

**The impact of mother's marital status on child mortality in sub-Saharan Africa:  
an analysis of birth and marital histories**

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## Summary

**Background** The negative effects of single motherhood and marital instability on child well-being have been studied extensively in developed countries, but this topic has received little attention in less developed countries.

**Methods** We analysed data from Demographic and Health Surveys conducted in five countries in sub-Saharan Africa, which contained retrospective birth and marital history calendars. Our sample consists of children born within the calendar period (n=11 321 in Ethiopia, n=6455 in Kenya, n=12 454 in Malawi, n=10 088 in Tanzania, and n=6129 in Zimbabwe). Using discrete time survival analysis and treating mother's marital status as a time-varying covariate, we estimated the effect of mother's marital status (ever unmarried vs. continuously married) on child mortality, adjusted for demographics and clustering. We also assess the effects of different types of ever unmarried mothers, including those who were never married, formerly married, and newly (re)married mothers.

**Findings** Children whose mothers were ever unmarried were between 41.3% and 77.5% more likely to die before reaching their fifth birthday compared to children whose mothers were always married. Adjusted odds ratios ranged from 1.42 (95% CI 1.09-1.86) in Kenya to 1.77 (1.29-2.42) in Ethiopia. Compared to children of married mothers, children of never married mothers experienced significantly higher mortality in Malawi (1.66; 1.19-2.33), Tanzania (1.45; 1.08-1.96), and Zimbabwe (2.22; 1.41-3.48) and children of formerly married mothers are significantly more likely to die in Ethiopia (1.61; 1.11-2.32), Kenya (1.72; 1.19-2.50), Malawi (1.67; 1.32-2.11), and Tanzania (1.52; 1.17-1.98).

**Interpretation** In sub-Saharan Africa, a region with the highest levels of child mortality, children of ever unmarried women face considerable disadvantage. These findings have important implications as several of these countries are currently not on track to reach the Millennium Development Goal (MDG4) of reducing child mortality by two-thirds by 2015.

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## Introduction

Sub-Saharan Africa bears the highest rates of child mortality, accounting for half of all child deaths worldwide.<sup>1</sup> Despite some progress since 1990, the region is far from meeting the Millennium Development Goal (MDG4) of reducing child mortality by two-thirds by 2015. Many of the resources devoted to reducing child mortality have focused on improving access to medical care (particularly vaccinations, antibiotics for acute respiratory infections, and oral rehydration for diarrhoea), safe water, and better nutrition. Yet previous research shows that social factors can play a pivotal role in determining which children can take advantage of these improvements. Unquestionably, the best-known example is the strong positive effect that mother's education has on child survival.<sup>2,3</sup> In fact, according to a recent study, about half of the decline in child mortality since 1979 can be attributed to women's increased education.<sup>4</sup>

In addition to mother's education, mother's marital status could have a strong effect on children's well-being, as it reflects the family environment, including the number of adults directly involved in the daily care of children and the household resources available to them. As a result of both high levels of non-marital childbearing and marital instability, many children, particularly in eastern and southern Africa, are raised in households which do not contain both biological parents. Premarital births are quite common. In one study of nine countries in eastern and southern Africa, premarital births ranged from 13% of first births in Malawi to 56% of first births in Namibia.<sup>5</sup> Rates of separation and divorce are also high in many of these countries. Roughly half of all first marriages end in divorce in Ethiopia, Togo, and Malawi.<sup>6-8</sup> Young women with children also face an elevated risk of widowhood in sub-Saharan Africa, particularly in those countries hit hardest by the AIDS epidemic.<sup>9</sup> Despite the large number of women who are unmarried or not married to the biological father of their children, the implications of women's marital status for children's health and well-being in sub-Saharan Africa has received little attention.

In contrast, numerous studies have examined the links between women's marital status and child well-being in developed countries, particularly in North America.<sup>10</sup> These studies consistently show that children of single mothers tend to fare worse with respect to their cognitive development,<sup>11</sup> behavioral adjustment,<sup>12</sup> and health outcomes.<sup>13,14</sup> Even if women remarry, the effects of having ever had a single mother may persist, as studies indicate that children raised in households with step-fathers typically fare worse than children living in households with their biological fathers.<sup>15</sup> Many of these studies in North America benefit from detailed retrospective or longitudinal data, while measures of family environments are generally available only at the time of the survey in most studies in sub-Saharan Africa. In addition, these studies generally do not rely on measures of women's marital status, but rather use indicators of female-headed households. These data limitations may partially or fully explain the surprisingly weak and inconsistent evidence that children living in female-headed households suffer from poorer health than children living in male-headed households.<sup>16-19</sup>

In this paper, we use detailed retrospective data from a monthly birth and marital history calendar collected in recent nationally representative surveys in Ethiopia, Kenya, Malawi,

Tanzania, and Zimbabwe. These data allow us to examine the effect of women's marital status on their children's survival as they move into and out of marriages. By relying on the time-varying measure of women's marital status rather than current measures of female-headed households, we overcome several important limitations of previous studies. In addition, we examine whether children with different types of single mothers, including those who were never married, those who were formerly married, and those who got married or remarried after the child's birth, suffer from higher child mortality than children raised in intact marriages.

## **Data and Methods:**

### ***Participants***

We obtained and analysed data from five recent Demographic and Health Surveys (DHS) conducted in Ethiopia (2005), Kenya (2003), Malawi (2004), Tanzania (2004-2005), and Zimbabwe (2005-2006). The DHSs are part of the MEASURE project based at ORC Macro International and are typically conducted in collaboration with the National Statistical Office, Ministry of Health, and prominent health NGO's in each country. DHSs are designed to generate a nationally representative population sample using a two-stage sampling design. In the first stage, urban and rural Enumeration Areas (EAs) were selected within each region using the most recent Population and Housing Census Sample. In the second stage, a systematic sample of households was drawn from each EA and all women age 15-49 in the selected households were eligible to be interviewed. In total, 14 070 women in Ethiopia, 8195 women in Kenya, 11 698 women in Malawi, 10 329 women in Tanzania, and 8907 in Zimbabwe were interviewed. Full details regarding the data collection, sampling, and interviewing procedures have been published previously.<sup>20-24</sup> Data collection procedures were reviewed by the ethical review boards of Macro International and collaborating agencies in the host countries.

A unique feature of these five DHSs is that they all contain monthly retrospective marital history calendars. These calendars begin in January five years before the start of the survey and record whether the respondent was married or living as married for each subsequent month until the time of the survey. We restrict our analyses to all children born during this calendar, in order to determine the marital status of mothers for each month of the child's life. Women in our sample had a total of 11 321 children in Ethiopia, 6455 in Kenya, 12 454 in Malawi, 10 088 in Tanzania, and 6129 in Zimbabwe during the five to six years covered by the calendar. The small percentage of children with inconsistent or missing dates of death were dropped from our final sample (n=11 210 in Ethiopia, 6409 in Kenya, 12 268 in Malawi, 10 040 in Tanzania, and 6129 in Zimbabwe).

### ***Procedures***

Women interviewed were asked to provide the date of birth for all their children and a date of death, if the child was no longer living. Using these dates, we constructed a person-month data file for each month that the child was alive. Drawing on the marital history calendar data, we created two time-varying covariates to capture women's marital status in each month of the

child's life. Our first measure equals "0" if women have been continuously married or living as married since the time of the child's birth (presumably to the child's biological father) and "1" if the woman was ever unmarried. This latter category includes women who are either currently unmarried or who were unmarried but later got married to men who are presumably not the child's biological father. However, since previous literature in sub-Saharan Africa suggests that if women marry within six months of a pre-marital birth, it is generally assumed that she has married the child's father,<sup>25</sup> we coded these mothers as continuously married. For our second measure of mother's marital status, we created a categorical time-varying covariate, where 1=continuously married, 2=never married, 3=formerly married, and 4=newly married or remarried. As with our first measure, women who marry within six months of the child's birth are classified as continually married rather than newly married.

The questionnaire also gathered data on key child and maternal characteristics, which are known to affect child mortality. Child characteristics include the child's sex, birth order, length of preceding birth interval (< 2 years, 2-3 years, >=3 years), and whether any previous siblings have died. Women were also asked whether their child resides with them or elsewhere. However, since this question was only asked if the child was alive at the time of the survey, it is not included in our regression analyses. Maternal characteristics include the mother's age at time of birth (measured as < 20, 20-30, and >=30), educational attainment (coded as no education, some primary school, some secondary school or higher), religion, and an index of household wealth. The index of wealth was calculated using a standard set of household consumer items and housing characteristics. Principal component analysis was used to assign women a score based on the ownership of these items and this score was divided into quintiles, ranging from 1=poorest to 5=wealthiest.<sup>26</sup> Lastly, we generated a dummy variable for each region and for urban residence.

### *Statistical analysis*

Analyses were conducted in Stata (version 11.0). For our survival analyses, we use discrete-time hazard models to estimate the adjusted odds ratios and 95% CIs.<sup>27</sup> Our base model (Model 1) was

$$\text{logit } h(t_{ij}) = \beta_1 \text{MarStat}_{ij} + \beta_2 \text{Urban}_{ij} + \sum \beta_k \text{Region}_{ij} + \sum \alpha_p \text{Age}_{ij}$$

in which t indicates whether child(i) died in month(j). Children who were alive at the time of the survey, but who had not reached their fifth birthday, were treated as censored. MarStat is a time-varying covariate indicating whether the mother was ever unmarried since the time of the child's birth. We lagged this variable by one month to ensure that marital transitions preceded child mortality events. Age of the child is grouped into five time periods (0-6 months, 7-12 months, 1-2-years, 2-3 years, and 3-5 years) to best fit the shape of the child mortality curve.  $\alpha$  represents the logit hazard (or the log odds) of child mortality in each of these time periods. Weights were not used as the analysis was conducted at the child-level rather than at the woman-level. Instead, dummies for each region and urban residence are included in all models to account for the two-stage study design. (For comparative purposes, key weighted results are presented in Appendix A). Model 2 included child characteristics and Model 3 added both child and maternal

characteristics. Survival curves are estimated from Model 3 based on marginal probabilities for continuously married and ever unmarried mothers averaging over the other covariates. In our final model, the marital status of ever unmarried mothers was further classified as 1) never married, 2) formerly married, and 3) newly married or remarried. To account for clustering of children within mothers, we used robust cluster sandwich estimator to calculate our standard errors. This specification allows for intragroup correlation within mothers with multiple children, but assumes independence across mothers. Inclusion of a variable indicating whether a previous sibling died further adjusts for unobserved mother-specific characteristics. We assessed the significance of individual predictors using a Wald statistic  $\chi^2$  and the goodness-of-fit with the -2 log likelihood ratio test. Tables present O.R., CIs and p-values of mother's marital status.

### ***Role of the funding source***

The sponsor had no role in the study design, data analysis, data interpretation, or writing of the report. The corresponding author had full access to all the data in the study and had final responsibility for the decision to submit for publication.

### **Results:**

The descriptive statistics presented in table 1 reflect the diversity in the level of economic development, population health, and women's status across these five countries. Child mortality was lowest in Zimbabwe (6.4%) and highest in Malawi (9.0%) (table 1). We also found considerable variation in the levels of pre-marital births and union disruption in early childhood. In the last month of observation, only 7.0% of children in Ethiopia had an ever unmarried mother compared to 17.0% of children in Kenya and 18.0% in Zimbabwe. Kenya also had the highest proportion of never married mothers (6.2%), reflecting the relatively high rates of premarital births in this country. In comparison, formerly married mothers, including those who were divorced or widowed, were most common in Zimbabwe (11.0%). Among those formerly married in the last month, the majority were divorced (69.4% in Ethiopia, 67.6% in Kenya, 78.7% in Malawi, 78.1% in Tanzania, and 63.0% in Zimbabwe). Rates of new marriages or remarriages during the short interval since the child's birth were relatively low, ranging from 0.8% in Ethiopia to 4.1% in Malawi. On average, children in our sample were observed for roughly 30 months (or 2.5 years). Only one-tenth of children in Malawi lived in urban areas compared to over a quarter of children in Kenya and Zimbabwe. Sex of the child, birth order and preceding birth interval also reflect standard fertility practices in each country. About half of all children were born to mothers aged 20 to 30, but over 15.0% of mothers in all countries were under the age of 20. Women's education varied considerably across countries. While only 4.1% of women in Zimbabwe had never been to school, this number rises to 77.1% in Ethiopia. Among children who were still alive at the time of the survey, over 90% lived with their mothers.

(insert Table 1 about here)

Table 2 provides adjusted estimates for the association between mother's marital status and child mortality. In Model 1, we find that having a mother who was ever unmarried significantly increases the odds of dying in all five countries. In our first model, having a mother who is not

married to the biological father increases the predicted probability of dying by 62.3% in Ethiopia, 23.3% in Kenya, 64.3% in Malawi, 46.9% in Tanzania, and 47.9% in Zimbabwe. After adjusting for child characteristics in Model 2, the effects of having an ever unmarried mother become stronger. Odds ratios range from 1.42 (95% CI 1.09-1.86) in Kenya to 1.77 (1.29-2.43) in Ethiopia. However, the addition of other maternal characteristics has little effect on this relationship. In our final model, we find that children in Ethiopia whose mothers have ever been unmarried are 75.5% more likely to die before the age of five compared to children with married mothers and fathers. The corresponding percentage increases are 41.3% in Kenya, 66.5% in Malawi, 48.4% in Tanzania, and 63.8% in Zimbabwe. Figure 1 depicts the adjusted survival curves for children with continuously married mothers and children with mothers who were ever unmarried mothers controlling for all covariates in Model 3. The odds ratios and CIs for the other covariates included in Model 3 are presented in Appendix B.

(insert Table 2 about here)

(insert Figure 1 about here)

Table 3 presents the results by type of ever unmarried mother. The effects of being never married, formerly married or newly married vary across countries. Among children with ever unmarried mothers, children whose mothers were not married at the time of birth experienced significantly higher mortality in Malawi (1.66; 1.19-2.33), Tanzania (1.45; 1.08-1.96), and Zimbabwe (2.22; 1.41-3.48). Children of formerly married mothers are significantly more likely to die in Ethiopia (1.61; 1.11-2.32), Kenya (1.72; 1.19-2.50), Malawi (1.67; 1.32-2.11), and Tanzania (1.52; 1.17-1.98). Having a mother who becomes newly married or remarried is also associated with an elevated risk of mortality. However, this effect is not significant in most countries, except Ethiopia, where the effect is particularly strong. Indeed, our model predicts that nearly half of Ethiopian children of newly married mothers will not survive until the age of five. This result, however, must be interpreted with caution as less than 0.5% of children have newly married mothers. Appendix C shows the full model with all covariates.

(insert Table 3 about here)

## Discussion

Consistent with studies conducted in North America, we find that children of unmarried mothers are disadvantaged relative to children whose parents are married. Although the benefits of growing up in a two-parent household in developed countries are well-known, in resource-poor settings, not having two parents present can lead to dire outcomes. Having an ever unmarried mother increased the probability that a child dies before the age of five between 41.3% and 75.5%. There is variation in the effects of mother's marital status both across countries and by type of unwed mother. In Ethiopia, where single motherhood is less common, the effects of being unmarried are most pronounced, while in Kenya, where a relatively high proportion of women give birth before marriage or experience a union rupture, the effects are less severe. These findings could indicate that in countries where single motherhood is less common, but potentially more stigmatized, unmarried women face considerable challenges in meeting the needs of their children.

Despite the strength of these findings and the use of rare marital history data, which allows us to model women's marital status over the child's lifespan, we can only speculate as to the mechanisms through which women's marital status affects their children's survival. First, from these data we cannot determine whether children who died lived with their mothers. Although these are young children (on average about 2.5 years old) and over 90% of living children lived with their mothers, it seems plausible that children of unmarried or newly married mothers would be at least slightly less likely to live with them.<sup>28</sup> Children who are cared for by grandparents, other relatives, or even non-relatives may receive fewer household resources. One study on orphans in Africa, for example, found that children who were not closely related to the household head were significantly less likely to be enrolled in school.<sup>29</sup>

Second, research in North America finds that single mothers are disproportionately represented among the poor.<sup>30</sup> Careful analyses which attempt to disentangle the effects of poverty from those of marital status *per se* find that about half of the detrimental effects on children can be attributed to the lower household income of single-parent families.<sup>10</sup> We find, however, that adjusting for household wealth has little effect on mitigating the relationship between mother's marital status and child mortality. Since single mothers in sub-Saharan Africa are more likely to live with relatives than single mothers in North America, they may experience less household-level poverty, even though their ability to direct household resources towards their children may be diminished. Third, unmarried mothers may be stretched between care of their children and securing an adequate income to support themselves and their children. As such, single mothers may be less able to provide supervision or lack the ability to seek medical care when a child falls sick. These children are also likely to be missing critical financial and emotional inputs from their fathers early in life.

As countries in sub-Saharan Africa struggle (and fail) to meet MDG4, the need to identify children with elevated risk of dying is pressing. Previous contributions by social scientists have shown that child mortality among mothers with at least 7 years of school was 58% lower than among mothers with no formal education.<sup>3</sup> The effects of mother's marital status are similarly striking, ranging from a 41.3% to a 75.5% increase in child mortality for unmarried mothers. Although additional research is required to understand why these children face a greater risk of dying, the global health community needs to recognize the greater vulnerability of this group, and to intensify and target their outreach efforts, in order to ensure that these children are not overlooked in programs designed to improve access to health care, safe water, and better nutrition.

## **Panel: Research in context**

### **Systematic analysis**

This paper provides information on the effects of mother's marital status on child mortality over the child's lifespan in sub-Saharan Africa. A systematic review found no previous published studies on the effects of women's marital status, although several previous studies have addressed the issue of child health and mortality in female-headed households.<sup>16-19</sup> These studies typically found weak and inconsistent effects of female-headship compared to male-headship on child outcomes.



**Interpretation**

This is the first study to use retrospective marital history data, rather than current female-headship measures, to examine how family structures affect child survival in sub-Saharan Africa. Unlike the previous literature using female-headed households, we find exceptionally strong and consistently negative effects in all five countries studied. Children whose mothers and fathers are not married are between 40% and 80% more likely to die compared to children whose parents are married. Children born outside of marriage face an increased risk of mortality in Malawi, Tanzania, and Zimbabwe, and children whose mothers got divorced or widowed suffered significantly higher mortality in Ethiopia, Kenya, Malawi, and Tanzania.

**Contributors**

SC conceptualized the study design, performed all data analyses, and wrote the manuscript. DH assisted with data preparation and construction of the marital and fertility histories.

**Conflicts of interests**

We declare that we have no conflicts of interest

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	Ethiopia		Kenya		Malawi		Tanzania		Zimbabwe	
<i>n</i>	11 210		6409		12 268		10 040		6073	
Child died before the age of 5	890	(7.9%)	518	(8.1%)	1106	(9.02%)	814	(8.11%)	388	(6.39%)
Ever unmarried <sup>a</sup>	780	(7.0%)	1088	(17.0%)	1906	(15.5%)	1599	(15.9%)	1090	(18.0%)
Marital Status <sup>a</sup>										
Continuously married <sup>b</sup>	10 430	(93.0%)	5319	(83.0%)	10 361	(84.5%)	8441	(84.1%)	4983	(82.1%)
Never married	62	(0.6%)	395	(6.2%)	227	(1.9%)	395	(3.9%)	262	(4.3%)
Formerly married	631	(5.6%)	488	(7.6%)	1181	(9.6%)	801	(8.0%)	667	(11.0%)
Newly (re)married	87	(0.8%)	205	(3.2%)	498	(4.1%)	403	(4.0%)	161	(2.7%)
Age of child (months) <sup>a</sup>	30.9	(30.6 to 31.3)	28.8	(28.3 to 29.3)	29.3	(28.9 to 29.6)	31.1	(30.7 to 31.4)	31.5	(31.0 to 32.0)
Resides in urban area	1570	(14.0%)	1658	(25.9%)	1298	(10.6%)	1738	(17.3%)	1549	(25.5%)
Male	5698	(50.8%)	3236	(50.5%)	6180	(50.4%)	5074	(50.5%)	3073	(50.6%)
Birth order										
First	2152	(19.2%)	1610	(25.1%)	2813	(22.9%)	2145	(21.4%)	1878	(30.9%)
Second	1853	(16.5%)	1252	(19.5%)	2513	(20.5%)	1956	(19.5%)	1516	(25.0%)
Third	1641	(14.6%)	1028	(16.0%)	1982	(16.2%)	1539	(15.3%)	999	(16.5%)
Fourth	1418	(12.7%)	729	(11.4%)	1532	(12.5%)	1173	(11.7%)	639	(10.5%)
Fifth or higher	4146	(37.0%)	1790	(27.9%)	3428	(27.9%)	3227	(32.1%)	1041	(17.1%)
Preceding birth interval										
Less than two years	2081	(18.6%)	1141	(17.8%)	1506	(12.3%)	1345	(13.4%)	453	(7.5%)
Two to three years	3081	(27.5%)	1703	(26.6%)	3314	(27.0%)	3142	(31.3%)	1152	(19.0%)
More than three years <sup>c</sup>	6048	(54.0%)	3565	(55.6%)	7448	(60.7%)	5553	(55.3%)	4468	(73.6%)
Previous sibling died	457	(4.1%)	204	(3.2%)	441	(3.6%)	354	(3.5%)	160	(2.6%)
Mother's age at birth										
Less than twenty	1777	(15.9%)	1120	(17.5%)	2601	(21.2%)	1650	(16.4%)	1248	(20.6%)
Twenty to thirty	5896	(52.6%)	3545	(55.3%)	6598	(53.8%)	5329	(53.1%)	3357	(55.3%)
More than thirty	3537	(31.6%)	1744	(27.2%)	3069	(25.0%)	3061	(30.5%)	1468	(24.2%)
Mother's education										
None	8639	(77.1%)	1306	(20.4%)	3265	(26.6%)	2819	(28.1%)	246	(4.1%)
Primary	1766	(15.8%)	3717	(58.0%)	7796	(63.6%)	6372	(63.5%)	2355	(38.8%)
Secondary or more	805	(7.2%)	1386	(21.6%)	1207	(9.8%)	849	(8.5%)	3472	(57.2%)
Wealth index (quintiles)										
Poorest	2849	(25.4%)	1599	(25.0%)	2344	(19.1%)	2168	(21.6%)	1543	(25.4%)
Poorer	2077	(18.5%)	1200	(18.7%)	2806	(22.9%)	2051	(20.4%)	1364	(22.5%)
Middle	2055	(18.3%)	1166	(18.2%)	2888	(23.5%)	2000	(19.9%)	1105	(18.2%)
Richer	1934	(17.3%)	1006	(15.7%)	2450	(20.0%)	2229	(22.2%)	1192	(19.6%)
Richest	2295	(20.5%)	1438	(22.4%)	1780	(14.5%)	1592	(15.9%)	869	(14.3%)
Child lives with mother <sup>d</sup>	10 121	(98.1%)	5599	(95.0%)	10764	(96.4%)	8685	(94.1%)	5276	(92.8%)

Data are number of children (%) or mean (95% CI).

a: In the last month of observation.

b: Includes women married at the time of the child's birth or within six months of that date.

c: Includes first-born children.

d: Among children who are alive at the time of the survey.

**Table 1. Child and maternal characteristics**

	<u>Model 1</u>			<u>Model 2</u>			<u>Model 3</u>		
	O.R.	Conf. Int.	P-value	O.R.	Conf. Int.	P-value	O.R.	Conf. Int.	P-value
Ethiopia (n=11 210)									
Continuously married (ref)	1.00			1.00			1.00		
Ever unmarried	1.63	(1.20-2.21)	0.002	1.77	(1.29-2.42)	0.000	1.77	(1.29-2.43)	0.000
Kenya (n=6409)									
Continuously married (ref)	1.00			1.00			1.00		
Ever unmarried	1.24	(0.95-1.60)	0.109	1.42	(1.09-1.86)	0.010	1.42	(1.09-1.86)	0.010
Malawi (n=12 268)									
Continuously married (ref)	1.00			1.00			1.00		
Ever unmarried	1.65	(1.37-1.98)	0.000	1.67	(1.38-2.01)	0.000	1.67	(1.38-2.03)	0.000
Tanzania (n=10 040)									
Continuously married (ref)	1.00			1.00			1.00		
Ever unmarried	1.47	(1.21-1.80)	0.000	1.51	(1.24-1.84)	0.000	1.49	(1.22-1.82)	0.000
Zimbabwe (n=6073)									
Continuously married (ref)	1.00			1.00			1.00		
Ever unmarried	1.48	(1.10-2.00)	0.010	1.62	(1.20-2.18)	0.001	1.65	(1.22-2.22)	0.001

Model 1: Adjusts for child's age, urban residence, and region.

Model 2: Adjusts for variables in Model 1 plus child's sex, birth order, previous birth interval, and previous sibling's death.

Model 3: Adjusts for variables in Model 2 plus mother's age at birth, education, wealth quintiles, and religion.

n equals the total number of months children were exposed to the risk of dying.

Note: All regressions are clustered by mother, n=number of children, pred. prob.=predicted probability of dying .

Significance: \*\*\* $p \leq 0.001$ , \*\* $p \leq 0.01$ , \* $p \leq 0.05$  - + $p \leq 0.10$

**Table 2. The effects of mother's marital status on child mortality (discrete time logistic regression).**

	O.R.	Conf. Int.	P-value
Ethiopia (n=11 210)			
Continuously married (ref)	1.00		
Never married	1.56	(0.74-3.26)	0.240
Formerly married	1.61	(1.11-2.32)	0.011
Newly (re)married	6.51	(2.79-15.18)	0.000
Kenya (n=6409)			
Continuously married (ref)	1.00		
Never married	1.19	(0.83-1.71)	0.353
Formerly married	1.72	(1.19-2.50)	0.004
Newly (re)married	1.70	(0.64-4.52)	0.288
Malawi (n=12 268)			
Continuously married (ref)	1.00		
Never married	1.66	(1.19-2.33)	0.003
Formerly married	1.67	(1.32-2.11)	0.000
Newly (re)married	1.77	(1.01-3.11)	0.046
Tanzania (n=10 040)			
Continuously married (ref)	1.00		
Never married	1.45	(1.08-1.96)	0.014
Formerly married	1.52	(1.17-1.98)	0.002
Newly (re)married	1.49	(0.70-3.15)	0.297
Zimbabwe (n=6073)			
Continuously married (ref)	1.00		
Never married	2.22	(1.41-3.48)	0.001
Formerly married	1.30	(0.87-1.93)	0.201
Newly (re)married	1.12	(0.15-8.36)	0.916

Note: All regressions are clustered by mother, n=number of children.

Significance: \*\*\* $p \leq 0.001$ , \*\* $p \leq 0.01$ , \* $p \leq 0.05$ , + $p \leq 0.10$

**Table 3. The effects of type of mother's marital status on child mortality (discrete time logistic regression).**

	Ethiopia			Kenya			Malawi			Tanzania			Zimbabwe		
	O.R.	Conf. Int.	P-value	O.R.	Conf. Int.	P-value	O.R.	Conf. Int.	P-value	O.R.	Conf. Int.	P-value	O.R.	Conf. Int.	P-value
<i>Number of children</i>		11 210			6409			12 268			10 040			6073	

Table 2, Model 3

Continuously married (ref)

Ever unmarried	1.98	(1.34-2.90)	0.001	1.52	(1.13-2.04)	0.005	1.74	(1.40-2.17)	0.000	1.54	(1.22-1.93)	0.000	1.84	(1.28-2.65)	0.001
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Table 3

Continuously married (ref)	1.00			1.00			1.00			1.00			1.00		
Never married	2.00	(0.74-5.38)	0.172	1.23	(0.83-1.82)	0.310	1.89	(1.27-2.81)	0.002	1.44	(1.04-2.00)	0.030	2.60	(1.45-4.67)	0.001
Formerly married	1.83	(1.18-2.84)	0.007	1.89	(1.25-2.87)	0.003	1.70	(1.32-2.20)	0.000	1.63	(1.20-2.20)	0.002	1.40	(0.91-2.17)	0.128
Newly (re)married	4.78	(1.74-13.17)	0.002	1.67	(0.57-4.90)	0.350	1.45	(0.79-2.64)	0.229	1.52	(0.62-3.73)	0.359	0.77	(0.10-5.80)	0.799

Note: All regressions are clustered by mother.

Significance: \*\*\*p<=0.001, \*\*p<=0.01, \*p<=0.05, +p<=0.10

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**Appendix A. The weighted results of table 2, model 3 and table 3: Effects of marital status on child mortality (discrete time logistic regression-weighted).**



	Ethiopia			Kenya			Malawi			Tanzania			Zimbabwe		
	O.R.	Conf. Int.	P-value	O.R.	Conf. Int.	P-value	O.R.	Conf. Int.	P-value	O.R.	Conf. Int.	P-value	O.R.	Conf. Int.	P-value
<i>Number of children</i>		11 210			6409			12 268			10 040			6073	
Ever single mother	1.77	(1.29-2.43)	0.000	1.42	(1.09-1.86)	0.010	1.67	(1.38-2.03)	0.000	1.49	(1.22- 1.82)	0.000	1.65	(1.22-2.22)	0.001
Male (ref=female)	1.24	(1.09-1.43)	0.002	1.23	(1.03-1.47)	0.025	1.3	(1.14-1.47)	0.000	1.12	(0.97- 1.29)	0.126	1.17	(0.95-1.43)	0.145
Birth order															
First	1.45	(1.07-1.98)	0.018	1.02	(0.66-1.58)	0.926	1.51	(1.12-2.03)	0.007	1.05	(0.76- 1.47)	0.75	0.61	(0.36-1.05)	0.075
Second	0.67	(0.52-0.88)	0.004	0.93	(0.66-1.32)	0.699	1.09	(0.85-1.39)	0.494	0.88	(0.68- 1.14)	0.339	0.63	(0.39-1.00)	0.050
Third	0.91	(0.72-1.15)	0.447	1.01	(0.73-1.40)	0.932	1.04	(0.82-1.31)	0.771	0.86	(0.65- 1.13)	0.273	0.73	(0.48-1.12)	0.147
Fourth	0.92	(0.73-1.17)	0.514	0.93	(1.65-1.32)	0.683	1.11	(0.89-1.40)	0.357	0.76	(0.58- 1.01)	0.056	0.74	(0.49-1.13)	0.166
Fifth or higher (ref)	1.00			1.00			1.00			1.00			1.00		
Preceding birth interval															
Less than two years	2.51	(2.06-3.05)	0.000	1.67	(1.29-2.17)	0.000	2.01	(1.66-2.44)	0.000	1.56	(1.24- 1.98)	0.000	2.23	(1.59-3.12)	0.000
Two to three years	1.31	(1.08-1.60)	0.007	0.87	(0.67-1.13)	0.300	1.12	(0.94-1.33)	0.205	1.05	(0.87- 1.27)	0.600	0.87	(0.64-1.18)	0.385
More than three years (ref)	1.00			1.00			1.00			1.00			1.00		
Mother's age at birth															
Less than twenty (ref)	1.00			1.00			1.00			1.00			1.00		
Twenty to thirty	0.67	(0.54-0.83)	0.000	0.95	(0.70-1.28)	0.739	0.81	(0.68-0.98)	0.032	0.83	(0.65- 1.06)	0.138	0.83	(0.60-1.16)	0.278
More than thirty	0.75	(0.56-1.00)	0.045	1.16	(0.76-1.76)	0.485	0.90	(0.68-1.20)	0.486	0.87	(0.61- 1.22)	0.405	0.63	(0.38-1.05)	0.076
Mother's education															
None	1.52	(0.77-1.82)	0.428	1.99	(1.32-2.99)	0.001	1.36	(1.00-1.87)	0.051	1.58	(1.11- 2.27)	0.012	0.93	(0.54-1.58)	0.777
Primary	1.35	(0.74-1.80)	0.522	1.49	(1.12-1.99)	0.006	1.27	(0.96-1.69)	0.094	1.42	(1.00- 2.00)	0.048	0.93	(0.72-1.19)	0.546
Secondary or more (ref)	1.00			1.00			1.00			1.00			1.00		
Urban (ref=rural)	1.12	(0.83-1.50)	0.460	0.90	(0.65-1.23)	0.491	0.75	(0.59-0.97)	0.030	1.07	(0.85- 1.35)	0.565	1.02	(0.61-1.70)	0.953
Wealth index (quintiles)															
Poorest (ref)	1.00			1.00			1.00			1.00			1.00		
Poorer	1.09	(0.88-1.35)	0.437	0.86	(0.66-1.13)	0.278	1.07	(0.89-1.28)	0.466	1.19	(0.96- 1.47)	0.120	1.07	(0.80-1.43)	0.653
Middle	1.24	(1.00-1.54)	0.048	0.98	(0.75-1.29)	0.897	1.06	(0.89-1.27)	0.524	1.12	(0.90- 1.39)	0.313	1.12	(0.81-1.54)	0.494
Richer	1.18	(0.94-1.48)	0.161	0.93	(0.67-1.30)	0.683	0.99	(0.81-1.21)	0.888	0.96	(0.75- 1.22)	0.727	1.04	(0.71-1.52)	0.841
Richest	0.73	(0.53-0.99)	0.040	1.13	(0.77-1.67)	0.531	0.82	(0.63-1.07)	0.151	0.90	(0.65- 1.24)	0.516	1.23	(0.72-2.09)	0.453
Child's age															
Less than six months (ref)	1.00			1.00			1.00			1.00			1.00		
Six months to one year	0.18	(0.15-0.23)	***	0.28	(0.22-0.36)	***	0.38	(0.32-0.44)	***	0.32	(0.26- 0.38)	***	0.22	(0.17-0.30)	***
One year to two years	0.10	(0.08-0.13)	***	0.12	(0.09-0.16)	***	0.15	(0.13-0.18)	***	0.20	(0.16- 0.24)	***	0.07	(0.05-0.10)	***
Two to three years	0.06	(0.05-0.08)	***	0.05	(0.03-0.08)	***	0.06	(0.04-0.08)	***	0.06	(0.04- 0.09)	***	0.04	(0.03-0.07)	***
Three to five years	0.02	(0.01-0.03)	***	0.01	(0.00-0.03)	***	0.02	(0.01-0.03)	***	0.01	(0.00- 0.02)	***	0.02	(0.01-0.04)	***

Note: All regressions are clustered by mother and control for religion and region.

Significance: \*\*\*p<=0.001, \*\*p<=0.01, \*p<=0.05, +p<=0.10

#### Appendix B. Full results from table 2, model 3: The effects of mother's marital status on child mortality (discrete time logistic regression).

	O.R.	Ethiopia Conf. Int.	P-value	O.R.	Kenya Conf. Int.	P-value	O.R.	Malawi Conf. Int.	P-value	O.R.	Tanzania Conf. Int.	P-value	O.R.	Zimbabwe Conf. Int.	P-value
<i>Number of children</i>		<i>11 210</i>			<i>6409</i>			<i>12 268</i>			<i>10 040</i>			<i>6073</i>	
<b>Marital history</b>															
Never unmarried (ref)	1.00			1.00			1.00			1.00			1.00		
Never married	1.56	(0.74-3.26)	0.240	1.19	(0.83-1.71)	0.353	1.66	(1.19-2.33)	0.003	1.45	(1.08-1.96)	0.014	2.22	(1.41-3.48)	0.001
Formerly married	1.61	(1.11-2.32)	0.011	1.72	(1.19-2.50)	0.004	1.67	(1.32-2.11)	0.000	1.52	(1.17-1.98)	0.002	1.30	(0.87-1.93)	0.201
Newly (re)married	6.51	(2.79-15.18)	0.000	1.70	(0.64-4.52)	0.288	1.77	(1.01-3.11)	0.046	1.49	(0.70-3.15)	0.297	1.12	(0.15-8.36)	0.916
Male (ref=female)	1.25	(1.09-1.43)	0.002	1.23	(1.03-1.48)	0.024	1.3	(1.14-1.47)	0.000	1.12	(0.97-1.29)	0.125	1.16	(0.95-1.43)	0.153
<b>Birth order</b>															
First	1.45	(1.06-1.98)	0.019	1.07	(0.69-1.66)	0.754	1.51	(1.12-2.03)	0.007	1.06	(0.76-1.48)	0.733	0.59	(0.34-1.01)	0.056
Second	0.67	(0.51-0.88)	0.004	0.94	(0.67-1.33)	0.743	1.09	(0.85-1.39)	0.496	0.88	(0.68-1.15)	0.342	0.63	(0.39-1.00)	0.050
Third	0.91	(0.72-1.15)	0.441	1.01	(0.74-1.40)	0.929	1.04	(0.82-1.31)	0.771	0.86	(0.65-1.13)	0.272	0.73	(0.48-1.12)	0.155
Fourth	0.92	(0.73-1.17)	0.508	0.93	(0.65-1.32)	0.677	1.11	(0.89-1.40)	0.356	0.76	(0.58-1.01)	0.056	0.75	(0.49-1.14)	0.174
Fifth or higher (ref)	1.00			1.00			1.00			1.00			1.00		
<b>Preceding birth interval</b>															
Less than two years	2.50	(2.05-3.03)	0.000	1.69	(1.30-2.19)	0.000	2.01	(1.66-2.44)	0.000	1.57	(1.24-1.98)	0.000	2.21	(1.58-3.10)	0.000
Two to three years	1.30	(1.07-1.60)	0.008	0.87	(0.67-1.14)	0.316	1.11	(0.94-1.33)	0.205	1.05	(0.87-1.27)	0.593	0.87	(0.64-1.19)	0.387
More than three years (ref)	1.00			1.00			1.00			1.00			1.00		
<b>Mother's age at birth</b>															
Less than twenty (ref)	1.00			1.00			1.00			1.00			1.00		
Twenty to thirty	0.67	(0.54-0.84)	0.000	0.94	(0.69-1.27)	0.676	0.81	(0.68-0.98)	0.032	0.83	(0.65-1.06)	0.135	0.84	(0.60-1.17)	0.292
More than thirty	0.75	(0.56-1.00)	0.051	1.14	(0.75-1.74)	0.527	0.90	(0.68-1.20)	0.488	0.86	(0.61-1.21)	0.397	0.65	(0.39-1.07)	0.090
<b>Mother's education</b>															
None	1.19	(0.77-1.84)	0.423	0.76	(0.57-1.03)	0.076	0.93	(0.81-1.07)	0.332	0.89	(0.76-1.06)	0.190	1.00	(0.60-1.65)	0.993
Primary	1.16	(0.74-1.81)	0.509	0.51	(0.34-0.77)	0.001	0.73	(0.54-1.00)	0.052	0.63	(0.44-0.91)	0.012	1.08	(0.63-1.84)	0.787
Secondary or more (ref)	1.00			1.00			1.00			1.00			1.00		
Urban (ref=rural)	1.13	(0.84-1.51)	0.431	0.89	(0.65-1.22)	0.467	0.75	(0.59-0.97)	0.030	1.07	(0.85-1.35)	0.563	1.01	(0.60-1.69)	0.975
<b>Wealth index (quintiles)</b>															
Poorest (ref)	1.00			1.00			1.00			1.00			1.00		
Poorer	1.08	(0.87-1.34)	0.467	0.86	(0.66-1.13)	0.290	1.07	(0.89-1.28)	0.469	1.19	(0.96-1.47)	0.121	1.07	(0.80-1.43)	0.657
Middle	1.24	(1.00-1.54)	0.051	0.98	(0.75-1.29)	0.909	1.06	(0.89-1.27)	0.527	1.12	(0.90-1.39)	0.311	1.11	(0.81-1.54)	0.512
Richer	1.17	(0.93-1.47)	0.169	0.93	(0.67-1.30)	0.675	0.99	(0.81-1.21)	0.887	0.96	(0.75-1.22)	0.732	1.04	(0.71-1.51)	0.840
Richest	0.72	(0.53-0.98)	0.038	1.13	(0.77-1.67)	0.531	0.82	(0.63-1.07)	0.153	0.90	(0.65-1.24)	0.521	1.22	(0.72-2.09)	0.463
<b>Child's age</b>															
Less than six months (ref)	1.00			1.00			1.00			1.00			1.00		
Six months to one year	0.18	(0.15-0.23)	***	0.28	(0.22-0.36)	***	0.38	(0.32-0.44)	***	0.32	(0.26-0.38)	***	0.23	(0.17-0.30)	***
One year to two years	0.1	(0.08-0.13)	***	0.12	(0.09-0.16)	***	0.15	(0.13-0.18)	***	0.201128	(0.16-0.24)	***	0.07	(0.05-0.10)	***
Two to three years	0.06	(0.04-0.08)	***	0.05	(0.03-0.08)	***	0.06	(0.04-0.08)	***	0.0643452	(0.04-0.09)	***	0.05	(0.03-0.08)	***
Three to five years	0.02	(0.01-0.03)	***	0.01	(0.00-0.03)	***	0.02	(0.01-0.03)	***	0.0061825	(0.00-0.02)	***	0.02	(0.01-0.04)	***

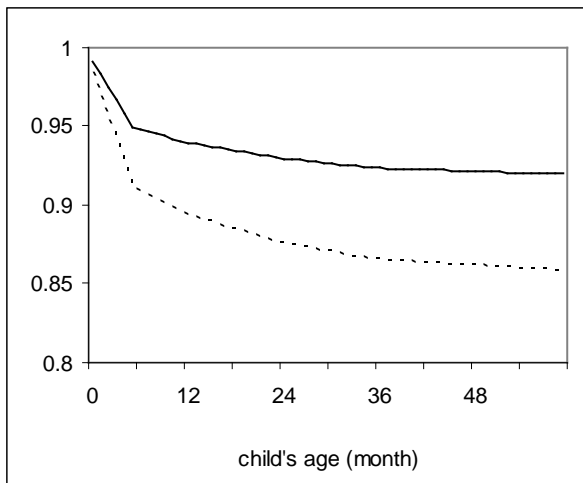
Note: All regressions are clustered by mother and control for religion and region.

Significance: \*\*\*p<=0.001, \*\*p<=0.01, \*p<=0.05, +p<=0.10

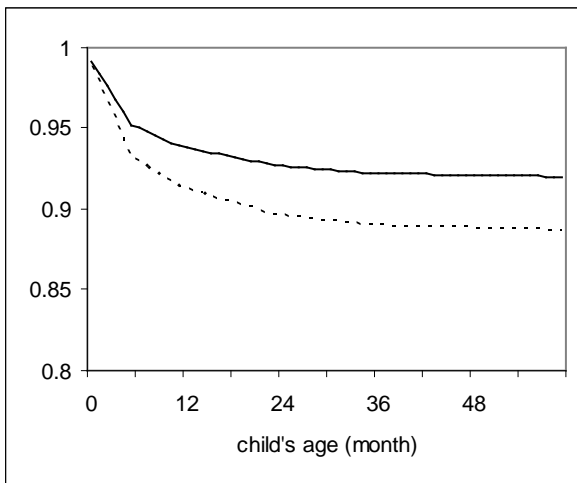
**Appendix C. Full results of table 3: The effects of type of mother's marital status on child mortality (discrete time logistic regression).**

**Figure 1: Adjusted child survival curves by mother's marital status.**

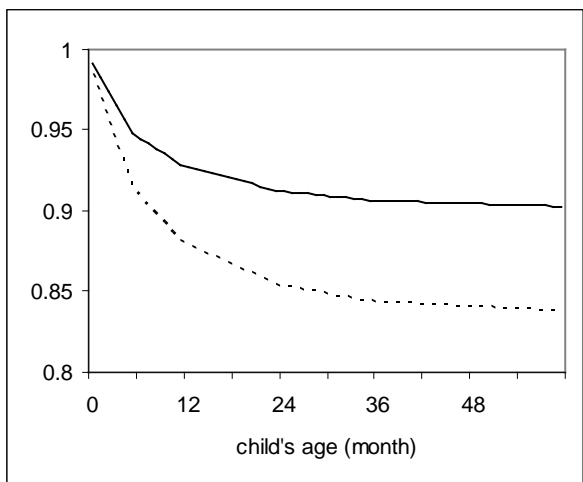
Ethiopia



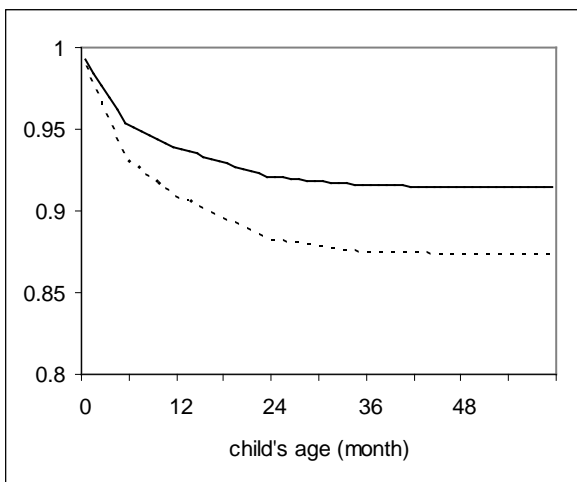
Kenya



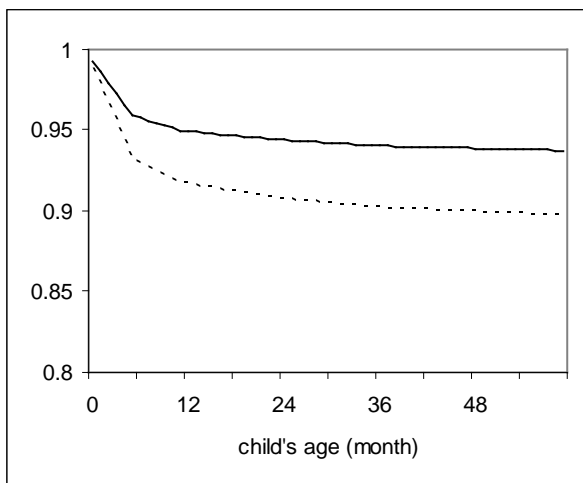
Malawi



Tanzania



Zimbabwe



Legend:

— continuously married mothers

- - - - - ever unmarried mothers