Article Type: Original Article

Home deaths of children under 5 years in rural South Africa: a population-based longitudinal study

Jessica Price[1], Merlin Willcox[2], Chodziwadziwa Whiteson Kabudula[3], Kobus Herbst[4,5], Kathleen Kahn[3], Anthony Harnden[1]

1 Nuffield Department of Primary Care Health Sciences, University of Oxford, UK

2 Department of Primary Care and Population Sciences, University of Southampton, UK

3 MRC-Wits Rural Public Health and Health Transitions Research Unit (Agincourt), University of the Witwatersrand, Johannesburg, South Africa

4 Africa Health Research Institute, KwaZulu-Natal, South Africa

5 School of Public Health, University of the Witwatersrand, Johannesburg, South Africa

Abstract

Objectives: To determine the proportion of under-5 deaths that occurred at home in rural South Africa, whether care was sought prior to death, and determinants of home deaths amongst those who sought care.

Methods: Verbal autopsy data were used for all under-5 deaths, 2000-2015, in two health and demographic surveillance system sites. Trends in place of death and care-seeking were assessed. Associations between sociodemographic factors and home death despite seeking care were assessed by multivariate logistic regressions.

Results: There were 3760 under-5 deaths; 1954 (53%) at home and 1510 (41%) in health facilities. 84% of children who died at home accessed healthcare during their final illness. Among neonates for whom care was sought, those who were 8-27 days old were more likely to die at home than those who were 0-7 days old (OR=5.56, 95%CI 2.69-11.55, p<0.001). Factors associated with home death of infants and young children despite seeking care included low maternal education (OR=1.71, 95%CI 1.31-2.24, p<0.001), larger household size (OR=1.56, 95%CI 1.17-2.06, p=0.002), traditional medicine use (OR=2.33, 95%CI 1.75-3.12, p<0.001) and Mozambican descent (OR=1.47, 95%CI 1.06-2.03,

p=0.020). The proportion of HIV-related deaths that occurred at home fell from 60% in 2008-2011 to 39% in 2012-2015 (Chi^2=13.86, p<0.001).

Conclusion: More than half of under-5 deaths in rural South Africa occurred at home although healthcare was sought for most children, highlighting that home deaths are not simply a function of poor care-seeking. Interventions should target high-risk sociodemographic groups.

Keywords: Child mortality, verbal autopsy, social autopsy, rural South Africa, home deaths, care seeking, sociodemographic risk factors

Introduction

Over 2.7 million children died in Sub-Saharan Africa in 2016 before reaching their fifth birthday, accounting for almost half of all under-5 deaths globally (1). Over 50% of under-5 deaths across sub-Saharan Africa occur at home, though this is as high as 77% in Mali, 76% in Niger, and 67% in Uganda (2–4). In South Africa specifically, the Committee on Morbidity and Mortality in Children under 5 years (CoMMiC) estimated that 55% of child deaths occurred outside health facilities at home or in the community (5). Yet little research has been done that focuses specifically on home deaths. A recent systematic review of social autopsies in low resource settings showed high rates of symptom recognition in fatal neonatal and childhood illness, and found that formal care was sought in 78-88% of deaths in children 1-59 months (4). Unfortunately, the analysis was not disaggregated by place of death. Indeed, to the best of our knowledge, no work has been published on differences between home deaths and health facility deaths or care seeking behaviour of children who die at home despite their significant contribution to overall child mortality.

This is perhaps unsurprising as home deaths represent a “hard to reach” though vulnerable group. Home deaths are missed by facility-based audits, such as the existing Perinatal Problem Identification Programme (PPIP) and Child Health Problem Identification Programme (ChIP) in South Africa. Population-based data collection is required to identify, enumerate and investigate cases of home deaths. Health and demographic surveillance systems (HDSS) provide the necessary infrastructure for such population-based research, and verbal and social autopsies used in such settings have provided information not only on the biological causes of death but also on care-seeking during the final illness (6–8).

A recent review of discrepancies in estimates of national under-5 and neonatal mortality rates also pointed towards a failure to count home deaths as an explanation for variations in the reported mortality rates (9,10). This has resulted in a call for further research focused on home deaths to better understand the avoidable factors in these deaths and barriers to accessing healthcare (11).

Using verbal autopsy (VA) data from two rural South African HDSS sites, this paper aimed to establish the proportion of under-5 deaths that occurred at home, to determine whether care was sought during the final illness for children who died at home, and if this pattern has changed over time. Finally, in those cases where care was sought, it aimed to understand differences between children who died at home and those who died in a health facility.

Methods

This population-based longitudinal study analysed VA and household data for all deaths of children under five years from 2000-2015 from two South African HDSS sites: Agincourt and the Africa Health Research Institute (AHRI) (Figure 1). Both are members of the International Network for the Demographic Evaluation of Populations and Their Health (INDEPTH) (www.indepth-network.org). Stillbirths were excluded from the analysis.

Study sites

Both AHRI and Agincourt HDSS sites are in poor, rural areas of South Africa with scarce infrastructure. The AHRI population health surveillance started in 2000 and now involves three-monthly monitoring of over 150 000 people in the Hlabisa region in northern KwaZulu-Natal Province. The Agincourt HDSS, in Mpumalanga province, has conducted annual censuses of key demographic and health data since 1992. It now covers a population of 116,000 people, including about 30% who are of Mozambican descent, after an influx of refugees during the Mozambican civil war. Both sites have high levels of temporary labour migration (33-36%) with household members oscillating between their place of work and their rural home (12–14). VA – a structured interview with the caregiver of the deceased - is used to determine the biological cause of death at both sites. VAs have been validated as a means of establishing cause of death in a rural South African population (7).

Conceptual framework

We used the WHO Commission on Social Determinants of Health conceptual framework (15) as the basis for grouping social determinants of health into distal and intermediate factors. We then applied this framework to the question of place of death in children under five to identify differences in the determinants of home and health facility deaths amongst children who sought care. Variables were grouped into four levels: distal determinants relating to the sociopolitical context of the community, intermediate factors relating to the socioeconomic position of the deceased's

household within its community, intermediate factors relating to household composition, and maternal and child conditions (Figure 2).

Study variables

Our primary outcome of interest was place of death (home or health facility) for neonates and infants and young children (children aged 1-59 months). We further broke down home deaths into those who consulted a formal medical provider (clinic, private GP, pharmacy or hospital) during the final illness, and those who did not. By comparing home deaths where care was sought with deaths in health facilities, we were able to control for care-seeking behavior, and so consider additional factors that contributed to place of death.

We classified exposure variables according to our modified conceptual framework (Figure 2). Year of death was used as a proxy for changes in political context, government policy and infrastructure development (building of new roads, clinics etc.) that took place over the course of the study period but were not measured individually. We assessed period of death in four-year intervals which broadly overlap with the HIV epidemic and changes to the prevention of mother-to-child-transmission (PMTCT) programme: 2000-2003 (pre-PMTCT; HIV-related mortality rising), 2004-2007 (PMTCT introduced: nevirapine prophylaxis for pregnant women and their newborn children; HIV-related mortality peaks), 2008-2011 (dual prophylaxis for pregnant women initially from 28 weeks' gestation, then from 14 weeks' gestation; HIV-related mortality steady), and 2012-2015 (lifelong highly active anti-retroviral therapy for all pregnant women; HIV-related mortality declining) (16,17). Given changes in policy relating to HIV and availability of PMTCT over time, we assessed HIV as an interaction term with year of death.

Socioeconomic position of the households was determined using asset ownership data collected during the household surveys. We grouped households into low socioeconomic status (SES) (poorest two quintiles) and medium/high SES (upper 3 quintiles). We also used maternal education to assess the socioeconomic position of the household, which we grouped into low maternal education (no education, or started or completed primary school) and intermediate/high maternal education (started or completed secondary school, or started or completed tertiary education).

We determined cause of death for all deaths from VA data, using InterVA 4.3. An HIV-associated death was defined as a death where the first, second or third cause identified by InterVA was "HIV/AIDS related death".

Statistical analysis

Bivariate and multivariate logistic regression models were employed to reveal relationships between socio-demographic exposures and place of death despite seeking care (home or health facility) for both neonatal deaths and deaths of children 1-59 months. Analysis was split by age group based on the hypothesis that the mechanisms through which social determinants of health might impact on place of death differ for very young children, particularly neonates, from those for older children. Signs of illness are less precise and recognizable in neonates than in older children, neonates decompensate more quickly than older children and so opportunities to seek care may differ. Furthermore, for early neonates who are born and die in hospital without discharge, care-seeking is often in response to maternal labour-related symptoms rather than symptoms of the child. Finally, neonates who are born and die in hospital bypass the primary care level and related referral processes.

We used the hierarchical approach described by Victora and colleagues (18) to develop multivariate logistic regression models in both age groups, namely a four-stage model starting with the most distal determinants and then adding intermediate determinants according to the groupings in Figure 2. We included year of death and study site in Model 1 and then used a forward-building model approach to determine the significant intermediate factors for socioeconomic position of the household (Model 2), the addition of variables reflecting household composition (Model 3) and finally the addition of maternal and child factors (Model 4). Model 4 therefore reflects the causal effects of the most proximal maternal and child factors, after adjusting for confounding of those factors included from Model 3 (and therefore are reported as adjusted odds ratios). The odds ratios for the distal and intermediate factors included in the final model represent the residual causal effect not mediated by any of the other explanatory variables in the model. To avoid underreporting the association between the distal and intermediate explanatory variable and the outcome of interest, we refer to the crude odds ratios. The full model building process is presented in Appendix 1, which provides adjusted odds ratios for the distal and intermediate explanatory variables. Statistical significance was set at $p<0.05$. All analyses were conducted in Stata12 (19).

Ethics

The University of Witwatersrand Human Research Ethics Committee (HREC) approved protocols for the regular household census and VA data collection at the Agincourt HDSS (M960720; M110138). Similar protocols for three-monthly census and VA data collection were approved by the University of Kwa-Zulu Natal Biomedical Research Ethics Committee (BREC) in the case of the AHRI HDSS (BE290/16).

Results

Between 2000 and 2015, 3760 under-5 deaths were recorded: 2033 in AHRI and 1727 in Agincourt. 1954 deaths (53%) occurred at home, 1510 (41%) in a health facility and 229 (6%) elsewhere. No significant differences were noted in frequency of place of death between the two study sites. There were 500 neonatal deaths (13%), and 2259 infant deaths (60%). 1775 (47%) of the children who died were female. In Agincourt, 39.7% (684/1721) were of Mozambican descent. The five most common overall causes of death were acute respiratory infections (30%), HIV/AIDS (26%), diarrhoeal diseases (7%), neonatal pneumonia (4%) and birth asphyxia (3%). However, this differed between the two sites. In Agincourt, HIV/AIDS accounted for 28% of under-5 deaths (cause-specific mortality rate 13/1000 live births), followed by acute respiratory infections (25%, 12/1000 live births), diarrhoeal disease (12%, 5/1000 live births), neonatal pneumonia (6%, 3/1000 live births) and malaria (4%, 2/1000 live births). In AHRI, acute respiratory infections accounted for 41% of deaths with a cause-specific mortality rate of 20/1000 live births, followed by HIV/AIDS (31%, 15/1000 live births), diarrhoeal disease (4% 2/1000 live births), neonatal pneumonia (4%, 2/1000 live births) and severe malnutrition (3%, 2/1000 live births). Seeking care from a formal medical provider was reported for 92% of all deaths and seeking care from a traditional healer or using traditional medicine was reported for 26%; no care-seeking at all was reported for only 6%. 53% of deaths occurred in low SES households; 31% of mothers had no secondary school education, of whom 225 (9%) had no formal education at all. Maternal death had occurred in 9% of cases, and 20% reported that the mother was a temporary migrant at the time of the child's death (Table 1).

Mortality rates by place of death and care-seeking

The under-5 mortality rate peaked in 2003, at 90 deaths per 1000 live births, before declining to 30 deaths per 1000 live births in 2015($p<0.001$, Figure 3). The rate of under-5 deaths *at home* also declined from 49 deaths per 1000 live births in 2003, to 11 deaths per 1000 live births in 2015 ($p<0.001$, Figure 3, green bars represent home deaths). However, the proportion of deaths at home (as a percentage of total deaths) declined more slowly between 2000-2011, from 54% to 51% over the 12 years, before falling to 46% of deaths in 2012-2015 (total decline 8%, 95%CI 3.2-12.6%, $p=0.001$).

For 92% of deceased children care had been sought from a formal medical provider during the final illness, including for 84% of children who died at home. As shown in Figure 3, there has been a decline in the absolute rate of in-facility deaths and deaths at home having sought care. This has resulted in a relative increase in the proportion of home deaths that failed to seek care (lowest in

2004, accounting for only 8% of home deaths and rising to 49% in 2015, excluding deaths where care-seeking was unknown; total increase 41%, 95% CI 23.5%-58.0%, p<0.001). The absolute rate of deaths at home without seeking care has remained consistent over time at 3-4 deaths per 1000 live births.

Risk factors for deaths at home among those who sought care

Late neonatal deaths (8-27 days) were significantly more likely to occur at home than early neonatal deaths (0-7 days) (adjusted OR=5.56, 95% CI 2.69-11.55, p<0.001) among neonates who accessed care during their final illness. Female neonates were significantly less likely to die at home having sought care (adjusted OR=0.47, 95%CI 0.22-0.99, p=0.047), as were neonates of Mozambican descent (in Agincourt only, crude OR=2.83, 95%CI 1.14-7.07, p=0.026) (Table 2). No socioeconomic, household or maternal predictors were significantly associated with place of death in neonates (the full model building process is shown in Appendix 1).

Table 3 shows risk factors for deaths at home despite seeking care for infants and young children (compared to those who died in a health facility). The final model reflects only those factors related to the maternal and child conditions that were significant after adjusting for year of death, study site, mother's education, and household size. When determining which socioeconomic-level variables to include in the model, the addition of socioeconomic quintile, mother's migrancy status, number of household members working, and whether the household head was working, did not significantly improve the model. Similarly, when assessing household factors, overall household size had the greatest impact on place of death; further addition of the number of children aged 0-4 years, gender of the household head, and distance of the household to the clinic did not improve the model (see Appendix 1 for full model building process).

Children aged 1-59 months were significantly less likely to die at home despite seeking care if their mother was more educated (p=0.005). Traditional medicine use significantly increased the risk of home deaths despite seeking care (adjusted OR=2.44, 95%CI 1.84-3.24, p<0.001), as did being of Mozambican descent in the Agincourt study site (crude OR=2.07, 95%CI 1.59-2.69, p<0.001). HIV-associated deaths were more likely to occur at home despite seeking care in 2004-2007 and 2008-2011 than deaths in 2012-2015 (adjusted OR=2.62, 95%CI 1.27-5.41, and adjusted OR=2.89, 95% CI 1.46-5.74 respectively, p=0.011).

HIV and place of death

Changes in place of death over time differed between deaths which were HIV-associated and those which were not (Figure 4). Around 60% of HIV-associated deaths occurred at home between 2000-2011; this declined sharply to 39% in 2012-2015 (within-group change: chi^2 =13.86, p<0.001). In contrast, about 50% of deaths from other-cause mortality occurred at home, a trend which remained stable from 2000-2015 . This finding reinforced the need to analyse HIV as an interaction term with year of death in the logistic regressions (table 3, OR=2.89, 95%CI 1.46-5.74, p=0.002 for HIV*time in 2008-2011, vs. OR=0.54, 95%CI 0.31-0.94, p=0.028 for HIV*time 2012-2015). No other causes of death were associated with place of death (analysis not shown).

Discussion

Home deaths accounted for over 50% of under-5 deaths at two rural South African HDSS sites between 2000-2015. Despite a significant decline in the under-5 mortality rate at both study sites, the proportion of under-5 deaths occurring at home has declined more slowly, especially in HIV-unrelated deaths where no real change took place. Furthermore, the large majority of child deaths at home occurred despite the family having sought care from a formal medical provider during the child's final illness.

Following our modified conceptual framework (Figure 2), socioeconomic and household factors that were significantly associated with dying at home despite seeking care were low maternal education and large household size (>15 people). Significant child factors were age (early neonatal deaths less likely to occur at home despite seeking care), traditional medicine use, cause of death (HIV-associated or other) and being of Mozambican descent, all of which were associated with greater odds of having died at home despite seeking care.

Education of girls and women is known to reduce child mortality risk and improve care-seeking behaviour overall (15,20). Our study corroborates this fact, demonstrating that lower maternal education was significantly associated with home death despite seeking care. This might arise through two mechanisms. Firstly, maternal education reflects the socioeconomic position of the household. Secondly, educated mothers might hold greater social capital and medical staff might take their concerns more seriously. Such social capital might also give them confidence to re-seek care should a child's condition fail to improve (15).

Household size was significantly associated with dying at home despite seeking care in post-neonatal deaths, though only when comparing households of 15 people or more to households with up to five members. This partially reflects lower socioeconomic position of larger households (less income per capita), but it also might reflect the physical and emotional burden of caring for dependents in large families: caregivers may be less likely to notice that a child's condition has deteriorated when they have to look after several people (21).

With regard to child-related determinants, early neonatal deaths were significantly more likely to occur in a health facility, reflecting those neonates who were born and died in a facility without discharge. Over 90% of deliveries in South Africa occur in health facilities attended by nurses, midwives or doctors (22) and so babies in a serious condition (e.g. birth asphyxia, and prematurity) can be admitted to hospital immediately after birth.

Traditional medicine is a common feature of South African healthcare and was most often used in combination with western medicine, as in other studies (23). Traditional beliefs about disease aetiology, loss of confidence in formal medical treatment, stigma, ease of access and shorter waiting times all contribute to traditional medicine use (24,25). Medical pluralism was found in this study too. However, it remains unclear whether traditional medicine is used before, after or in parallel with formal care during the child's final illness, and why it is associated with death at home. It is possible that traditional care is a marker for serious and chronic illness, and for discharge from a health facility with inadequate follow-up, as parents try all options to treat their child.

The place of HIV-related deaths changed over time, reflecting changes in South African HIV policy on testing and treatment. In the early 2000s the country was still struggling with AIDS denialism, and only introduced a PMTCT programme in 2002 after a court order (16). However, by 2011 South Africa had the largest antiretroviral rollout programme globally (26), and current policy supports the WHO's test and treat guidelines (27). Significant gains have been made in improving access to HIV care, both in the form of available, acceptable and effective treatment and in terms of overcoming barriers created by stigma. The changing pattern in place of death could partly reflect these improvements in access to care, successful integration of HIV patients into formal healthcare systems, and a greater sensitivity to clinical signs and symptoms in HIV-positive children by parents and health professionals. The current package of HIV-related care (including health promotion materials and education of mothers about breastfeeding, growth and danger signs of illness) could be applied more broadly in primary care child health services to motivate greater emphasis on

health promotion, education of caregivers about common danger signs, developmental milestones and nutrition.

Finally, in Agincourt, being of Mozambican descent was significantly associated with dying at home despite seeking care for infants and young children. Mozambican descent is partially a proxy for socioeconomic position in Agincourt, but likely also reflects differences in cultural beliefs around illness and treatment seeking (28). Of concern is the possibility of xenophobia experienced at healthcare facilities which has been noted elsewhere in the country (29,30). Further work on this question is required to understand the barriers in this community.

Strengths and limitations

This study uses population-based data, which is essential to provide information on deaths at home or in the community that are unavailable in facility-based studies. Furthermore, the duration of the dataset (going back to 2000) allowed us to track changes in under-5 mortality over much of the HIV/AIDS epidemic in South Africa, and how this relates to place of death and care seeking behaviour over that time.

However, there are a number of important limitations. Firstly, neonatal deaths may be missed by the HDSS update rounds, as the death might occur before the birth was captured. To minimise this risk, data are captured on all pregnancies in the household. Secondly, care seeking data is self-reported. The rate of care-seeking from traditional healers is likely underestimated as participants may be hesitant to report such activity to researchers who are seen to be "western". For similar reasons, it is possible that care-seeking from formal healthcare facilities could be over-reported. Furthermore, care-seeking data are only available as a binary response (yes care was sought, or no it was not), and so it is not possible to explore the timing of care-seeking, which might help explain the high proportion of home deaths that had sought care. Thirdly, as the data are observational it is impossible to draw causal inferences from the associations we have reported. Further qualitative research is needed to understand the reasons for these associations, and whether causality can be attributed to any of them. Finally, data on some of the explanatory variables of interest, particularly maternal education and maternal employment, were incomplete, which may have biased the associations noted in this analysis. Analysis of the patterns of missing data suggests that for both maternal education and maternal employment, records with missing data were overrepresented in the lower socioeconomic quintiles (1-3) and for children who died at home despite seeking care, which may have weakened the associations (towards the null) between maternal education, maternal employment and place of death despite seeking care. No patterns were identified between

the missing maternal education data and other explanatory variables; but records with missing data on maternal employment tended to feature younger maternal age at the child's death, smaller households and fewer children under 5 years in the household, and so the current estimate may exaggerate the association between maternal employment and home death despite seeking care.

Conclusions and recommendations

This study confirms that home deaths account for the over half of all under-5 deaths in rural South Africa despite high rates of care-seeking during the final illness. Therefore, a shift in research is required, not only on questions of symptom recognition, caregiver response and barriers to accessing care, but also on questions about where and why children fall out of formal care pathways only to subsequently die at home. By controlling for care-seeking, this study has identified several socio-demographic and disease-specific factors that are associated with dying at home despite seeking care, and should serve as a starting point to target interventions to reduce under-5 deaths.

Acknowledgements

The Africa Health Research Institute's Population Intervention Programme is funded by the Wellcome Trust (201433/Z/16/Z) and the South Africa Population Research Infrastructure Network (funded by the South African Department of Science and Technology and hosted by the South African Medical Research Council). The MRC/Wits Rural Public Health and Health Transitions Research Unit and Agincourt Health and Socio-Demographic Surveillance System have been supported by the University of the Witwatersrand, the Medical Research Council, South Africa, the Wellcome Trust, UK (grants 058893/Z/99/A; 069683/Z/02/Z; 085477/Z/08/Z; 085477/B/08/Z) and the South Africa Population Research Infrastructure Network. JP was funded by the Rhodes Scholarship. The salary of MW was funded by the National Institute of Health Research, under grant CL-2016-26-005.

References

1. United Nations Inter-agency Group for Child Mortality, Estimation (UN IGME). 'Levels & Trends in Child Mortality: Report 2017, Estimates Developed by the UN Inter-agency Group for Child Mortality Estimation [Internet]. New York; 2017 [cited 2017 Nov 16]. Available from: http://data.unicef.org/resources/levels-trends-child-mortality/
2. Koffi AK, Maina A, Yaroh AG, Habi O, Bensaïd K, Kalter HD. Social determinants of child mortality in Niger: Results from the 2012 National Verbal and Social Autopsy Study. J Glob Health [Internet]. 2016 Jun [cited 2017 Feb 20];6(1):010603. Available from: http://www.ncbi.nlm.nih.gov/pubmed/26955473
3. Willcox ML, Kumbakumba E, Diallo D, Mubangizi V, Kirabira P, Nakaggwa F, et al. Circumstances of child deaths in Mali and Uganda: a community-based confidential enquiry. Lancet Glob Heal. 2018 Jun;6(6):e691–702.
4. Moyer CA, Johnson C, Kaselitz E, Aborigo R. Using social autopsy to understand maternal, newborn, and child mortality in low-resource settings: a systematic review of the literature. Glob Health Action [Internet]. 2017 [cited 2018 Jun 13];10(1):1413917. Available from: http://www.ncbi.nlm.nih.gov/pubmed/29261449
5. National Department of Health. 2nd Triennial Report of the Committee on Morbidity and Mortality in Children Under 5 Years (CoMMiC): 2014. 2014 [cited 2017 Jul 16]; Available from: http://www.kznhealth.gov.za/mcwh/2nd-CoMMiC-Triennial-Report-Abridged.pdf
6. D'Ambruoso L, Kahn K, Wager RG, Twine R, Spies B, van der Merwe M, et al. Moving from medical to health systems classifications of deaths: extending verbal autopsy to collect information on the circumstances of mortality. Glob Heal Res Policy [Internet]. 2016 Dec 15 [cited 2017 Feb 13];1(1):2. Available from: http://ghrp.biomedcentral.com/articles/10.1186/s41256-016-0002-y
7. Kahn K, Tollman SM, Garenne M, Gear JSS. Validation and application of verbal autopsies in a rural area of South Africa. Trop Med Int Heal [Internet]. 2000;5(11):824–31. Available from: http://ovidsp.ovid.com/ovidweb.cgi?T=JS&PAGE=reference&D=emed8&NEWS=N&AN=32001044
8. Streatfield PK, Khan WA, Bhuiya A, Hanifi SMA, Alam N, Ouattara M, et al. Cause-specific childhood mortality in Africa and Asia: evidence from INDEPTH health and demographic surveillance system sites. Byass P, Sankoh O, editors. Glob Health Action [Internet]. 2014;7:25363. Available from: http://www.globalhealthaction.net/index.php/gha/article/view/25363

9. Rhoda N, Velaphi S, Gebhardt GS, Kauchali S, Barron P. Reducing neonatal deaths in South Africa: Progress and challenges. South African Med J [Internet]. 2018 Mar 2 [cited 2018 May 23];108(3a):9. Available from: http://www.samj.org.za/index.php/samj/article/view/12239
10. Bamford LJ, McKerrow NH, Barron P, Aung Y. Child mortality in South Africa: Fewer deaths, but better data are needed. South African Med J [Internet]. 2018 Mar 2 [cited 2018 May 23];108(3a):25. Available from: http://www.samj.org.za/index.php/samj/article/view/12238
11. Pillay Y, Barron P. On the path to reach the SDG targets: Decreasing maternal and child mortality in South Africa. South African Med J [Internet]. 2018 Mar 2 [cited 2018 Sep 24];108(3a):2. Available from: http://www.samj.org.za/index.php/samj/article/view/12243
12. Tanser F, Hosegood V, Bärnighausen T, Herbst K, Nyirenda M, Muhwava W, et al. Cohort Profile: Africa Centre Demographic Information System (ACDIS) and population-based HIV survey. Int J Epidemiol [Internet]. 2008 Oct [cited 2018 Sep 10];37(5):956–62. Available from: http://www.ncbi.nlm.nih.gov/pubmed/17998242
13. Kahn K, Collinson MA, Gomez-Olive FX, Mokoena O, Twine R, Mee P, et al. Profile: Agincourt health and socio-demographic surveillance system. Int J Epidemiol. 2012 Aug;41(4):988–1001.
14. Gómez-Olivé FX, Montana L, Wagner RG, Kabudula CW, Rohr JK, Kahn K, et al. Cohort Profile: Health and Ageing in Africa: a Longitudinal Study of an INDEPTH Community in South Africa (HAALSI). Int J Epidemiol [Internet]. 2018 Jan 6 [cited 2018 May 23]; Available from: http://academic.oup.com/ije/advance-article/doi/10.1093/ije/dyx247/4791962
15. Solar O, Irwin A. A conceptual framework for action on the social determinants of health. [Internet]. Geneva Switzerland World Health Organization [WHO] 2010.; 2010 [cited 2018 Sep 4]. Available from: https://www.popline.org/node/216706
16. Barron P, Pillay Y, Doherty T, Sherman G, Jackson D, Bhardwaj S, et al. Eliminating mother-to-child HIV transmission in South Africa. Bull World Health Organ [Internet]. 2013 Jan 1 [cited 2018 Sep 10];91(1):70–4. Available from: http://www.who.int/entity/bulletin/volumes/91/1/12-106807.pdf
17. The South African Antiretroviral Treatment Guidelines 2013 [Internet]. 2013 [cited 2018 Sep 10]. Available from: http://www.sahivsoc.org/Files/2013 ART Treatment Guidelines Final 25 March 2013 corrected.pdf
18. Victora CG, Huttly SR, Fuchs SC, Olinto MT. The role of conceptual frameworks in epidemiological analysis: a hierarchical approach. Int J Epidemiol [Internet]. 1997 Feb 1 [cited 2018 Sep 6];26(1):224–7. Available from: https://academic.oup.com/ije/article-lookup/doi/10.1093/ije/26.1.224
19. StataCorp. Stata Statistical Software: Release 12. College Station, TX: StataCorp LP; 2011.

20. Caldwell J, McDonald P. Influence of maternal education on infant and child mortality: levels and causes. Health Policy Educ [Internet]. 1982 Mar [cited 2018 Sep 20];2(3–4):251–67. Available from: http://www.ncbi.nlm.nih.gov/pubmed/10256648
21. Kayode GA, Adekanmbi VT, Uthman OA. Risk factors and a predictive model for under-five mortality in Nigeria: Evidence from Nigeria demographic and health survey. BMC Pregnancy Childbirth [Internet]. 2012 Feb;12:10. Available from: http://ovidsp.ovid.com/ovidweb.cgi?T=JS&PAGE=reference&D=emed18b&NEWS=N&AN=51890869
22. Moodley J, Pattinson RC, Fawcus S, Schoon MG, Moran N, Shweni PM. The Confidential Enquiry into Maternal Deaths in South Africa: a case study. BJOG. 2014;121 Suppl:53–60.
23. Moshabela M, Pronyk P, Williams N, Schneider H, Lurie M. Patterns and implications of medical pluralism among HIV/AIDS patients in rural South Africa. AIDS Behav [Internet]. 2011 May [cited 2017 Jul 16];15(4):842–52. Available from: http://www.ncbi.nlm.nih.gov/pubmed/20628898
24. Scott K, McMahon S, Yumkella F, Diaz T, George A. Navigating multiple options and social relationships in plural health systems: a qualitative study exploring healthcare seeking for sick children in Sierra Leone. Health Policy Plan [Internet]. 2014 May;29(3):292–301. Available from: http://ovidsp.ovid.com/ovidweb.cgi?T=JS&PAGE=reference&D=emed16&NEWS=N&AN=605810573
25. Hill Z, Kendall C, Arthur P, Kirkwood B, Adjei E. Recognizing childhood illnesses and their traditional explanations: Exploring options for care-seeking interventions in the context of the IMCI strategy in rural Ghana. Trop Med Int Heal [Internet]. 2003 Jul;8(7):668–76. Available from: http://ovidsp.ovid.com/ovidweb.cgi?T=JS&PAGE=reference&D=emed9&NEWS=N&AN=36836513
26. Evans D. Ten years on ART – where to now? South African Med J [Internet]. 2013 Feb 26 [cited 2018 Jul 30];103(4):229. Available from: http://www.samj.org.za/index.php/samj/article/view/6835
27. Department of Health. Implementation of the Universal Test and Treat strategy for HIV positive patients and differentiated care for stable patients [Internet]. 2016 [cited 2018 Jul 30]. Available from: https://connect.emailsrvr.com/owa/attachment.ashx?attach
28. Hargreaves JR, Collinson MA, Kahn K, Clark SJ, Tollman SM. Childhood mortality among former Mozambican refugees and their hosts in rural South Africa. Int J Epidemiol [Internet]. 2004 Dec 1 [cited 2018 Sep 15];33(6):1271–8. Available from: https://academic.oup.com/ije/article-lookup/doi/10.1093/ije/dyh257

29. Human Rights Watch. South Africa: Improve Migrants' Access to Health Care | Human Rights Watch. Human Rights Watch [Internet]. 2009 Dec [cited 2018 Jul 30]; Available from: https://www.hrw.org/news/2009/12/07/south-africa-improve-migrants-access-health-care
30. Lepodise O. Medical Xenophobia: Public hospitals deny migrants health care services – SAHRC | Daily Maverick. Daily Maverick [Internet]. 2018 Mar [cited 2018 Jul 30]; Available from: https://www.dailymaverick.co.za/article/2018-03-29-medical-xenophobia-public-hospitals-deny-migrants-health-care-services-sahrc/

Correspondence: Jessica Price, Nuffield Department of Primary Care Health Sciences, Room 20.33, Gibson Building, 1st Floor, Radcliffe Observatory Quarter, Woodstock Road, Oxford OX2 6GG, UK. Phone +447491869157, Email Jessica.Price@gtc.ox.ac.uk

Table 1: Population descriptors of child deaths and care seeking behaviour 2000-2015

Variable	Total (N=3760)		AHRI (N=2033)		Agincourt (N=1727)		P value
	n/N*	%	n	%	n	%	
Child descriptors							
Female	1775	47	961	47	814	47	0.992
Child age:							<0.001
0-7 days	369	10	138	7	231	13	
8-27 days	131	3	49	2	82	5	
28 days-1 year	1759	47	1009	50	750	43	
1-4 years	1501	40	837	41	664	38	
Mozambican descent	684/1721	40	-	-	684/1721	40	-
Maternal descriptors							
Mother deceased	349/3694	9	71/1967	4	278/1727	16	<0.001
Mother's age (mean ± SD)	27±7	-	26±7	-	27±7	-	0.012
Relationship Status							<0.001
Single	2145	57	1596	79	549	32	
Married/Cohabiting	712	19	300	15	412	24	
Divorced/Separated	51	1	3	0.2	48	3	
Widowed	68	2	31	2	37	2	
Unspecified	784	21	103	5	681	39	
Household descriptors							
Household size (median, IQR)	10 (7-15)	-	11 (8-15)	-	9 (6-15)	-	<0.001
Number of children in the household aged 0-4 years (median, IQR)	2 (1-3)	-	2 (1-3)	-	2 (1-3)	-	<0.001
Household head female	1485/3689	40	764/2008	38	721/1681	43	0.003
Socioeconomic descriptors							
Socioeconomic quintile							<0.001
Quintile 1 (poorest)	960/3340	29	617/1783	35	343/1557	22	
Quintile 2 (poor)	807/3340	24	460/1783	26	347/1557	22	
Quintile 3 (medium)	655/3340	20	342/1783	19	313/1557	20	
Quintile 4 (rich)	508/3340	15	207/1783	12	301/1557	19	
Quintile 5 (richest)	410/3340	12	157/1783	9	253/1557	16	
Mother's education							<0.001
None	225/2557	9	44/925	5	181/1632	11	
Primary School	572/2557	22	185/925	20	387/1632	24	

High School	1657/2557	65	645/925	70	1012/1632	62	
Tertiary Education	103/2557	4	51/925	6	52/1632	3	
Mother temporary migrant	718/3532	20	564/1967	29	154/1565	10	<0.001
Mother working	480/2258	21	216/967	22	254/1291	20	0.278
Household head working	1292/3298	40	466/1763	26	826/1535	54	<0.001
Number of household members working (median, IQR)	2 (1-2)		2 (1-3)		1 (1-2)		<0.001
Descriptors of death and care seeking behaviour							
Deaths at home	1954/3693	53	1068/1966	54	886/1727	51	0.067
Sought care from a formal healthcare provider during the final illness	2796/3050	92	1539/1607	96	1257/1443	87	<0.001
Traditional medicine used/traditional healer consulted during the final illness	747/2880	26	294/1381	21	453/1499	30	<0.001
Proportion of home deaths who sought care from a formal healthcare provider	1139/1361	84 [ϕ]	652/712	92	487/649	75	<0.001

[*]Where N is not specified, data is available for all deaths.

[ϕ] % of deaths at home who sought care, where data were available on care-seeking behaviour.

Table 2: Predictors of neonatal death at home despite seeking care compared to death in a facility

Variable	Total		Unadjusted Model			Model 4: Model 3 + individual level variables		
	n	%	Crude OR	95% CI	P value	Adjusted OR*	95% CI	P value
Distal determinants:								
Year of death (reference: 2012-2015)	62	18	1	-	0.024	1	-	0.091
2000-2003	108	31	1.16	0.33-4.02	-	0.62	0.16-2.45	-
2004-2007	77	22	1.92	0.56-6.56	-	0.95	0.25-3.58	-
2008-2011	100	29	3.63	1.18-11.17	-	2.13	0.65-6.97	-
Study site (reference: AHRI)	138	40	0.66	0.34-1.27	0.212	0.46	0.21-1.01	0.053
Socioeconomic position:								
Socioeconomic status (reference: quintile 1 – poorest))	69	22	1	-	0.207	-	-	-
Quintile 2 – poor	68	21	3.32	1.12-9.81	-			
Quintile 3 – medium	60	19	1.97	0.61-6.38	-			
Quintile 4 – rich	67	21	1.99	0.63-6.27	-			
Quintile 5 - richest	54	17	1.31	0.36-4.76	-			
Maternal education (reference: none)	14	6	1	-	-	-	-	-
Started/completed primary school	52	21	0.80	0.08-8.30	0.849			
Started/completed secondary school	166	67	1.99	0.25-15.94	0.518			
Started/completed tertiary education	14	6	(empty)					
Mother temporary migrant	60	18	0.97	0.41-2.31	0.942	-	-	-
Mother working	53	25	0.68	0.24-1.90	0.462	-	-	-
Household head working	134	44	1.00	0.51-1.94	0.996	-	-	-
Number of household members working	248	-	1.25	1.00-1.56	0.053	-	-	-

Environmental and household factors:								
Household size (reference 1-5 members)	48	14	1	-	0.281	-	-	-
6-10 members	140	40	2.07	0.58-7.41	-	-	-	-
10-15 members	91	26	1.65	0.42-6.39	-	-	-	-
>15 members	68	20	3.21	0.85-12.09	-	-	-	-
Number of children aged 0-4 in the household	347	-	1.15	0.98-1.36	0.096	-	-	-
Household head female	145	43	1.05	0.55-2.03	0.876	-	-	-
Distance to clinic	347	-	1.16	0.99-1.37	0.072	-	-	-
Maternal conditions:								
Mother deceased	19	5	2.98	1.01-8.77	0.047	-	-	-
Young mother (<20 years)	93	27	0.63	0.28-1.42	0.265	-	-	-
Mother relationship status (reference: single)	193	65	1	-	-	-	-	-
Married/cohabiting	92	31	0.82	0.38-1.79	0.617	-	-	-
Divorced/separated	8	3	2.24	0.43-11.72	0.339	-	-	-
Widowed	2	1	(empty)			-	-	-
Child conditions:								
8-27 days (reference 0-7 days)	80	23	6.30	3.18-12.51	<0.001	5.56	2.68-11.55	<0.001
Female child	164	47	0.54	0.27-1.06	0.074	0.47	0.22-0.99	0.047
Mozambican descent[Ŧ]	63	30	2.83	1.14-7.07	0.026	-	-	-
Traditional medicine	11	4	3.94	1.10-14.11	0.035	-	-	-

*Adjusted OR is adjusted for all other variables in the table.

Ŧ in Agincourt only

Table 3: Predictors of death at home despite seeking care compared to death in a facility for infants and young children

Variable	Total		Unadjusted Model			Model 4: Model 3 + individual level variables		
	n	%	Crude OR	95% CI	P value	Adjusted OR*	95% CI	p value
Distal Determinants:								
Year of death (reference: 2012-2015)	317	14	1	-	<0.001	1	-	-
2000-2003	667	29	0.98	0.75-1.29	-	0.84	0.51-1.39	-
2004-2007	699	31	1.57	1.20-2.05	-	1.00	0.65-1.53	-
2008-2011	588	26	1.40	1.06-1.84	-	1.05	0.73-1.51	-
Study site (reference: AHRI)	1306	58	1.00	0.84-1.18	0.962	0.66	0.51-0.86	0.002
Socioeconomic Position:								
Socioeconomic status (reference: quintile 1 - poorest)	556	27	1	-	0.031	-	-	-
Quintile 2 - poor	515	25	1.18	0.93-1.51	-	-	-	-
Quintile 3 – medium	422	20	0.98	0.76-1.26	-	-	-	-
Quintile 4 – rich	316	15	0.96	0.73-1.27	-	-	-	-
Quintile 5 - richest	263	13	0.72	0.54-0.97	-	-	-	-
Maternal education (reference none)	123	8	1	-	0.005	1	-	<0.001
Started/completed primary school	294	20	0.84	0.55-1.28	-	0.82	0.50-1.35	-
Started/completed secondary school	1002	68	0.61	0.42-0.89	-	0.52	0.33-0.81	-
Started/completed tertiary education	61	4	0.44	0.23-0.83	-	0.38	0.19-0.78	-
Mother temporary migrant	419	20	0.78	0.63-0.97	0.024	-	-	-
Mother working	263	20	0.82	0.63-1.08	0.164	-	-	-
Household head working	710	36	0.78	0.65-0.94	0.009	-	-	-
Number of household members working	1417	-	0.97	0.91-1.05	0.481	-	-	-
Environmental and household factors:								
Household size (reference 1-5	318	14	1	-	0.027	1	-	0.309

members)								
6-10 members	858	38	1.15	0.89-1.49	-	1.13	0.80-1.58	-
10-15 members	591	26	1.04	0.79-1.37	-	1.07	0.73-1.57	-
>15 members	504	22	1.56	1.17-2.06	-	1.39	0.95-2.02	-
Number of children aged 0-4 in the household	2271	-	1.09	1.04-1.14	<0.001	-	-	-
Household head female	931	42	1.04	0.86-1.23	0.676	-	-	-
Distance to clinic	2269	-	0.99	0.95-1.04	0.770	-	-	-
Maternal conditions:								
Mother deceased	213	10	1.20	0.91-1.60	0.200	-	-	-
Young mother (<20 years)	284	13	0.89	0.69-1.14	0.354	-	-	-
Mother relationship status (reference: single)	1389	73	1	-	0.014	-	-	-
Married/cohabiting	410	22	0.80	0.64-1.00	-	-	-	-
Divorced/separated	28	1	2.17	0.97-4.83	-	-	-	-
Widowed	46	2	1.60	0.88-2.92	-	-	-	-
Child conditions:								
29 days-1 year (reference 1-4 years)	1231	54	0.99	0.84-1.17	0.921	-	-	-
Female child	1090	48	0.88	0.75-1.04	0.130	-	-	-
Mozambican descent ₸	372	39	2.07	1.59-2.69	<0.001	-	-	-
Traditional medicine	552	26	2.10	1.72-2.58	<0.001	2.44	1.84-3.24	<0.001
HIV/AIDS*time (ref category 2012-2015)	90	30	1	-	0.009	1	-	0.011
HIV*time (2000-2003)	294	47	1.61	0.88-2.92	-	1.53	0.70-3.34	-
HIV*time (2004-2007)	242	39	2.29	1.25-4.20	-	2.61	1.27-5.39	-
HIV*time (2008-2011)	169	31	2.63	1.41-4.94	-	2.86	1.44-5.68	-
HIV/AIDS in 2012-2015 (reference period)	90	30	0.66	0.40-1.09	0.103	0.54	0.31-0.93	0.027

*Adjusted OR is adjusted for all other variables in the table, excluding Mozambican descent which is only measured in Agincourt.

₸ in Agincourt only

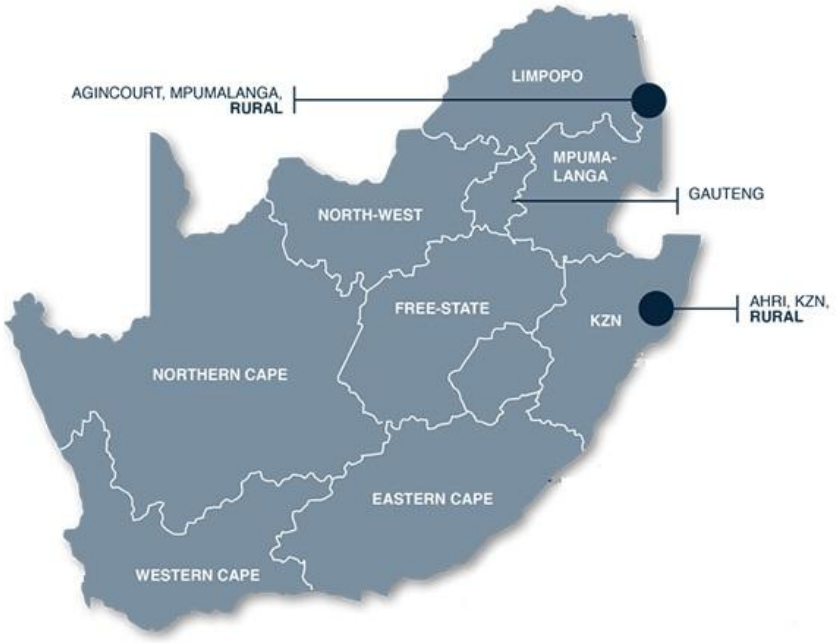


Figure 1: Map of South Africa, including HDSS site locations, adapted from http://saprin.mrc.ac.za/nodes.html

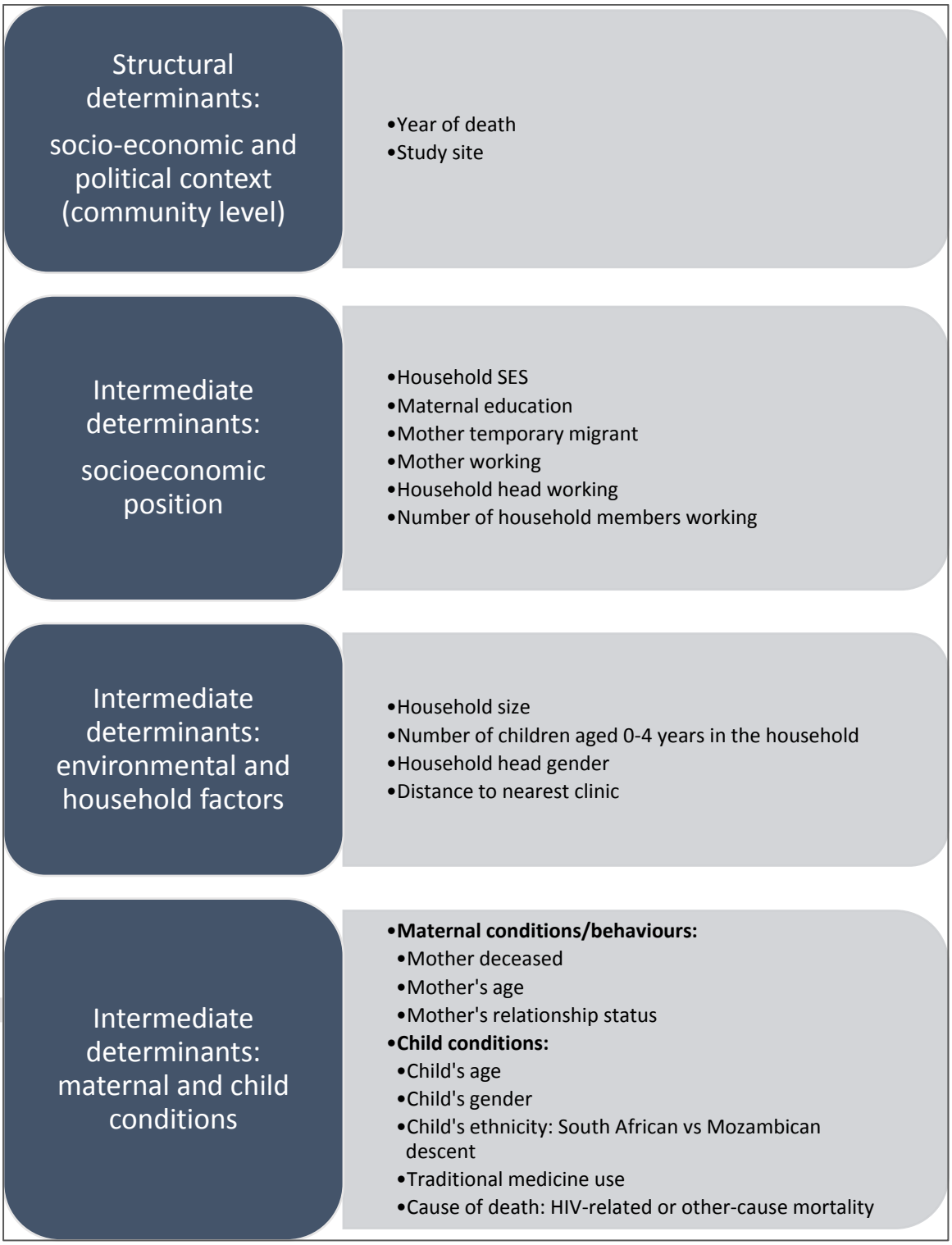


Figure 2: Conceptual hierarchical framework of risk factors for place of death in rural South Africa, adapted from the WHO social determinants of health inequalities[15]

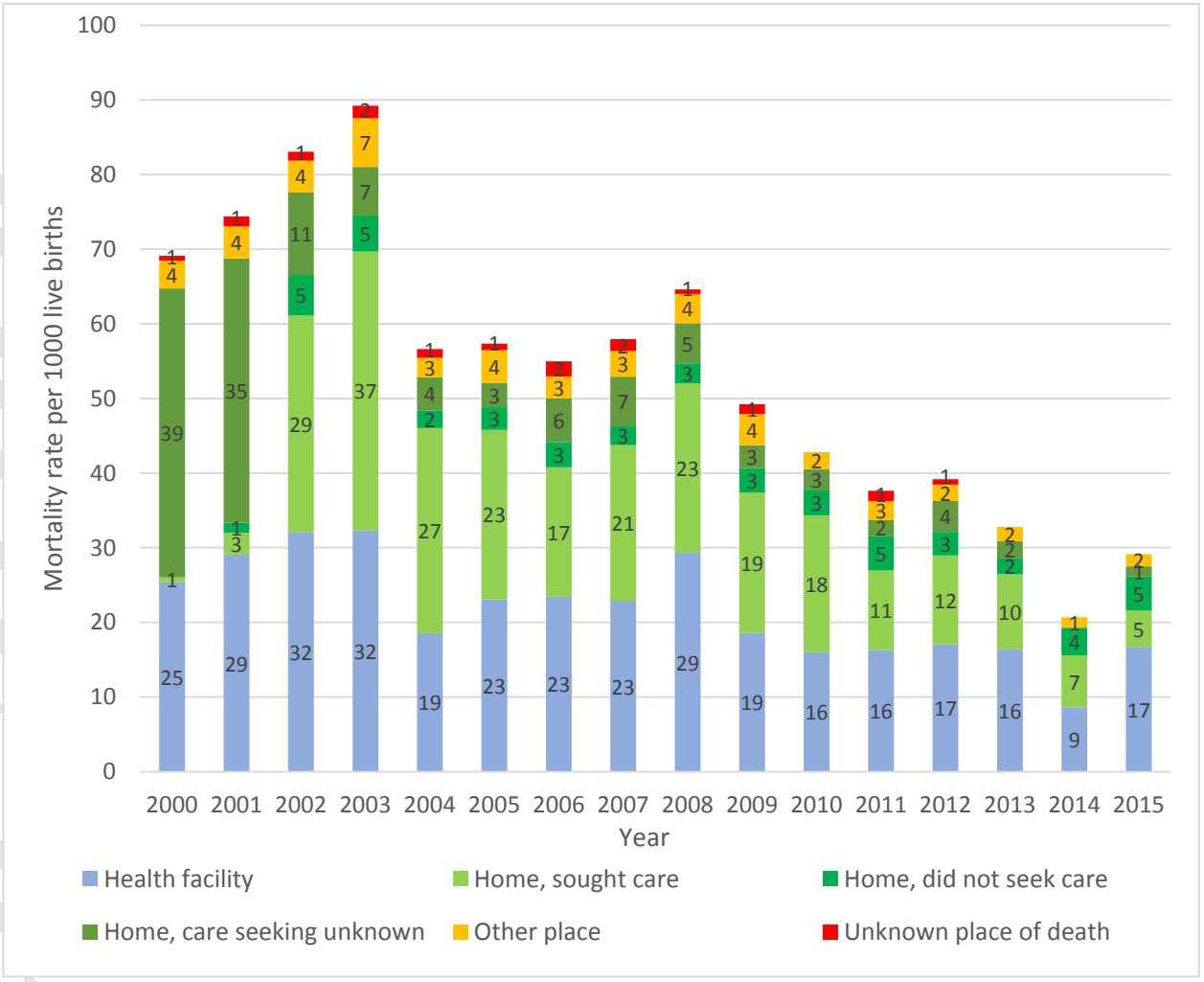
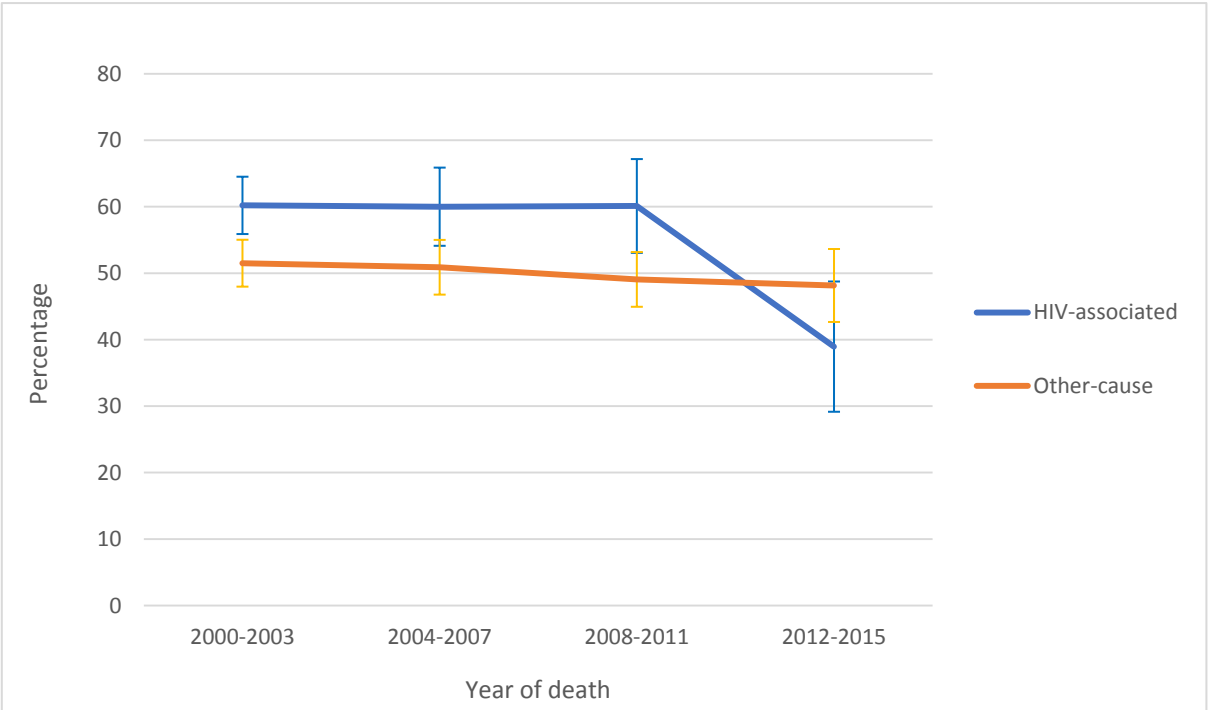


Figure 3: Place of death and care seeking in rural South Africa, 2000-2015



Cause of death	Proportion who died at home 2008-2011 (%)	Proportion who died at home 2012-2015 (%)	Chi2 (within group change over time)	p-value
HIV-associated	60	39	13.86	<0.001
Other-cause mortality	49	48	0.18	0.669

Figure 4: Proportion of deaths at home for HIV-associated or other-cause mortality

Model building process for neonatal deaths

Variable	Model 1			Model 2 (Model 1 + Socioeconomic variables)			Model 3 (Model 2 + environmental/household variables)			Model 4 (Model 3 + individual level variables)		
	OR*	95% CI	P value	OR*	95% CI	P value	OR*	95% CI	P value	OR*	95% CI	P value
Distal Determinants:												
Year of death (reference: 2012-2015)	1	-	0.004	1	-	0.004	1	-	0.004	1		0.091
2000-2003	0.66	0.18-2.50	-	0.66	0.18-2.50	-	0.66	0.18-2.50	-	0.62	0.15-2.45	
2004-2007	1.51	0.43-5.30	-	1.51	0.43-5.30	-	1.51	0.43-5.30	-	0.95	0.25-3.58	
2008-2011	3.49	1.12-10.84	-	3.49	1.12-10.84	-	3.49	1.12-10.84	-	2.13	0.656.97	
Study site (reference: AHRI)	0.40	0.19-0.85	0.017	0.40	0.19-0.85	0.017	0.40	0.19-0.85	0.017	0.46	0.21-1.01	0.053
Socioeconomic Position:												
Socioeconomic status (reference: quintile 1 - poorest)				-	-	-	-	-	-	-	-	-
Quintile 2 - poor				-	-	-	-	-	-	-	-	-
Quintile 3 – medium				-	-	-	-	-	-	-	-	-
Quintile 4 – rich				-	-	-	-	-	-	-	-	-
Quintile 5 - richest				-	-	-	-	-	-	-	-	-
Maternal education (reference none)				-	-	-	-	-	-	-	-	-
Started/completed primary school				-	-	-	-	-	-	-	-	-
Started/completed secondary school				-	-	-	-	-	-	-	-	-
Started/completed tertiary education				-	-	-	-	-	-	-	-	-
Mother temporary migrant				-	-	-	-	-	-	-	-	-
Mother working				-	-	-	-	-	-	-	-	-
Household head working				-	-	-	-	-	-	-	-	-
Number of household members working				-	-	-	-	-	-	-	-	-

Environmental and household factors:								
Household size (reference 1-5 members)			-	-	-	-	-	-
6-10 members			-	-	-	-	-	-
10-15 members			-	-	-	-	-	-
>15 members			-	-	-	-	-	-
Number of children aged 0-4 in the household			-	-	-	-	-	-
Household head female			-	-	-	-	-	-
Distance to clinic			-	-	-	-	-	-
Maternal conditions:								
Mother deceased						-	-	-
Young mother (<20 years)						-	-	-
Mother relationship status (reference: single)						-	-	-
Married/cohabiting						-	-	-
Divorced/separated						-	-	-
Widowed						-	-	-
Child conditions:								
8-27 days (reference 0-7 days)						5.56	2.68-11.55-	<0.001
Female child						0.47	0.22-0.99	0.047
Traditional medicine						-	-	-

Model building process for post-neonatal deaths

Variable	Model 1			Model 2 (Model 1 + Socioeconomic variables)			Model 3 (Model 2 + environmental/household variables)			Model 4 (Model 3 + individual level variables)		
	OR	95% CI	P value	OR*	95% CI	P value	OR*	95% CI	P value	OR*	95% CI	P value
Distal Determinants:												
Year of death (reference: 2012-2015)	1	-	<0.001	1		<0.001	1	-	<0.001	1	-	<0.001
2000-2003	0.97	0.74-1.28		0.58	0.42-0.81		0.57	0.41-0.79	-	0.84	0.51-1.39	
2004-2007	1.56	1.19-2.04		1.36	0.98-1.87		1.33	0.96-1.83	-	1.00	0.65-1.53	
2008-2011	1.40	1.06-1.84		1.44	1.07-1.93		1.42	1.06-1.90	-	1.05	0.73-1.51	
Study site (reference: AHRI)	0.96	0.81-1.14	0.654	1.18	0.95-1.47	0.144	1.20	0.95-1.50	0.120	0.66	0.51-0.86	0.002
Socioeconomic Position:												
Socioeconomic status (reference: quintile 1 - poorest)				-	-	-	-	-	-	-	-	-
Quintile 2 - poor				-	-	-	-	-	-	-	-	-
Quintile 3 – medium				-	-	-	-	-	-	-	-	-
Quintile 4 – rich				-	-	-	-	-	-	-	-	-
Quintile 5 - richest				-	-	-	-	-	-	-	-	-
Maternal education (reference none)				1	-	<0.001	1	-	0.001	1	-	<0.001
Started/completed primary school				0.80	0.52-1.23	-	0.81	0.55-1.26	-	0.82	0.50-1.35	-
Started/completed secondary school				0.54	0.36-0.80	-	0.56	0.37-0.83	-	0.52	0.33-0.81	-
Started/completed tertiary education				0.39	0.20-0.74	-	0.42	0.22-0.81	-	0.38	0.19-0.78	-
Mother temporary migrant				-	-	-	-	-	-	-	-	-
Mother working				-	-	-	-	-	-	-	-	-
Household head working				-	-	-	-	-	-	-	-	-
Number of household members working				-	-	-	-	-	-	-	-	-
Environmental and household factors:												
Household size (reference 1-5 members)							1	-	0.029	1	-	0.309
6-10 members							1.08	0.79-1.47	-	1.13	0.80-1.58	-
10-15 members							0.99	0.70-1.41	-	1.07	0.73-1.57	-
>15 members							1.51	1.07-2.14	-	1.39	0.95-2.02	-
Number of children aged 0-4 in the							-	-	-	-	-	-

household								
Household head female				-	-	-	-	-	-
Distance to clinic				-	-	-	-	-	-
Maternal conditions:								
Mother deceased							-	-	-
Young mother (<20 years)							-	-	-
Mother relationship status (reference: single)							-	-	-
Married/cohabiting							-	-	-
Divorced/separated							-	-	-
Widowed							-	-	-
Child conditions:								
29 days-1 year (reference 1-4 years)							-	-	-
Female child							-	-	-
Traditional medicine							2.44	1.84-3.24	<0.001
HIV/AIDS*time (ref category 2012-2015)							1	-	0.011
HIV*time (2000-2003)							1.53	0.70-3.35	-
HIV*time (2004-2007)							2.61	1.27-5.39	-
HIV*time (2008-2011)							2.86	1.44-5.68	-
HIV/AIDS in 2012-2015 (reference period)							0.54	0.31-0.93	0.027