

**HIV and Child Mortality: Evidence from
Surveillance Studies in Uganda, Tanzania and
Malawi**

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HIV and child mortality: evidence from surveillance studies in Uganda, Tanzania and Malawi

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Abstract

The steady decline in child mortality that has been seen in most African countries in the 1960s, 70s and 80s has stalled in many countries in the 1990s, because of the AIDS epidemic. However, the census and household survey data that are generally used to produce estimates of child mortality do not enable the adverse effect of HIV on child mortality to be precisely quantified. This paper uses pooled data from three longitudinal community based studies that classified births by the mother's HIV status to calculate the excess risks of child mortality due to maternal HIV status. The excess risks of child death due to increased mortality among mothers are also estimated, and the joint effects of maternal HIV status and maternal survival are quantified using multivariate techniques in a survival analysis. The analysis shows that the excess risk of death associated with having an HIV positive mother is 3.2, and this effect lasts throughout childhood ages. The excess risk associated with a maternal death is 3.6 in the two year period centred on the mother's death, with children of both infected and uninfected mothers experiencing elevated mortality risks at this time.

Introduction

HIV has caused adult mortality rates to increase in many countries of sub-Saharan Africa (1, 2), and there is some indication that child mortality rates are also rising due to vertical transmission. Since HIV prevalence levels are high, and still increasing in many countries (3) the effect of AIDS on child mortality is likely to persist for several decades. However, for a variety of reasons, direct evidence for the impact of HIV on child mortality is relatively weak.

Steady improvements in child mortality seen since the 60s were faltering in many countries even before the AIDS crisis, possibly because of structural adjustment and warfare leading to stagnation in the development of primary healthcare (4), making it difficult to disentangle the contribution of HIV simply by monitoring time trends. A few longitudinal studies linked to HIV sero-surveys allow us to analyse the mortality of children by HIV status of mother, and thereby obtain population attributable fractions (PAF) for the contribution of HIV to child mortality (5-7). However, since HIV positive women suffer increased mortality and decreased fertility (8) the widely used retrospective techniques for measuring child mortality (directly, through birth history analysis, or indirectly using the Brass techniques [9]) no longer yield reliable estimates, as we cannot assume independence between the mortality experience of mothers and children.

This paper uses pooled data from community based studies in Uganda, Tanzania and Malawi, in which it was possible to trace the survival of children classified by their mothers' HIV status and thereby compare the experience of children born to infected mothers with that of children born to healthy mothers, and to examine the population level impact of HIV on child mortality.

Background information about participating studies

The Tanzanian and Ugandan studies (10, 11) have a broadly similar design, with repeated HIV testing of the entire adult population in the study area, linked to demographic surveillance of births, deaths and migratory movements occurring in the study households.

The Masaka study, conducted jointly by the Uganda Virus Research Institute and the UK Medical Research Council, covers a population of 17,000 in 15 villages in Southern Uganda. Since 1989, annual censuses collected basic demographic information supplemented by special socio-economic and health enquiries. Censuses are followed by serological testing of adults aged 13 and over. Children were tested in 1989, but not subsequently. Demographic events (births, deaths and migrations) can be dated accurately to within a month, and mother and child records can be linked. HIV prevalence among pregnant women ranged from 7% to 8% over the course of the study.

The Kisesa cohort study is part of the TANESA programme, a collaboration between the Tanzanian National Institute for Medical Research, the Bugando zonal referral hospital the Mwanza Regional Medical Office and the Dutch government. The study covers one ward in Magu district, containing six villages and a semi-urban roadside settlement, with a population that had grown to 27,000 by 2001. Censuses were conducted at four-monthly intervals from 1994 to 1996, later half-yearly, ensuring high rates of completeness in recording demographic events. Serological surveys conducted in 1994, 1997 and 2000 of adults aged 15-49 showed that HIV prevalence among child-bearing women rose slowly from 5% to 6%. The demographic surveillance system establishes the inter-round interval within which births, deaths and migrations occur, so that even if dates are not reported accurately they can be located to within a few months.

The Karonga "Family Health" study is based on a retrospectively identified cohort, originally recruited as part of a leprosy and TB research programme (12). The study is located in the Karonga district, a remote rural area of Northern Malawi. Blood samples on filter papers collected between 1981 and 1989 for studies on leprosy were tested for HIV in the 90s, with permission from the National Health Sciences Research Committee of Malawi, and 197 HIV positive individuals and 396 matching HIV negative controls were contacted again in 1998-2000 to form a retrospective cohort. All the spouses and children of the original index individuals were also recruited into the present study, yielding data on nearly 4,000 individuals who had been resident in the area between 1980 and 1999. The 2,237 family members who were still living in the district in 1999 answered a questionnaire survey on demographic, socio-economic and health topics. Care was taken to obtain full demographic data on index individuals, spouses and children who had left the area or died. After counselling and if consent was given, blood samples were obtained from resident index individuals, their spouses, and adult offspring and tested for HIV. Although a few individuals have been followed for as long as 18 years, the retrospective dating of some events in this study can only be considered accurate to within a year. HIV prevalence measured in ante natal clinics in 1999-2001 was 10%; data for pregnant women are not available for the mid eighties when the study began, but community prevalence then was below 2% (13).

Table 1 summarises the availability and quality of basic data of interest for the analysis of child mortality in the three studies. Separate analyses have been undertaken for each of these data sets (5, 14, 15) in which the strengths of the different data collection methods have been exploited, and the weaknesses allowed for using a variety of analytical techniques. In order to pool the data to perform a meta-analysis, it was necessary to apply common definitions, and to limit our investigation to those factors collected by all three studies.

Completeness of reporting of infant deaths, especially those occurring in the neo-natal period, and associated births is thought to be highest in Kisesa, because of the higher frequency of demographic monitoring. The timing of demographic

events is likely to be least reliable in Karonga, because of reliance on retrospective reporting of events that happened a long time ago. For the joint analysis we restrict ourselves to births occurring after 1986, which eliminates some of the earliest births in the Karonga study.

Analytical Methods

Figure 1 illustrates different HIV testing histories experienced by mothers. Some time segments of a mother's life cannot be unambiguously classified as HIV positive or negative. These segments include the whole experience of mothers who have never been tested for HIV; the time lived after the last negative HIV test by mothers who never have a positive HIV test; the time between the last negative test and the first positive test for sero-converters; and the time lived before the first positive HIV test by women who never had a negative HIV test. Births in all three studies were classified as above, according to the HIV status of the mother at the time of birth. Serological testing procedures used in the three studies are described elsewhere (10 – 12).

Population attributable fractions have been calculated to measure the impact of HIV and the impact of maternal mortality, defined as:

$$PAF = \frac{\text{mortality in the population} - \text{mortality in the unaffected population}}{\text{mortality in the population}}$$

Statistical analysis was undertaken using STATA 7.0 (16)

Results

Mortality risks of children of HIV positive mothers

Table 2 shows the life table proportions of children dying by age 1 and age 5, classified by HIV status of mother at birth in each of the three studies. Infant mortality is between 2.1 and 4.3 times higher among children of HIV positive women. Child mortality differentials are slightly narrower, from 2.9 to 3.3. The risk ratio is highest in Masaka, where infant mortality is lowest. The risk ratio falls between infancy and childhood in Masaka, but rises in Kisesa and Karonga.

A narrower differential at age five than at age one in Masaka implies that the effects of HIV are concentrated in infancy, but the data from Kisesa and Karonga suggest that the cumulative mortality differential continues to grow. Age-specific

death rates (deaths / person-years exposure) calculated using pooled data, (figure 2) show mortality differences by HIV status of mother persisting into the third year of life, though it is difficult to draw strong conclusions because of the relatively small numbers – a total of nine child deaths at ages three and over were reported to HIV positive mothers in all three studies, thirteen to HIV negative mothers.

Mortality associated with orphanhood and maternal morbidity

The survival chances of children may be adversely affected by the death of their mothers. When HIV prevalence is low the number of orphans with HIV negative mothers is likely to be larger than the number whose mother was HIV infected. In Kisesa, where HIV prevalence amongst pregnant women reached 5%, of the 36 children orphaned by age five whose mother had been tested for HIV, 28% had an infected mother; in Masaka where prevalence in pregnant women was 8%, children of infected mothers accounted for 55% of the 42 orphans under five; in Karonga, where ANC prevalence reached 10% by 1999, 62% of orphans under five would have had infected mothers in a population sample.

In analysing the effects of orphanhood on child survival it is important to keep in mind that deaths of orphans constitute a small proportion of overall infant and child deaths – in the overwhelming number of cases where both the mother and child die, it is the child who dies first. This is a consequence of the frailty of infants and very young children – the longer the follow-up, the more closely balanced the number of maternal and child deaths, as can be seen in Table 4, by comparing the numbers in Kisesa (where the average length of follow-up for children is only two years), with numbers in Masaka (average follow-up four years) and Karonga (average follow-up six years).

The years prior to and following a mother's death are a high risk period for children. A disproportionate number of deaths occur in this relatively short period, and this is especially clear when the age of the child is taken into consideration. These effects are demonstrated in Table 3, where death rates in infancy and childhood are compared for children living through the year before their mother's death (hereafter referred to as the period of her terminal illness), for children who have been orphaned for less than one year, for children who survived the first year of orphanhood and for children of "healthy" mothers.

The rates reported in Table 3 are central mortality rates (deaths / person-years exposure) rather than conventional infant mortality and child mortality rates. Since the mother is alive at the birth of the child, children generally do not become orphans from the moment of birth; conversely after a mother dies the child does not remain exposed to the risk factors associated with the period we have termed "mothers terminal illness." Because we need to make allowances

for transitions between the various states of the mother's health and survival, the conventional IMR and child mortality rates become rather artificial constructs. In contrast to the mother's HIV status at the time of birth, the survival status of mothers is by definition a time varying effect, so it is more appropriate to compare mortality rates than cumulative probabilities of death.

Small numbers at risk in some categories preclude some observed differentials attaining statistical significance, nevertheless the results are highly suggestive, and warrant grouping children of "terminally ill" mothers together with recent orphans for further analysis. Age-specific mortality rates for children classified by mother's survival status are shown in Figure 3. Recent, or impending death of the mother is strongly associated with mortality of children under 3, but after that age the impact is harder to measure given the numbers involved.

A comparison of Figures 2 and 3 suggests that the child mortality differential due to the survival of mothers is larger than that due to maternal HIV status. However, part of the mortality of adult women observed in these populations is due to HIV: in Masaka the proportion of HIV negative mothers who died was 1.0% compared to 20.8% of the HIV positive; in Kisesa (with a shorter follow-up period) the proportions dying were 1.0% and 7.8% for HIV negative and positive mothers respectively; and in Karonga (with a longer follow-up) the corresponding proportions were 1.4% and 40.0%. Overall, children of HIV positive mothers are far more likely to have their mother die with risk ratios from eight to 20 over the follow-up times of these studies, which range, on average, from five to 13 years.

Combined effects of maternal survival and HIV status

Individual level data from the three studies were combined, limited to child-years lived at ages under five, since data for this age range were available from all three studies. All the variables that could be measured in a similar fashion in each of the separate studies were retained, and a categorical variable introduced to indicate which study had generated an individual record. Table 4 shows the distribution of the combined births, child-years of exposure and mortality rates in the pooled dataset, categorised by those variables that are common to all three studies and known to influence child mortality.

Masaka has lower overall child mortality than the other two sites. The importance of age is highlighted: mortality declines rapidly after infancy. Boys have slightly higher mortality than girls, as is found in most populations. The current age of the mother has an important effect, with children of teenage mothers highly disadvantaged. Calendar year of observation is also important, with higher mortality risks observed in the past. As previously suggested, the experience of mother's death or terminal illness also place children at very high risk of death, but if a child survives for a year or more after the mother's death there is no indication of further excess risk (though only 90 children were

observed who had been orphaned for over a year). Children of HIV positive mothers face much higher risks of dying, but even those whose mothers have never been tested, or whose mothers' HIV status is ambiguous suffer higher mortality than children of HIV negative mothers.

The differentials in Table 4 arise as a result of complex inter-actions between co-variables. For example, the Karonga study goes further back in time to when mortality rates were higher; follow-up in Kisesa is shorter, so fewer older children are included; older children are less likely to have mothers who are still teenagers; mothers in their twenties are more likely to be HIV positive than either teenagers or older women; HIV positive mothers are more likely to fall seriously ill and die. To separate out these overlapping risks a multivariate analysis was performed, using a piecewise exponential hazards model, allowing for both fixed co-variables (study, sex, mother's HIV status at birth) and time varying co-variables (child's age, calendar year, mother's age, survival and current HIV status).

Table 5 shows the results of the final model selected for the multivariate analysis. A relative risk of 1 indicates the reference category for each variable against which other risks are assessed. Some variables (specifically child's age 3+, mother's age 20+, mother terminally ill or dead) were re-grouped where the categories used in Table 4 shared very similar hazard ratios. Calendar year was dropped from the final model, since it was not statistically significant when study site was controlled for. Hazard ratios for the remaining variables are statistically significant at the 5% level.

As was suggested in the univariate analysis, Karonga has the highest level of child mortality, and Masaka the lowest, though the difference in mortality between Kisesa and Karonga is not significant. After allowing for confounding, all the hazard ratios are in the expected directions. The maternal age effect is reduced – before adjusting for child's age, having a teenage mother appeared to double child mortality, after allowing for other factors the mortality hazard is increased by 30%. Children of HIV positive mothers have mortality rates nearly three times as high as children of HIV negative mothers (hazard ratio 2.9, confidence limits 2.3 to 3.6) after controlling for all other variables.

After controlling for age of child, but before re-grouping, maternal death appeared to have a more severe impact immediately after the event (hazard ratio 5.2, confidence limits 3.0 to 8.5) than in the year before (hazard ratio 3.2, CL 2.0 – 5.3). The differences in hazard ratio for the period immediately before and immediately after the mother's death are almost significant at the 5% level, but the two periods were grouped together in the final model. Since the accuracy of dating of events is questionable, this avoids making artificial distinctions between closely spaced events. After grouping the two periods together the overall impact of mother's death on child mortality is higher (hazard ratio 3.9, CL 2.3 – 3.6) than that of mother's HIV status.

Allowing for inter-action between child's age, mother's HIV status and mother's survival did not produce any significant effects or improvements in the overall goodness of fit of the model. However, there are a priori reasons for expecting an inter-action between mother's HIV status and mother's survival in their effect upon child mortality, since mothers who are in the later stages of HIV infection with high levels of viremia would be expected to have a higher probability of transmitting the virus to their unborn child, and would have higher probabilities of dying shortly after giving birth.

To investigate this, the final model was run separately for HIV positive and HIV negative mothers. For uninfected mothers, the hazard ratio associated with mother's death was 3.3, with 95% confidence limits of 1.2 to 8.9; for infected mothers the hazard ratio was 3.8, CL 2.3 to 6.5. This small difference is in the expected direction, though not statistically significant. In the regression analyses for children of infected women, some of the hazard ratios (e.g., for teenage mothers) whilst changing very little (from 1.3 to 1.4) lost significance (from $p=0.002$ to $p=0.413$), due to the relatively small numbers involved. Overall, grouping HIV positive and negative mothers together for estimation of maternal mortality effect was justified because of the similarity in the outcome, and the increased power of the grouped analysis.

The regression model of Table 5 was also re-run separately for each study site to confirm that pooling of the data was justified. The differences that emerged in the hazard ratios did not attain statistical significance, though one is worthy of comment since it suggested a change in direction of influence. In Karonga the hazard ratio for children of mothers who had never had an HIV test was 0.9 (CL 0.5 to 1.4), probably explained by the fact that the never tested group in Karonga consisted mainly of mothers who had lived in the area in the mid-eighties, but had born children and left before the spread of the HIV epidemic.

Population level effects

Based on cumulated mortality risks, the population attributable fraction of infant mortality due to maternal HIV infection is 19.4%, for child mortality it is 15.7% in the pooled dataset in which HIV prevalence is 11%. The corresponding figures for the impact of maternal mortality are 2.4% and 2.5% for infant and child mortality respectively. In the case of maternal mortality, the exposed populations are defined as children who lose their mothers within one year or within five years of birth, they form 0.3% and 2.3% respectively of the pooled dataset.

Discussion

The analysis above shows that after allowing for geographical differences in levels of background mortality, for child's sex and for mother's age, the mortality rates of children born to HIV positive women are almost three times those of children born to HIV negative women. On top of this, children whose mothers die experience mortality rates over three times as high in the two-year period centred on the mother's death, irrespective of the mother's HIV status. Presumably this is due to the disruption of breastfeeding in infants, and the inability of the mother to care for her children when she herself is subject to a terminal illness. Since children of HIV positive mothers are far more likely to experience maternal death (17, 18), they face a double jeopardy with respect to childhood mortality risks.

Although the hazard ratios associated with maternal death are higher than those associated with maternal infection, maternal death remains a relatively rare event, although more frequent for young children of HIV infected mothers. Altogether 277 of 10807 (2.6%) of the children born into the three study populations experienced the death or terminal illness of their mothers: 66 of 6526 (1.0%) of the children born to HIV negative mothers; and 89 of the 408 (21.8%) children born to infected mothers. The relatively low proportion of children experiencing a maternal death or terminal illness means that the population attributable fraction of infant and child mortality due to maternal mortality is of the order of 2.5%. By contrast, in the combined population where the HIV prevalence among mothers is around 11%, the population attributable fraction due to HIV is between 15% (for children up to age 5) and 20% (for infants). In interpreting the PAF statistics, it should be born in mind that preventing HIV infection in women would not only eliminate vertical transmission, but also prevent a large fraction of current deaths among mothers. Preventing maternal deaths, however, might not eliminate vertical transmission of HIV to children, although providing anti-retroviral therapy to infected women would impact both.

The multivariate analysis shown in Table 5 implies that background mortality in Karonga was slightly worse than that in Kisesa, and significantly worse than in Masaka. This ties in with historical evidence from censuses and surveys showing that Malawi had higher child mortality than Tanzania or Uganda (19).

Figure 2 suggests that the adverse effect of maternal death may be limited to the first two years of life. Adding an inter-action term between child's age and maternal survival did not add significantly to the explanatory power of the model. However, we only have firm evidence about the scale of the excess mortality risk in children up to the age of five, after that age only 30 person-years exposure to maternal death were observed – too low to measure the continuing excess risk. Since the very frail HIV infected children will form a steadily declining fraction of the cohort born to HIV infected mothers, we would expect the excess risk associated with maternal HIV status to decline with age. On the other hand, the mortality of the remaining HIV infected children might be expected to eventually

rise with age, in the same way that mortality of HIV infected adults rises with duration since infection.

Several of the findings reported above are statistically significant only in restricted age ranges: children under five (effects of maternal HIV infection) and those under three (maternal survival). Since the Masaka and Kisesa studies continue to amass data round by round, and a further follow-up of the Karonga retrospective cohort is planned for 2004, it will be useful to repeat this analysis when longer follow-up times are possible.

Identification of the relatively short period in which children of dead or dying mothers face extremely high mortality risks is a new finding, that may have important policy implications. Help for families with seriously ill mothers needs to be provided before the mother's death, and in the period immediately afterwards. Orphans whose mothers died over a year ago have already lived through the worst and may not need help to such an extent. The concentration of infant and child deaths around the time of mother's terminal illness and death suggests that enforced, hurried weaning may be the immediate precipitating factor. Provision of the implements, supplies and know-how needed to make up healthy formula feed might be an appropriate intervention for families with seriously ill mothers.

Having a dead or dying HIV negative mother carries as serious (short-term) consequences for child mortality as having a healthy HIV positive mother. At prevalence levels around 10% in populations with moderately high adult mortality there will be almost as many non-AIDS orphans as AIDS orphans at ages under five. This implies that assistance for families with dead or dying mothers should be provided irrespective of the mother's HIV status. By not enquiring into the cause of the mother's death it will be possible to avoid stigmatising the family.

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Tables

Table 1 Data quality and availability

	Masaka, Uganda	Kisesa, Tanzania	Karonga, Malawi
Child's birth date	month	approximate month	year
Child's death date	month	survey round	year
Child leaving date	month	survey round	year
HIV status of child	round 1		at follow-up
Birth order		most mothers	all mothers
Birth interval	survey births only	all births	all births
Mother's age	single years	approximate year	approximate year
Mother HIV status	annually	94, 96 & 99	81-4 or 87-9, 98-2000
Mother's death	month	survey round	year
Mother's leaving	month	survey round	year
Father's age		approximate year	approximate year
Father HIV status		94, 96 & 99	81-4 or 87-9, 98-2000
Father's death		survey round	year
Father's leaving		survey round	year
Socio-economic data	some rounds	94, 96 & 99	82-4, 98-2000

Table 2 Infant and child mortality by HIV status of mother at birth

		Masaka	Kisesa	Karonga
Number of births				
	all births	3727	6049	1073
	never tested	271	1562	202
	ambiguous	452	1179	224
	negative	2786	3185	580
	positive	218	123	67
Infant mortality Q(1)				
	all births	0.068	0.086	0.103
	never tested	0.071	0.096	0.051
	ambiguous	0.086	0.100	0.143
	negative	0.051	0.072	0.091
	positive	0.221	0.153	0.227
	ratio pos / neg	4.3	2.1	2.5
Child mortality Q(5)				
	all births	0.132	0.144	0.172
	never tested	0.133	0.159	0.132
	ambiguous	0.173	0.185	0.219
	negative	0.102	0.112	0.132
	positive	0.331	0.324	0.439
	ratio pos / neg	3.3	2.9	3.3

Table 3 Mortality rates in infancy and childhood by maternal survival

Age range	Masaka		Kisesa		Karonga		
	Mother's survival	d / PY	Mortality rate	d / PY	mortality rate	d / PY	mortality rate
Infancy (0-1)							
	Alive	230 / 3269	0.070	440 / 4505	0.098	104 / 995	0.105
	terminally ill	6 / 14	0.421	5 / 8	0.659	1 / 4	0.274
	recently dead	4 / 4	1.005	5 / 7	0.767	2 / 3	0.581
Childhood (1-5)							
	alive	159 / 7767	0.020	131 / 5434	0.024	59 / 2933	0.020
	terminally ill	3 / 35	0.085	3 / 26	0.114	1 / 18	0.056
	recently dead	3 / 30	0.100	0 / 13	0.000	3 / 15	0.205
	died long ago	0 / 39	0.000	0 / 10	0.000	0 / 24	0.000

Table 4 Combined data: individuals at risk, exposure and mortality rates

		individuals	exposure	deaths
total numbers		10849	30429	1178
crude death rate				38.1
Co-variates		proportions		mortality rate
		individuals ever at risk	person-years exposure	
study	Masaka	34.4%	44.4%	36.3
	Kisesa	55.8%	39.8%	58.4
	Karonga	9.9%	15.9%	42.6
age of child	0-1	100.0%	35.0%	90.5
	1-2	66.1%	23.9%	36.9
	2-3	47.1%	17.8%	20.6
	3-4	35.5%	13.3%	7.8
	4-5	26.6%	10.0%	8.8
sex	male	49.7%	49.9%	51.3
	female	50.3%	50.1%	40.9
time period	1986-90	6.6%	5.7%	66.5
	1991-95	37.7%	34.1%	47.9
	1996-00	83.1%	60.2%	43.1
mother's age	<20	17.6%	8.5%	80.9
	20-24	38.5%	27.0%	50.1
	25-29	36.9%	26.1%	44.4
	30+	39.5%	38.4%	36.7
mother's survival	alive	99.6%	99.0%	45.1
	terminally ill	1.4%	0.4%	181.2
	recently died	0.8%	0.3%	236.8
	died long ago	0.5%	0.3%	0.0
mother's HIV status at birth of child	negative	60.4%	72.7%	35.0
	positive	3.8%	3.7%	113.9
	ambiguous	17.1%	11.4%	71.9
	never tested	18.7%	12.2%	58.6

Table 5 Multivariate analysis of mortality hazards for combined data

Co-variates		hazard ratio	95% confidence intervals		P-values
Study					
	Masaka	1			
	Kisesa	1.21	1.06	1.38	0.005
	Karonga	1.31	1.10	1.55	0.045
Child's age					
	0	1			
	1	0.44	0.38	0.51	< 0.001
	2	0.25	0.20	0.31	< 0.001
	3+	0.10	0.08	0.14	< 0.001
Sex					
	male	1			
	female	0.78	0.69	0.88	< 0.001
Mother's age					
	>=20	1			
	<20	1.30	1.10	1.54	0.002
M survival					
	alive	1			
	terminally ill or dead	3.94	2.79	5.57	< 0.001
M HIV status					
	negative	1			
	positive	2.89	2.33	3.59	< 0.001
	ambiguous	1.61	1.38	1.90	0.000
	never tested	1.26	1.06	1.49	0.008

Figures

Figure 1 HIV Status categories

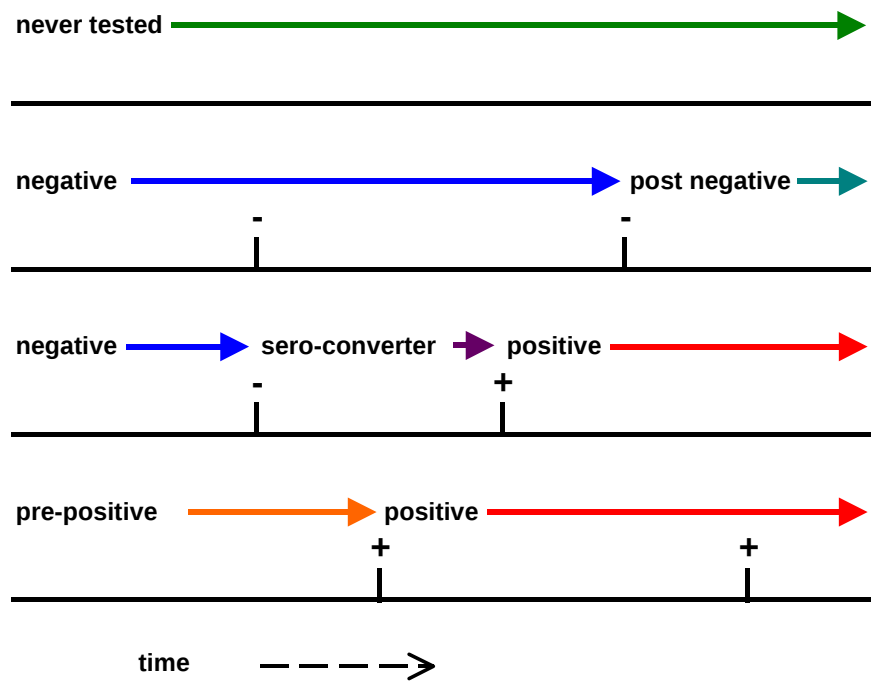


Figure 2 Age-specific mortality rates, by HIV status of mother at birth, unadjusted

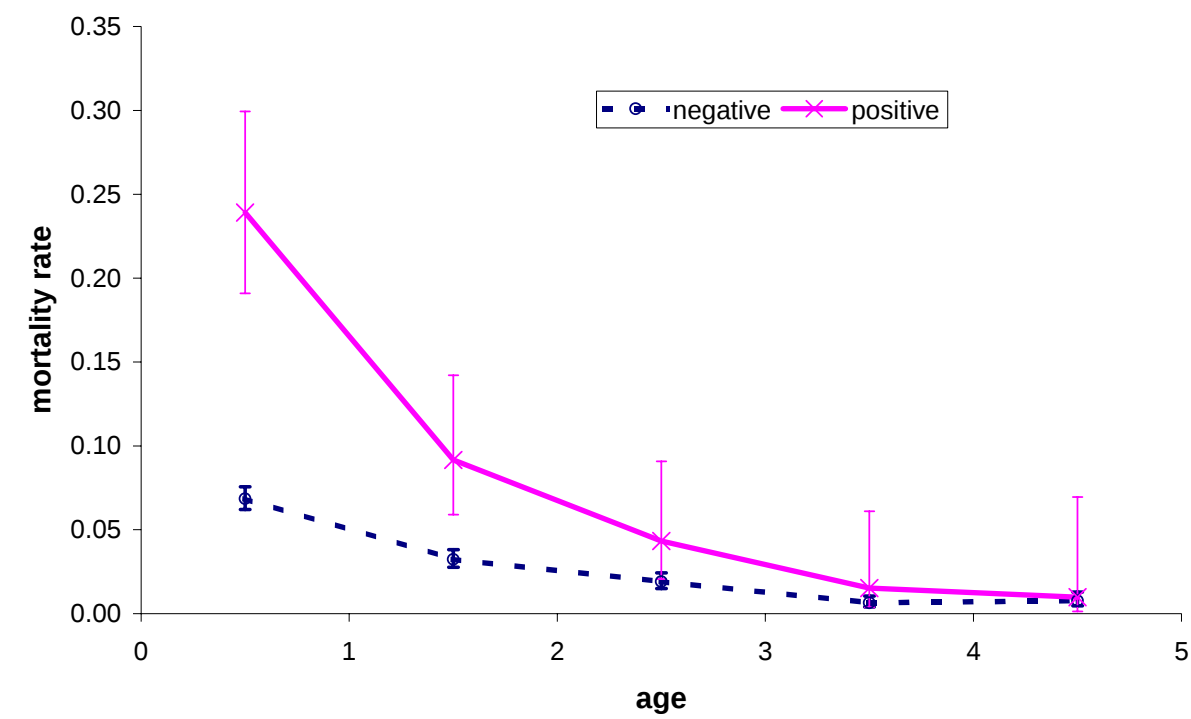


Figure 3 Age-specific mortality rates by mother's survival, pooled data, unadjusted

