A mother's death and child survival: a comparative analysis of two demographic surveillance sites in rural South Africa

Brian Houle,[1,2,3] Chodziwadziwa Kabudula,[2] Kobus Herbst,[4,5] Samuel J Clark[2,3,6]

[1] School of Demography, The Australian National University, Canberra, ACT Australia
[2] MRC/Wits Rural Public Health and Health Transitions Research Unit (Agincourt), School of Public Health, Faculty of Health Sciences, University of the Witwatersrand, Johannesburg, South Africa
[3] CU Population Center, Institute of Behavioral Science, University of Colorado at Boulder, Boulder, CO USA
[4] Africa Health Research Institute, Durban, South Africa
[5] School of Public Health, University of the Witwatersrand, Johannesburg, South Africa
[6] Department of Sociology, The Ohio State University, Columbus, Ohio, USA

Short abstract

Maternal and child mortality levels in Sub-Saharan Africa are among the highest globally, but evidence on risk is lacking in rural, poor areas. We aim to provide comparable evidence on the relationship between children's mortality and the timing of their mothers' deaths using data from two South African demographic surveillance sites. Data were organised as child-months for under-five children. We estimated the probability of dying using multi-level relative risk regressions. A child's probability of dying began to increase several months before the mother's death and continued for several months afterwards. Over time the temporal pattern attenuated, with the probability of dying associated with the timing of a mother's death decreasing in 2004-2007 and 2008-2015. Our findings show evidence that children are equally vulnerable in the period before a mother's death as afterwards, providing evidence to help direct public health planning to help support vulnerable children.

Extended abstract

Background

The United Nations Millennium Development Goals, adoption of the Sustainable Development Goals, and the launch of the updated Secretary-General's Global Strategy for Women's and Children's Health highlight the global commitment to improving women's and children's health. Reducing child mortality and improving maternal health are central Sustainable Development Goals: Goal 3 targets reducing the under-five mortality rate to 25 per 1,000 live births by 2030. A stronger evidence base is needed to translate these international commitments into tangible outcomes. In order to achieve these targets, we need to identify and support vulnerable mothers and their children in regions where mortality burden is greatest.

In Sub-Saharan Africa, women face high levels of mortality, particularly to communicable diseases including HIV/AIDS (1). Women in Sub-Saharan Africa have a life expectancy of 50 years compared to more than 80 years in high-income countries (1). Pregnancy and childbirth remain risky for women – estimates suggest the region accounted for 62% of global maternal deaths in 2013 (2). Levels of child mortality remain the highest in the world, comprising almost half of global under-five deaths, with a mortality rate of 98 per 1,000 live births (3). This is compounded by projections that the child population in the region is expected to increase rapidly in the next 20 years, which may stagnate or even increase the number of under-five deaths (3).

Most prior research concentrates on the period following the mother's death (4, 5), but emerging evidence suggests critical risk periods for children before the mother dies. An analysis of pooled data from three HIV cohort studies in East Africa found that when a mother died, mortality risks tripled for her children in the two years surrounding her death (6). However, the study was unable to isolate an effect for the period prior to the mother's death. Another study including time periods before the HIV epidemic and at its peak found that children were at high risk of dying not only after their mother's death but also in the months prior when she was seriously ill (7).

The links between a mother's death and child mortality is further exacerbated by the HIV pandemic. Globally, HIV is the leading cause of death in women of reproductive age (1). Death of a mother and HIV are further linked to child and wellbeing (8) for both HIV-infected and HIV-negative children of HIV-positive mothers (9).

Efforts to address these serious problems are complicated by a lack of reliable data. The extent to which studies are generalisable across cultures is also unclear, particularly given marked differences in household organisation, available resources and care-taking practices. Greater attention is needed in rural, poor areas, as well as in populations with high HIV/AIDS prevalence.

Using two demographic surveillance sites (DSS) in South Africa, this study provides comparative evidence using prospective, longitudinal, individual-level data on the relationship between mortality experiences of children and the timing of their mothers' deaths. Such an evidence base is critical for a focus on the most vulnerable children – the poorest, those living in the context of HIV/AIDS, and those in rural areas with limited access to health services.

Method

Data

We use data from two DSS in rural South Africa: (1) the Agincourt Health and Socio Demographic Surveillance System (AHDSS) and (2) the Africa Health Research Institute (AHRI). AHDSS monitors a geographically-defined population through an annual census of the population since 1992 (10). In 2011 the surveillance population was approximately 90,000 people residing in 27 villages. Trained fieldworkers collect information on vital events, migration, and other information such as socioeconomic status. Infrastructure in the area is limited and unemployment is high. Up until recently mortality was increasing in children and young and middle-aged adults (7, 11). Clinics within the study area began providing ART in 2007 (12). AHRI monitors a geographically-defined population through bi-annual household visits by trained fieldworkers (13). While HIV/AIDS has had a significant impact on this population, recent work suggests that the ART programme has significantly increased life expectancy in the population (14). ART first became widely available in the study area in 2004.

Statistical analysis

We modelled child mortality using discrete time survival analysis (15). Each child is at risk of dying for each month they are observed. We organise the data as child-months for children under-five years of age, including one observation for each observed child-month. Our covariates include time-constant and time-varying factors defined at the beginning of each child month. We modelled the monthly probability of a child dying using relative risk regression, accounting for intra-mother correlation and including time constant covariates of DSS, child sex, multiple birth, and mother's age at birth; and time varying covariates of child age, time period, timing of mother's death, household mortality shocks, and the presence of father, older brother or sister, aunt, uncle, or grandmother. Data collected were split into three time periods: 2001 – 2003, 2004 – 2007, and 2008 – 2015. The split between 2003 and 2004 marks the beginning of ART availability at AHRI, while the split between 2007 and 2008 marks the beginning of ART availability at the AHDSS. This permits an examination of the impact of ART availability on the temporal associations observed. For timing of mother's death, we categorize periods before and after her death, with the referent being mother alive or will die 12 or more months in the future. Multilevel models are also currently being estimated. DSS and covariate interactions are tested to assess commonalities and differences in effects across sites.

Preliminary results

There was a total of 129,882 children and 70,449 mothers; a total of 3,626 children and 6,805 mothers died between 2000 and 2015. Figure 1 shows the predicted probabilities of child death by year for both sites from a bivariate logistic regression model. The probability of dying began to decline at AHRI in 2004 and in 2009 at AHDSS.

Figure 1. Monthly probability of child death by year and demographic surveillance site, South Africa (2000-2015).
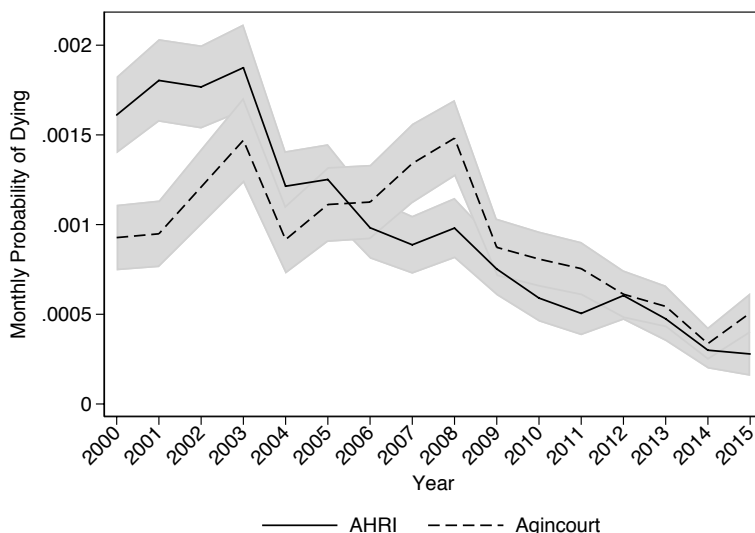

Figure 2 shows predicted probabilities of a child dying by timing of a mother's death and DSS. There are two key findings: (1) the probability of dying begins to increase several months before the mother's death and continues for several months afterwards; and (2) the temporal effect was elevated at AHDSS compared to AHRI.

Figure 2. Monthly probability of child death by time before/after mother's death and demographic surveillance site, South Africa (2000-2015).
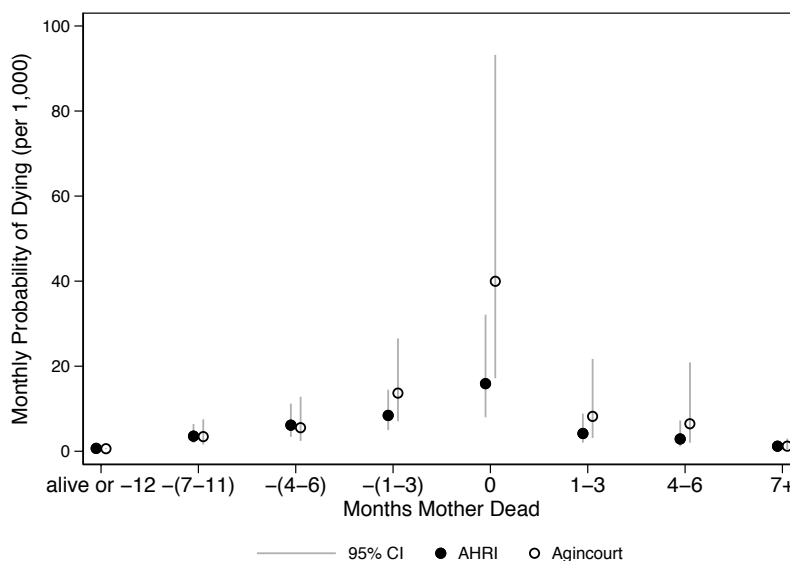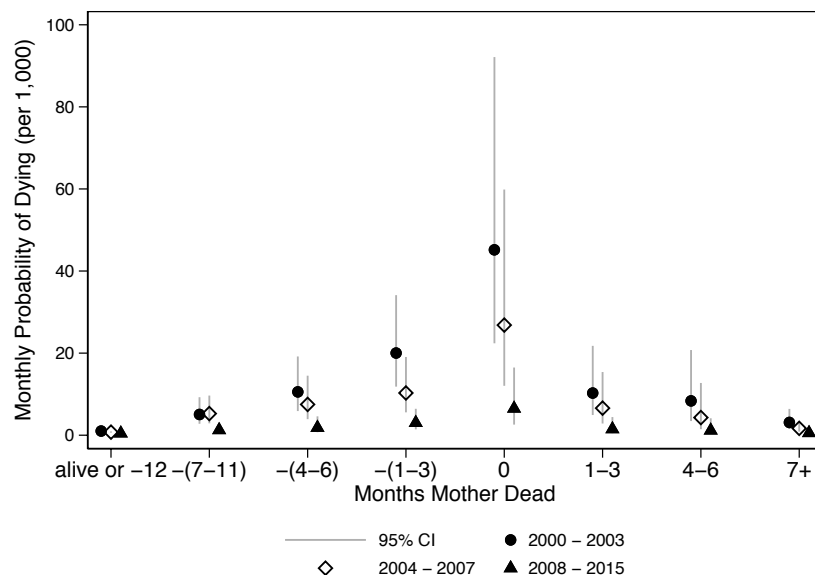

Figure 3 shows the predicted probabilities of a child dying by timing of a mother's death and time period. The probability of dying associated with the timing of a mother's death attenuated over time – decreasing in 2004-2007 and 2008-2015 compared to 2001-2003.

Figure 3. Monthly probability of child death by time before/after mother's death and time period, South Africa (2000-2015).

Monthly Probability of Dying (per 1,000)

100
80
60
40
20
0

alive or −12 −(7−11) −(4−6) −(1−3) 0 1−3 4−6 7+
Months Mother Dead

——— 95% CI   ● 2000 – 2003
◇ 2004 – 2007   ▲ 2008 – 2015

Next steps

Investigating the temporal relationship between maternal and child death carries important implications for policies and interventions to enhance child survival. Our findings show evidence that children are equally vulnerable in the period before a mother's death as afterwards. As the period of illness shortly before a mother's death puts her young children at high risk, programs need to identify mothers and their families and intervene before the mother's death, in addition to providing support for the children after the mother dies. Further, this study supports efforts to strengthen healthcare systems and integrate maternal and child care within the primary health care system. For instance, drawing on widely-used access routes such as post-delivery assessments and immunisation services would be key to achieving this.

Further work will estimate the model in a multilevel framework and examine the mediating/moderating effect of household socioeconomic status and the role of other family members in protecting vulnerable children before and after the death of the mother.

References

1. WHO. Women and Health: Today's Evidence Tomorrow's Agenda. Geneva: WHO Press; 2009
2. WHO, UNICEF, UNFPA, The World Bank, United Nations Population Division. Trends in maternal mortality: 1990 to 2013. Geneva: WHO Press; 2014
3. UN. Levels and Trends in Child Mortality: Report 2013. New York: United Nations Children's Fund; 2013
4. Anderson FW, Morton SU, Naik S, Gebrian B. Maternal mortality and the consequences on infant and child survival in rural Haiti. Matern Child Health J. 2007;11:395-401.
5. Ronsmans C, Chowdhury ME, Dasgupta SK, Ahmed A, Koblinsky M. Effect of parent's death on child survival in rural Bangladesh: a cohort study. Lancet. 2010;375:2024-2031.
6. Zaba B, Whitworth J, Marston M et al. HIV and Mortality of Mothers and Children. Epidemiology. 2005;16:275-280.
7. Clark SJ, Kahn K, Houle B et al. Young children's probability of dying before and after their mother's death: a rural South African population-based surveillance study. PLoS Med. 2013;10:e1001409.
8. Houle B, Stein A, Kahn K et al. Household context and child mortality in rural South Africa: the effects of birth spacing, shared mortality, household composition and socio-economic status. Int J Epidemiol. 2013;42:1444-1454.
9. Newell M-L, Brahmbhatt H, Ghys PD. Child mortality and HIV infection in Africa: a review. AIDS. 2004;18:S27-S34.
10. Kahn K, Collinson MA, G√≥mez-Oliv√© FX et al. Profile: Agincourt Health and Socio-demographic Surveillance System. Int J Epidemiol. 2012;41:988-1001.

11. Houle B, Clark SJ, Gomez-Olive FX, Kahn K, Tollman SM. The unfolding counter-transition in rural South Africa: mortality and cause of death, 1994-2009. PLoS One. 2014;9:e100420.
12. Gomez-Olive FX. Measuring, monitoring, investigating and responding to the HIV epidemic in Agincourt: development of an HIV research agenda. Wits AIDS Research Symposium. 2009
13. Tanser F, Hosegood V, Barnighausen T et al. Cohort Profile: Africa Centre Demographic Information System (ACDIS) and population-based HIV survey. Int J Epidemiol. 2008;37:956-962.
14. Herbst AJ, Cooke GS, Barnighausen T, KanyKany A, Tanser F, Newell ML. Adult mortality and antiretroviral treatment roll-out in rural KwaZulu-Natal, South Africa. Bull World Health Organ. 2009;87:754-762.
15. Allison PD. Event history analysis: Regression for longitudinal event data. Thousand Oaks, CA: Sage; 1984