Original article

Determinants of mortality among one to four years old children in Ethiopia: A study based on the 2011 EDHS data

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Abstract

Background: According to the UN report for the 10 years before 2011, the mortality rate for under-five children has decreased by 35% worldwide. UNICEF reported that Ethiopia reduced under-five mortality by 40% over the 15 years before 2008. From the EDHS 2011 report child mortality rate in Ethiopia went down from 50 out of 1000 deaths in 2005 to 31 out of 1000 in 2011. Despite this encouraging development the country is expected to do more to bring down child mortality rate to a lower level.

Objectives: This study was done to estimate the survival of one to four years old children in Ethiopia and to identify determinants of mortality for this age group of children.

Methods: The study used the 2011 Ethiopian Demographic and Health Survey data. Survival analysis was employed to analyze the data on 12,710 children.

Results: The results showed that the predictors mother's education, mother's age, marital status, birth order(s) and place of residence had significant impact on child mortality. On the other hand sex of a child, family size, wealth index, water source and toilet facility were not found to be significant.

Conclusion: A lot of effort has to be made to intensify educating females so as to alleviate their level of empowerment. The concerned government and nongovernment bodies, the media and the wider community should discourage early marriage. Due to the fact that a much larger proportion of child mortality occurred in rural areas of the country, it is necessary to avail child and mothers maternal care services infrastructure outside the urban areas.
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Introduction

Child mortality is a factor that is strongly associated with the well-being of a population; it is taken as an indicator of health development and socioeconomic status. That is why reduction of infant and child mortality is a worldwide target and one of the most important key indicators of the Millennium Development Goals (MDGs). The minimum target of 67 deaths per 1000 live-births was set in the 1990 world summit as the fourth target of the MDGs.

Many countries have shown considerable progress in tackling child mortality. Almost one-third of the 49 least developed countries have managed to reduce under-five mortality rates by 40 percent or more during the past twenty years. The number of countries with under-five mortality rates of 100 deaths per 1,000 live-births or higher has been halved from 52 in 1990 to 26 in 2010. In addition, no country had an under-five mortality rate above 200 deaths per 1,000 live-births in 2010, compared with 13 countries in 1990. In sub-Saharan Africa, the region with the greatest burden of under-five deaths, the rate of decline doubled. But these rates are still insufficient to achieve Millennium Development Goal Number 4 (MDG 4) by 2015 (1).

Africa accounts for only 22% of births globally but half of the 10 million child deaths annually occur on the continent. Africa is the only continent that has seen rising numbers of deaths among children under-five since the 1970s (2). By contrast, many countries with unacceptably high rates of child mortality, most notably in sub-Saharan Africa, have made little or no progress in recent years. Sub-Saharan Africa has achieved only around a 30% reduction in under-five mortality, less than half that is required to reach MDG 4. The main reason for the limited progress in reducing child mortality at the global level, despite more than half the regions having already achieved reductions of more than 50%, is the large and growing share of under-five deaths that occur in sub-Saharan Africa and South Asia. All 36 countries with child mortality rates above 100 per 1000 births are in sub-Saharan Africa, with the exception of Afghanistan and Myanmar (3). Many of these children die of preventable and curable diseases. According to UNICEF (4), malaria is the cause of 18% of under-five deaths in Africa. Diarrheal diseases and pneumonia - both illnesses that thrive in poor communities where sanitation is severely compromised, and where residents are often undernourished and exposed to pollution - account for a further 40% of child deaths. Another major killer is AIDS.

Ethiopia has reduced child mortality by 40% over the 15 years between 1990 and 2006 (5). According to the 2011 EDHS report child mortality rate in Ethiopia was reduced from 50/1000 deaths in 2005 to 31/1000 deaths in 2011. The major causes of child mortality include preventable or treatable diseases such as measles, malaria, diarrhea, pneumonia and respiratory infections. It was observed

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that the decline of infant and child mortality had been achieved through the intervention of health-oriented programs. In addition to such programs, understanding determinants of child mortality is essential to inform policies and strategies to accelerate the reduction of child mortality. Child mortality is often associated with poverty, maternal education, maternal fertility characteristics, maternal under-nutrition, intervals between births, access to adequate safe water and basic curative health services (6). This study included maternal, socio-economic and household environmental predictors that had been considered and analyzed in similar studies as determinants of child mortality.

Methods

The source of the data used in this study was the Ethiopian Demographic and Health Survey conducted in 2011 (2011 EDHS) which was part of the worldwide demographic and health survey project. The survey was conducted by the Central Statistical Agency with the support of the Ministry of Health. This was the third Demographic and Health Survey (DHS) conducted in Ethiopia, under the worldwide MEASURE DHS project, a USAID-funded project providing support and technical assistance in the implementation of population and health surveys in countries worldwide.

The subjects of this study were children of age one to four years. The study used survival analysis to estimate mortality and identify socioeconomic, demographic and household environmental determinants of mortality among children of age one to four years in Ethiopia.

The survey interviewed a nationally representative population in about 18,500 households, and all women of age 15-49 and all men of age 15-59 in every household. Indicators relating to family planning, fertility levels and determinants, fertility preferences, infant, child, adult and maternal mortality, maternal and child health, nutrition, women empowerment, and knowledge of HIV/AIDS were obtained for the nine regional states and two city administrations (Addis Ababa and Dire-Dawa) of the country. The researchers of this study concentrated on the kind of data that were pertinent to the present undertaking. Information on child mortality was found from the birth history of women who were included in the survey. Since the interest of this study was about children from age one until age four, a data set consisting of 12,710 children was used. This age group was selected because the risk of death was expected to be higher in the group. The risk for children above age five was observed to be much lower relative to that for children of age one to four. The data were extracted as they appeared in the CSA document – not aggregated. At a later stage, categories of covariates were created according to the purpose of the study.

The statistical methods employed in this study were the descriptive, Kaplan-Meier with the associated log rank test and Cox-regression (proportional hazards regression). The response/outcome variable was the survival time of a child measured in months from year one until death before reaching age five. The predictor/explanatory variables used in the Cox model were classified into three groups: maternal, socioeconomic and household environment. Based on EDHS 2011 the classification of the variables related to mothers included maternal (bio-demographic), socio-economic and household environment factors. *Maternal (bio-demographic) factors* included birth order(s), mother's age at birth, sex of a child, and marital status. Age of mothers was divided into two categories namely, 15-19 years and 20 years and older. This had to be done because a further splitting of the latter age group into smaller age intervals would make the analysis meaningless due to the resulting skewed distribution of age. *Socio-economic factors* covered mother's education, place of residence, family size, and wealth index (the five categories in the survey document were collapsed into three: poorest + poorer as "poor", richest + richer as "rich" and "middle"). Two *Household environment factors* included in the study were source of drinking water and toilet facility. The Statistical Software SAS version 9.0 was used to analyze the data.

Results

Results of the Descriptive Analysis:

From the total of 12,710 children (of age one to four years) covered by the survey complete information about causes of illness was obtained for 8409. It was found that the mean survival age was 34.75 months with a standard deviation of 0.15 and a 95% confidence interval (34.47, 35.04).

A summary description (censored and dead by categories of variables/factors) of the distribution of characteristics for the 12,710 children is provided in Table 1. The survey results showed that a total of 2,476 deaths occurred. This is a high figure in absolute terms; percentagewise it forms almost 20% of the total population of 1-4 years children. Although the mortality among 1-4 years old children in Ethiopia has been declining in recent times, the survey brought to light a 20% death rate which is significant.

In addition to what Table 1 shows the categories of each of the covariates considered; the number of censored and death cases and the corresponding percentages are given row-wise. In addition to the descriptive statistics gives in Table 1, Kaplan-Meier survival curves are plotted for some important covariates (Fig 1 - 4).

Table 1: **Distribution of the maternal, socio-economic/household environmental characteristics of one to four years children from 2011 EDHS (**n=12,710**)**

Covariates	Category	Censored	Number of death (%)	Total
Place of residence	Urban	1,768	311 (15.0%)	2,079
	Rural	8,466	2,165 (20.%)	10,631
Mother education	No education	7,294	2,103 (22.4%)	9,397
	Primary +	2,940	373 (11.3%)	3,313
Birth order(s)	1	2,011	571 (22.1%)	2,582
	2-5	5,600	1,502 (21.1%)	7,102
	6+	2,623	403 (13.3%)	3,026
Family size	1-4	2,439	648 (21.0%)	3,087
	5-8	6,389	1,552 (19.5%)	7,941
	9+	1,406	276 (16.4%)	1,682
Wealth index	Poor	4,951	1,319 (21.0%)	6,270
	Middle	1,657	439 (20.9%)	2,096
	Rich	3,626	718 (16.5%)	4,344
Source of drinking water	Pipe	2,718	561 (17.1%)	3,279
	Protected	2,638	697 (20.9%)	3,335
	Unprotected	4,878	1,218 (20.0%)	6,096
Toilet facility	Available	4,631	1,035 (18.3%)	5,666
	No facility	5,603	1,441 (20.5%)	7,044
Mother's age at birth	15-19	6,387	1,821 (22.2%)	8,208
	20**+**	3,847	655 (14.5%)	4,502
Sex of a child	Female	5,031	1,179 (19.0%)	6,210
	Male	5,203	1,297 (20.0%)	6,500
Marital status	Married	8,885	1,993 (18.3%)	10,878
	Not married	1,349	483 (26.4%)	1,832

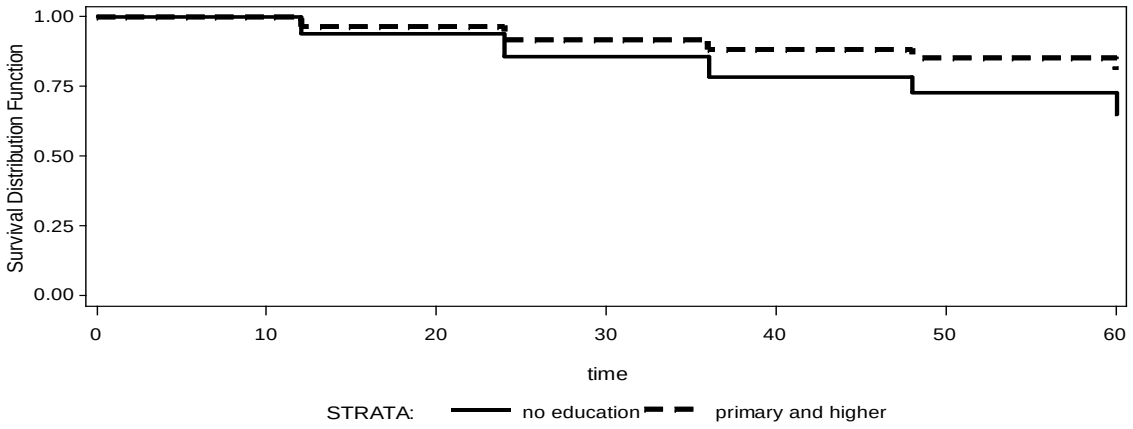

Figure 1: **Survival curve by mother's level of education**

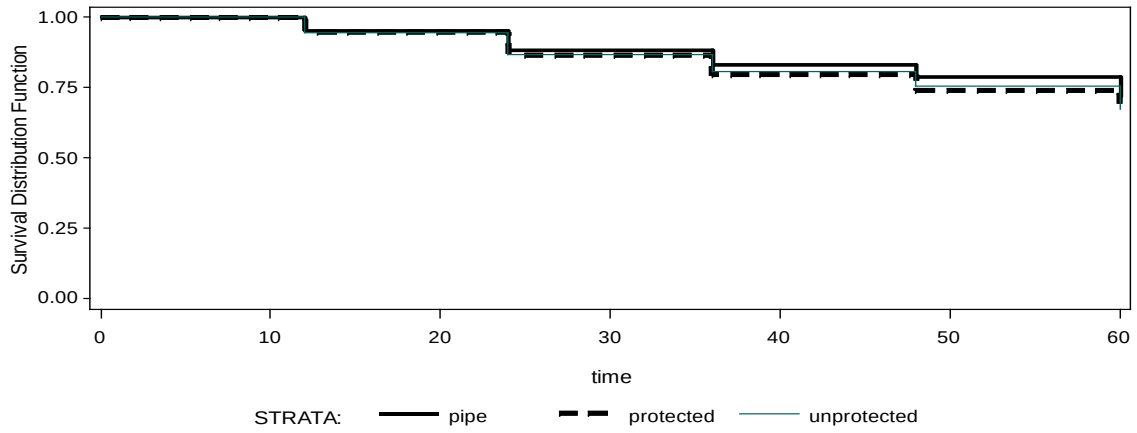

Figure 2: **Survival curve by type of source of water**

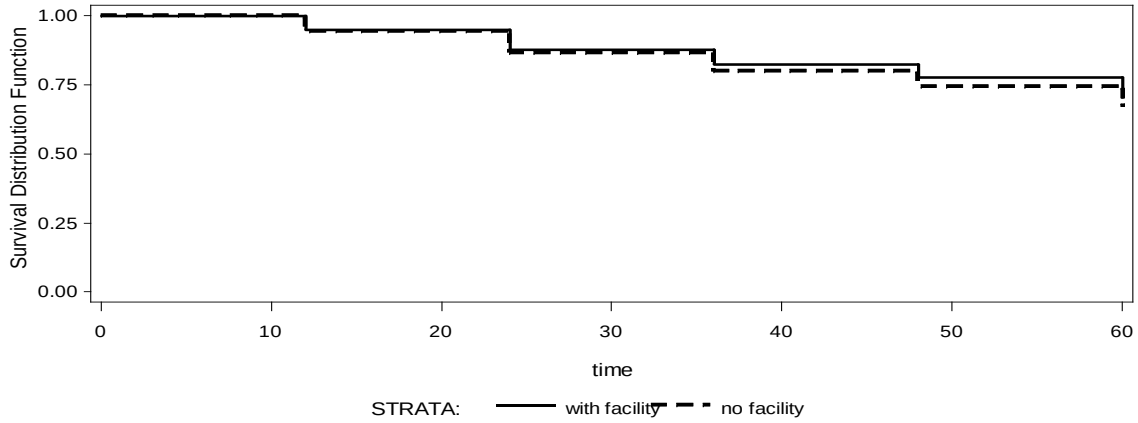

Figure 3: **Survival curve by type of toilet facility**

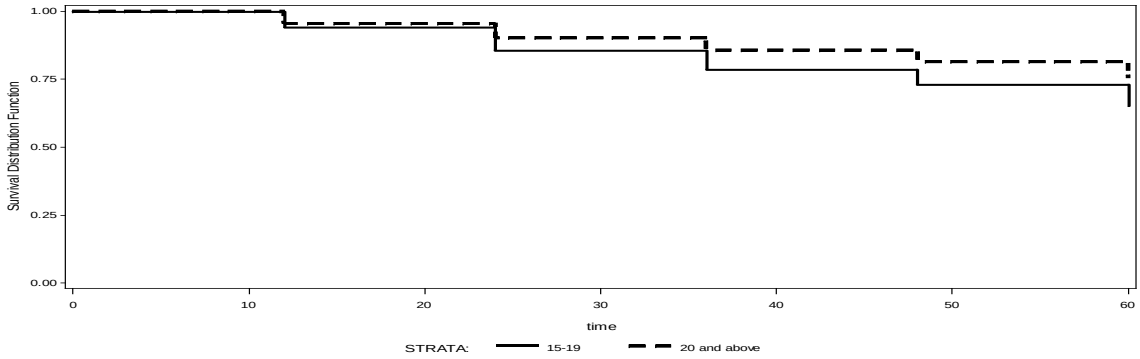

Figure 4: **Survival curve by mother's age at birth**

The results of the log rank test performed at 0.05 level suggested that there were significant differences between/among the survival of different groups of covariates with the exception of the sex of a child. This was an indication that there was no significant difference in survival between males and females. Hence, this variable had to be dropped.

Results of the Cox Regression Analysis:
The bivariate analysis (numerical results not given here) showed that the nine predictors (sex of a child already dropped) qualified as potential candidates for further consideration of inclusion in the multiple Cox regression model. In doing so, the conclusions and recommendations of the findings here are based on statistical significance of covariates.

Further analysis of the regression model resulted in a final model with five covariates namely, "mother's age", "marital status", "mother's education", "place of residence" and "birth order". Summary statistics for the final model are presented in Table 2.

Table 2: **Results of the Cox regression analysis of the data for one to four years children from 2011 EDHS (**n=12,710**)**

Predictor/explanatory variable	$\widehat{HR}$	Est. 95%CI for HR	
		lower	Upper
Mother's age – 15 to19 (ref.: 20 years and older)	1.573	1.437	1.721
Marital status - currently not married (ref.: currently married)	1.513	1.368	1.673
Mother's education – illiterate (ref.: primary and higher)	2.076	1.851	2.328
Place of residence - rural (ref.: urban)	1.168	1.031	1.322
Birth order (ref.: birth orders ≥ 6)			
Birth order 1	2.120	1.861	2.414
Birth orders 2-5	1.772	1.586	1.979

Interpretations of the findings of the study are provided in the remaining part of this section.

The estimated hazards ratio ($\widehat{HR}$) for age group 15 to 19 (inclusive) was 1.573 (95% CI: 1.437 - 1.721; p < .0001). This means that children born to mothers of age group 15 up to 19 had a 57.3% higher risk of dying than children born to mothers in the age group 20 and above (reference group) controlling for other covariates in the model.

The $\widehat{HR}$ for a child born to currently not married mothers was 1.513 (95% CI: 1.368 - 1.673; p < .0001) showing that children born to not married mothers had a 51.3% higher risk of dying than children born to currently married mothers (the reference group) controlling for other covariates in the model.

The $\widehat{HR}$ of a child born to a mother with no education was 2.076 (95% CI: 1.851 - 2.328; p < .0001) showing that the risk of dying for a child born to a mother with no education was 2.13 times higher compared to a child whose mother had primary and higher education (the reference group) controlling for other covariates in the model.

The $\widehat{HR}$ of a child born in a rural area was 1.168 (95% CI: 1.031 - 1.322; p < .0143) implying that the risk of dying for a child born in a rural area was 16.8% higher than a child born in an urban area (the reference group) controlling for other covariates in the model.

For a first born child and a child in the birth orders 2-5 $\widehat{HR}$ = 2.120(95% CI: 1.861 - 2.414; p < .0001) and $\widehat{HR}$ = 1.772(95% CI: 1.586 - 1.979; p < .0001), respectively. The interpretations are that: a first born child had a 2.12 times higher risk of dying than a child belonging to orders six and more (the reference category) controlling for other covariates in the model; for a child belonging to birth orders 2-5 the risk was 77.2% higher than a child in the reference group.

Discussion
The results of the regression analysis given above showed that place of residence, birth order, mother's age at the time of giving birth, mother's education and marital status were significantly associated with child mortality.

This section is devoted to bringing to light the findings of similar studies undertaken in Ethiopia, Africa and some countries in the developing world with the purpose to discuss the findings of the current study by way of comparison.

Using data from the 2000 and 2005 EDHS (7) showed that: children born to women not currently married, first born children, children born within 18 months of the previous birth and children who were breastfed for less than 6 months; children born in households of small size, born in male headed households, born to mothers and fathers with no education, and to some extent children born to mothers and fathers with primary education were exposed to a high risk of mortality.

Child mortality risk was found to be highly associated with birth intervals shorter than two years, short birth orders, place of residence (rural) and children born to illiterate mothers and fathers in Ethiopia based on the 2005 EDHS data (8).

Under-five mortality was high among children whose mothers' educational level was elementary school and below, unvaccinated children and when the next birth interval was shorter than 24 months. No significant difference in mortality was observed between males and females on the basis of the findings in Southwest Ethiopia (9).

Using the results from the 2000 Ethiopia DHS it was found that children born in rural areas face higher mortality risk compared with those born in urban areas (10).

The findings of the Kenyan 2003 DHS study showed that infant and child mortality were lower among those who were of birth orders 2-3, for birth interval more than two years, single births, among wealthier households, poor access to drinking water and sanitation facilities, and users of low polluting fuels as their main source of cooking. However, maternal age, maternal education and gender of the child had no significant association with child mortality (11).

While a mother's educational level and economic status had significant impact on infant and child mortality a higher rate of infant and child mortality prevailed in urban areas of Kenya (12). The present study contradicts the finding in (12) that relates to prevalence of high child mortality in urban areas.

The findings based on a 2005/06 Zimbabwean study pointed out that birth order, preceding birth intervals, maternal age, type of birth (single/multiple) and sanitation factors had pronounced effect on infant mortality but had a weak effect on child mortality (13).

A study of DHS data for 24 African countries found that infant and child mortality in urban areas were lower relative to rural areas; various factors related to urban-rural variation such as better education and better public health facilities in urban areas seemed to account for the difference (14). The present study came to the same conclusion.

Child mortality in Uganda had a strong relation with low parental education and mother's age at birth being 35 years and higher (16).

A significant number of deaths of children under-five years in India could have been averted by providing access to electricity, improving the education of women, providing sanitation facilities and reducing indoor air pollution (17).

The most significant predictors of neonatal, post-neonatal, and child mortality in Rajshahi district, Bangladesh, were immunization, breastfeeding, mother's age at birth and birth interval. Parents' education and availability of toilet facilities were significant predictors during neonatal and childhood period. The risk of child mortality decreased with increased female education and wider access to safe treatment places (18).

Birth interval, child immunization, family size, family income, and mother's education had significant influence on infant and under-five mortality in Malakal town, southern Sudan (19).

Analysis of DHS data for 12 countries in West Africa concluded that the survival of children depended on the mothers' age at birth, birth order and place of residence. Birth order was closely related to mothers age at birth; the first born were less likely to survive infancy than higher order births; multiple births were associated with a higher risk of death, especially during infancy; maternal education was observed to have a strong impact on child survival; the lower the level the higher the risk of mortality. Children residing in urban areas had a better chance of survival than those residing in rural areas (20).

A study in Malawi suggested that mothers' age at first birth had a significant effect on child mortality showing that children born to very young mothers experienced the highest risk of dying (21). A Tanzanian study pointed out that children born to mothers of age below 20 years had the highest risk of dying than children born to mothers of age 20 years and higher (22). Our finding in this regard concurs with the above.

A study based on three demographic and health surveys in Ghana (the 1993, 1998, and 2003 DHSs) found that child mortality was almost two times higher among children born to mothers not in union than to those children born to married mothers (23). The present study agrees with the above.

In Bangladesh it was found that children born to illiterate mothers had the highest risk of mortality (24). The illiteracy of mothers contributed to higher mortality in Kenya (25). The risk of early childhood mortality was more than twice among illiterate mothers compared with literate mothers (26).

In conclusion, the findings of this study agreed, to a great extent, with the findings of the studies discussed above. However, we noted that two studies on Kenya showed that maternal age and maternal education did not have significant association with child mortality (11), and that infant and child mortality was higher in urban areas (12). Our findings and those discussed above showed the opposite when it came to the relationship between child mortality rate, on the one hand, and maternal age at birth, mother's level of education and place of residence (urban versus rural) on the other.

Conclusion and Recommendations:

The survey results showed that a total of 2,476 deaths occurred among 1-4 years old children from a total of 12,710 of the same age group; this is a 20% mortality rate. The mean survival age of children in the above age category was about 35 months.

It was found that mothers' age, marital status, birth order, mother's level of education and place of residence were found to be significantly associated with child mortality.

Ethiopia is trying to achieve the Millennium Development Goals by 2015. One of the goals is reducing child mortality. The government has implemented health-oriented interventions as a means to achieve this goal. In order to reduce the rate of child mortality this study recommends the following: educate females and persistently strive towards improving the level of education of women; create awareness about the disadvantages of early marriage and giving birth at early ages; and expand child and maternal health care infrastructure in rural areas of the country.

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