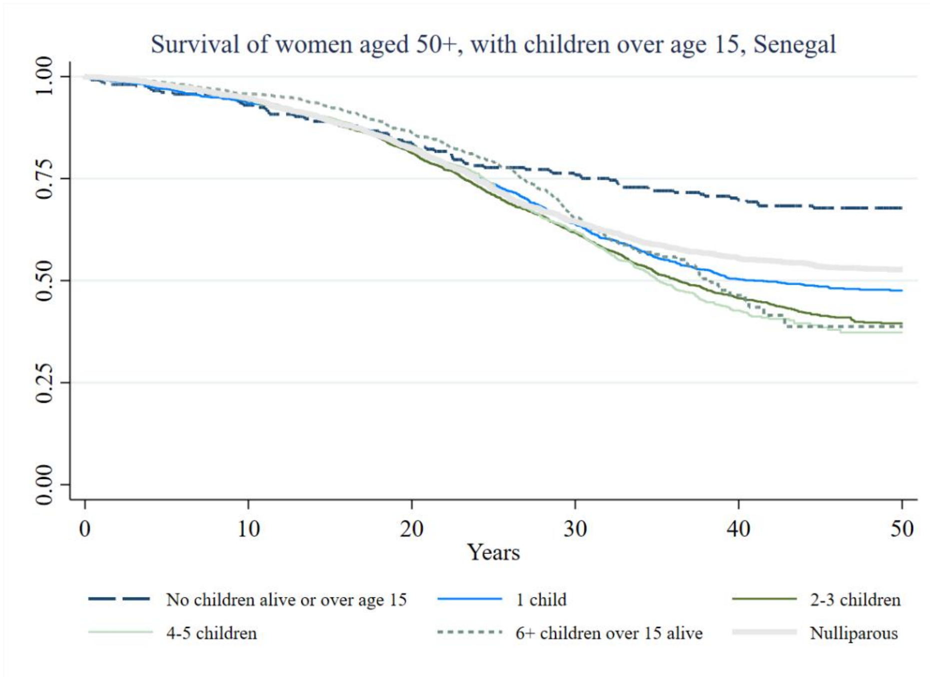
We measure the time-varying number of surviving 15-49 year olds, by sex, and also specify whether the surviving children live on the HDSS site. Using semi-parametric Cox models we assess whether there are differences in mortality over age 50 according to the number of children. Additionally we compare mortality among nulliparous adults to mortality of parents over age 50. We test with Poisson models whether this varies according to parents' ages, that is, whether the PSH can similarly be used to estimate mortality among 60 year olds, 70 year olds or 80 year olds. To assure the analysis is accurate, we further compare results among individuals who have remained on the HDSS site for their entire lives, to those who have spent part of their lives outside of the HDSS (where their life events are not recorded). Finally, we evaluate whether the findings are consistent across all HDSS.

Preliminary findings

Preliminary analysis, on the three HDSS in Senegal suggests that women who have never had children have higher survival than women who have had children (see nulliparous category in Figure 1). However, this should be interpreted with caution since over 50 year olds without matched mother IDs are also included in this category.[1] Women who are over 50 without children over age 15 (because they are younger or because they are no longer alive) seem to have better survival. If this is found to be true after robustness checks and across sites, it suggests that mortality estimates based on PSH would over-estimate mortality of women over age 50.

[1] Missing IDs will be removed to create distinct categories. Mother IDs in the three Senegalese sites combined are missing for 9% of all individuals, and 16% of individuals are missing Father IDs.

Figure 1: Female mortality over age 50 in three Senegalese HDSS, according to number of children aged 15 and above



Differences in female survival according to the number of children seems to be of less concern according to Figure 1. This is confirmed in Table 1, where we consider the relationship between the number of children and female survival in Senegal. Here women who have never had children are excluded from the analysis, so when the number of children is zero, it means that any children born are no longer alive. In the first model we consider the number of children of all ages, who are alive and living in one of the HDSS site. This model indicates that the risk of a mother's death is not related to more surviving children on site. Similarly, in a second model where we limit the children to only females who are over age 15 (typical respondents to surveys in LMICs), we cannot conclude that there are differences in female survival according to the number of female surviving children. However, when we examine each site separately, we note that in Bandafassi there is some increase in mother's death with more female adult offspring, with an increased risk of death between 3% to 15% for each additional potential respondent. Overall, these results are encouraging, as it suggests that selection bias in PSH may only be an artifact of having children or not, and not the number of children alive to report on their parent's survival. This could be explained by adult children not living near their parents to look after them directly, or by a weak relationship between socioeconomic status and fertility in these rural settings. That said, this may differ by setting, and further development of these models may lead to different results.

Table 1: Cox model results estimating the relationship between number of children and female mortality over age 50 in three Senegalese HDSS

	Senegal (3 sites)	Senegal (3 sites)	Bandafassi	Mlomp	Niakhar
Children alive and on site	1.01				
	[0.992,1.029]				
Number of female children over age 15 alive		1.006	1.092**	1.012	0.97
		[0.978,1.034]	[1.033,1.153]	[0.952,1.075]	[0.933,1.009]
Niakhar=reference site					
Bandafassi	1.148**	1.143**			
	[1.055,1.250]	[1.051,1.244]			
Mlomp	0.944	0.947			
	[0.856,1.041]	[0.858,1.045]			
Observations	138361	138361	29528	24248	84585
chi2	14.61	13.61	9.398	0.138	2.26
Number of men	11223	11223	2397	1891	6935
PYARs	220138.2	220138.2	51834.6	40923.7	127379.9
Number of deaths	2973	2973	805	544	1624

Exponentiated coefficients; 95% confidence intervals in brackets; * p<0.05, ** p<0.01, *** p<0.001

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