

Identifying factors determining the survival time of under-five year children in rural parts of Ethiopia

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Abstract

In Ethiopia, the remarkable progress in child survival was made. However, Ethiopia is ranked as fifth burden countries of under-five deaths, particularly in rural areas. Therefore, this study was aimed to identify determinants that causes under-five death in the rural parts of Ethiopia.

Only 7301 women from rural residence who had under-five children were involved in this study. Descriptive, None-parametric and Cox proportional hazard regression analysis were used to examine the determinants associated with the under-five mortality. This study revealed that 6.5% of children were died before reaching their fifth birthday in the rural parts of Ethiopia. Sex, place of delivery, family size, Mother education, number of under-five children, contraceptive use and source of drinking water had significant effect on the survival time of under-five children.

Conclusion: A significant risk factors associated with under-five mortality in rural areas were identified in this study. Children delivered at home, children from uneducated mothers, children from not using contraceptive method mothers, drink water from not piped source had higher risk of death. Giving awareness about benefits of delivering in health facility and uses of contraceptive method, improving mother education and infrastructure like sources of water, decreases mortality of under-five children.

Background

The first five years of life has paramount importance to the physical and intellectual development of children. Under-five child death is the likelihood of dying between the period of delivery and the fifth birthday of children articulated per 1,000 live births, and it is a good indicator of the level of child health and the overall development of countries [1].

The global under-five death rate was reduced from 93 deaths per 1,000 live births in 1990 to 41 in 2016 with the highest burden report from countries in Sub-Saharan and Southern Asia regions [2]. In 2016, the Sustainable Development Goals-2016 (SDGs) had designed strategies and interventions that can significantly contribute reducing under-five mortality rate below 25 per 1,000 live births or less by 2030 [3], and a number of nations have reported reducing the under-five mortality [4]. However, developing countries of Sub-Saharan Africa still have really high under-five death rate due to several factors. Out of an estimated 5.3 million under-five deaths in 2018, almost half (52%) of these deaths were reported from Sub-Saharan Africa [2], which is a home to five of the six countries with an average under-five mortality of 78 per 1000 live births in 2018 [5, 6, 7].

More recently, studies done in Nigeria, Sub-Saharan Africa, Bangladesh, South Sudan and Ethiopia demonstrated residence area [8, 9], family size [10, 11], source of water[11, 12] and toilet facility as determinant (major) factors of under-five mortality with variability and inconsistencies across areas [13, 11].

Ethiopia ranked as fifth of heavy under-five deaths burdened countries of Sub-Saharan and Southern Asia regions [2]. But the country showed a major improvement with a gradual decline from 244.8 of 1970 to 50.7 deaths per thousand live births in 2019. This achievement was actually brought through improvements in overall socioeconomic conditions of the country and wider area coverage of health facilities with well interventions in prevention and/or treatments of the major causes of child mortality [14].

Socioeconomic and socio-demographic factors, and maternal, and child-related risk factors were reported on under-five deaths of child with the worst situation in rural areas of Ethiopia. Several studies conducted across the country implied the significant effect of areas of residence on the under-five death with higher prevalence in the rural areas than the urban ones [15], [16]. Another study which was done using EDHS 2011, also revealed 18.3% and 14% deaths of under-five children in rural and urban residences, respectively [16]. Moreover, the World Health Organization (WHO) 2020 report from one-third of 47 low and middle-income countries presented that the death of under-five was higher in rural residents than in urban by 20 deaths per 1000 live births [5].

An earlier study that used Ethiopia Demographic and Health Survey (EDHS) estimate of 2000, 2005 and 2011 revealed higher child mortalities in the rural parts of the country, where above 80% of the total population live. According to this report, having high number of children in the family rise the risk of maternal and children mortality [10], implying that children from mothers who didn't receive healthcare during pregnancy and post-delivery care had a greater risk of under-five mortality than those of mothers who have received the treatment.

Moreover, another study conducted in Ethiopia, Sub-Saharan Africa and Nigeria also revealed that gender of family head, gender of children, household economic status and mother education status had significantly related with the mortality of under-five children [17, 18, 8, 15]. Children being born from educated women were related with reduced risk of under-five mortality than children being born from uneducated women [15]. Decreasing these disproportions through the countries and saving more children lives remain a significant concern through interventions mechanisms that promote child survival [5]. Therefore, there are differences in risk factors determining the survival time of under-five children in the rural parts of Ethiopia. Understanding the determinant factors of under-five mortality and survival has significant importance (particularly important) to inform the public health officials and policy designers design strategies to accelerate the reduction of under-five mortality. And, this study was aimed to identify the factors that determine the survival time of under-five children in the rural parts of Ethiopia.

Methods

Study Settings

According to 2018 estimate, the total population of Ethiopia was above 108 million, making it the 12th rapid population growth country in the world and the second most populous country in Africa, following

Nigeria. More than 80% of the total population lives in rural areas, and the country's economy is predominantly agriculture based. Ethiopia's rapid population growth is putting the country in an increasing pressure on the land resources, an increase of land degradation and deforestation, and an increase in scarcity of basic necessities such as food.

The data for this study was extracted from 2016 Ethiopian Demographic and Health Survey, which was a population-based cross-sectional study collected between January 18, 2016 and June 27, 2016 through the country. This dataset is accessible online using the link received from DHS database https://www.dhsprogram.com/data/dataset_admin/login_main.cfm.

According to EDHS of 2016, the samples were selected in two phases. In the first phase, 645 clusters (202 from urban and 443 from rural) were randomly selected proportional to the household extent from the sampling strata and secondly, 28 households per cluster were selected using systematic random sampling, and only rural clusters were incorporated in this study.

According to EDHS report data were collected using different questionnaires and the data of the child mortality and associated factors were obtained from a woman's questionnaire of women who met the eligibility criteria (women aged 15–49 years). From samples of 18,008 households proposed, 16,650 households were interviewed for individual interview and 16,583 qualified women were identified from the interviewed household. About 15,683 women aged 15–49 interviews were completed [19]. Out of 10,641 women were included due to having children preceding five years survey to compute the under-five mortality. Accordingly, 7,301 children born in rural areas between 2011 and 2015 in the 5 years prior to the assessment were considered in this investigation.

Study Variables

Time to death of under-five children which was measured in months (0–59 month) between the prior five years of the study was the response variable of the study. The under-five child mortality was used as event and coded as 1 if the child was died and 0 if the child was survived during the survey. Predictor variables are place of delivery, sex of children, birth weight of children, gender and age of head of the family, family size, mother's age at first birth, marriage to first birth, current marital status, father's and mother's education, residence, religion, number of under-five children, wealth index, ANC visit, contraceptive method use, toilet availability and source of drinking water were considered as predictor variables of this study.

Statistical Methods

All obtained data was cleaned, coded and examined by SPSS_20 and R- version 3.6.2 statistical software packages. Descriptive analysis, none parametric estimation and Cox PH model were employed to examine the risk factors of under-five mortality. The Cox proportional hazard regression model is one of

the common model, which is a broadly applicable, and the most widely used method of survival analysis [20]. Predictor variables those found significant in the univariable analysis were involved in the multivariable Cox PH regression analysis, and estimated hazard ratios with p-value less than 5% were used to indicate statistical significance of the variable in multivariable analysis. Moreover, the log-rank test was also used to identify the association of survival times among the different groups of explanatory variable.

Results

Prevalence of under-five children death associated with child related factors in rural Ethiopia

From 7301 under-five children eligible for this investigation, 6.5% were passed away before reaching their fifth birthday. Out of a total participants, almost half (51.4%) of them were male and 59.7% were died preceding the five-years of survey. More than three-fourths (77.2%) of the children were delivered at home while the rest (22.8%) were delivered at health centers and other places. About 41% of the under-five children had been delivered with an average size, and the death proportions among those having larger than average size, average size and smaller than average size were 25.2%, 40.3% and 34.5%, respectively. However, the death proportion of children who were born at home was found exceedingly larger, 83% (Table 1).

Prevalence of under-five children death associated with parental related factors in rural Ethiopia

Approximately, 72% of mothers' of the study children were uneducated and 65.4% were in the age group of less than 20 years at their first birth. The children's death proportion from uneducated and less than 20 years aged mothers were 76% and 63.4%, respectively. Above 83%, study children's mother were enrolled in ANC during their pregnancy less than 4 times, however, child mortality rate among these mothers were 83%. Moreover, 55.8% of the participants were from mothers that had not used contraceptive methods and the death proportion was reported to be 60.5%. Most of the heads of household were males (84%) and three-fourth of them were aged 30 years and above. About 53.1% and 17.9% children from uneducated father, and secondary and above educated father were died before their 5th year's birthday.

Prevalence of under-five children death associated with household related factors in rural Ethiopia

Study participating children were drawn from all regional states of Ethiopia, however, children from Oromia (17.5%), Somali (14.2%), South Nation Nationality and People Region (SNNPR) (13.9%), Afar (11.5%) and Amhara (10.5%) covered the largest proportion. Of these, the recorded death proportions of Afar, Somali, Oromia, SNNPR and Benishangul Gumuz, were 15.3%, 15.3%, 14.5%, 12.2% and 10.5%, respectively. Majority of the mothers had 1–2 other under-five children preceding the five years survey while 3% had no any other child. Out the 7301 participants, 65% of the children were from poorer families and the recorded death proportion was 70% within this wealth index category. Of all participants, 59.6% of the children were from families having four and above family size while the remaining (40.4%) were from families having less than four family-size. The death proportion among those having > 4 family were surprisingly large, 62.8% (Table 1).

None-parametric test for association of participants' information and survival time

The Log rank test results showed that sex of children, family size, region of residence, religion, educational background of child's father and mother, number of under-five child, wealth index and contraceptive method use were statistically significant (Table 2). This result implied that the survival time of under-five children under the different categories of covariates had different survival time and all listed covariates checked by Kaplan-Meier curves.

Determining factors associated with under-five children death in the rural

To attain the final multivariable Cox PH model the assumption of PH and the univariable analysis was conducted, and variables that were significant in the univariable analysis were involved in the final Cox PH model. Sex of children, place of delivery, family size, mother education, number of under-five child in the family, use of contraceptive, and source of drinking water had statistically significant effect on the survival time of under-five children in rural parts of the country. Sex of children shown that the under-five death was meaningfully fewer for females compared to the male counterparts (HR = 0.728, 95%CI = 0.606, 0.875), and this indicates that female gender had a reduced risk of death by 27.2% compared to male gender of the child (Table 3).

Moreover, children who were delivered in the health facility had a reduced under-five mortality rate than children delivered at the home holding other variables constant (HR = 0.738, 95% CI = 0.572, 0.951). This implies that there is a significant association of child survival time and place of delivery. Children who were delivered at home had 26.2% more risk of mortality than children who were born in the health center. Additionally, family size is found to have a significant effect on under-five children's mortality. An estimated hazard ratio of children whose family had three and above family size (HR = 1.256, 95% CI = 1.040, 1.517) implies that children from families having three and above family size is 1.256 times more likely to experience death than their counterpart (1–3 children). Children from a mother with secondary school and above educational background had a reduced risk of death compared to children from uneducated mothers (HR = 0.464, 95% CI = 0.301, 0.714). This result disclosed that children who were born from mothers with secondary school and above educational experience had 53.6% higher survival time compared to children from uneducated mothers (Table 3).

The risk of death among under-five children having three and above under-five brothers and sisters in the household was 1.733 times higher than their counterpart (HR = 1.733, 95% CI = 1.120, 2.682), and these children had 73.3% higher risk of death compared to those having no any other under-five children.

An estimated hazard ratio for children from mothers who practiced using contraceptive methods at a different time is (HR = 0.797, 95% CI = 0.662, 0.960), and this showed that mothers who experienced using contraceptive methods had a decreased influence of under-five mortality compared to women having not experienced any methods of contraception. The children from households not having piped water sources for drinking had an increased risk of death compared to children from families of having piped water (HR = 1.303, 95% CI = 1.044, 1.627), and it is indicated that children's from households having no

piped drinking water sources were 1.303 times more likely to die than children from households of having piped water in rural parts of the country (Table 3).

Discussion

There is still a high proportion of under-five child death globally with the highest burden in the rural areas of developing countries including Ethiopia. This study was intended to examine the risk factors associated with the mortality of under-5 children in rural parts of Ethiopia using the survival analysis method. Out of 7301 under-five children involved in this study, 6.5% were died before reaching their fifth birthday, and this study is in line with a study done in Northern Ghana that is (6.14%) [21]. However, it is found very low compared to previous study done in Ethiopia using EDHS data of 2011 (18.3%) [16]. And, it could imply the decreasing ratio of child death in the preceding five years survey time of the country.

Out of the total died children, 59.7% were male and it is higher compared to reports of previously study in Ethiopia, 50.27% [16] but is in line with study done in the in rural areas of Northern Ghana 53.3% [21]. The higher finding of this study could be due to the variation of the study sites (rural versus urban).

As a whole, still this study implied higher mortality rate of children in rural parts of the country. Of all study children, 77.2% were given birth at home and among these the death proportion were very high (83%) indicating the impact of giving birth at home, and this is consistent with other studies in Ethiopia[15] and Southern Ghana [21]. This can be considered as a good indicator for most of the mothers not attending the antenatal care visit properly and this could be due to the absence of health facilities that provides ANC in their localities.

To analyze the risk factors of under-five death non-parametric and semi-parametric regressions were applied. Gender of child, place of delivery, family size, mother's educational status, number of under-five child, use of contraceptive methods, and sources of drinking water were among identified factors of under-five child death in the country. In this regard, female child had a reduced hazard of death than male, and it is in line with several studies conducted in Sub-Saharan region using a multi-country analysis of under-five mortality [9], Ethiopia [22, 23] and Ghana [24] and with estimates established by the UN Inter-agency Group for child mortality estimation [1].

Moreover, delivery place was meaningfully correlated with under-five deaths and death rate of children delivered in the health facility had less risk of death than child delivered at home. This outcome is reliable with the previously reports from Ethiopia [15], Sub-Saharan region [9], Tigray regional state (qualitative study) of Ethiopia [25], and rural parts of Southern Tanzania [26]. This might be because of unavailability of enough health facilities in the nearby sites or their distant situation that might result in transportation problem.

The household size was found to be a significant determinant of under-five death; accordingly, it is predictable that following the increase in number of household members there will be an increased under-five death rate as well. The hazard of death for children from household size of 4 and above is 25.6%

higher compared to children from a household of 1–3. This finding is supported by prior studies conducted Ethiopia [16] and [27]. Many researchers suggested the significant association of mothers' educational level with under-five child mortality. This study also revealed that children from mothers having secondary school and above educational background had less risk of death than those from uneducated ones. This is in agreement with previously studies conducted in Gilgel-Gibe Field Research Center of Southwest Ethiopia [28] and the whole Ethiopia [16, 23, 29], Ghana [21, 30, 24], and countries of Sub-Saharan Africa [31].

A fewer number of under-five child in the family had a proportionally reduced death rate. This finding implied that children from mothers of having three and above under-five children in the household were 73.3% times more exposed to death in comparison with other under-five children with lesser number of sisters and/or brothers. This is in agreement with two studies conducted in Sub-Saharan region [31], and Ghana [32]. Mothers who were reported to use different contraceptives had significantly reduced risk of their child's mortality when compared to mothers who did not use any types of contraceptive methods to plan their family size. This is also in line with studies conducted in Ethiopia [15] and Ghana [24]. Drinking water had found to be significantly associated with the death of under-five children. As shown in this study, children from family's who did not use piped water for drinking had a higher risk of death than children from families that did use piped water. This is also reported in previous studies investigated in Ethiopia [16] and Ghana [24]. Nevertheless, it is very contradicting with other prior study conducted in Ethiopia [15]. This may be due to the variation of samples that this study targeted both urban and rural residing under-five children.

Conclusion

This finding identified the factors that related with under-five children mortality in the rural parts of Ethiopia using the Ethiopian Demographic Health Survey 2016. Applying Cox PH model variables such as female gender, child's birth in health facilities, having a mother with secondary school and above educational background, presence of 1–2 under-five children in the household, and having mothers who practiced contraceptive method had reduced risk of under-five death. While, children from 4 and above family size, 3 and above number of under-five children, and birth from a family that did not use piped water sources for drinking had higher hazard of under-five death in rural parts of the country. To overcome the death rate of children all mothers should be aware of the factors that determine the survival times of children, all concerned bodies have to give due emphasis to the rural children since still, the mortality rate of children and mothers were high in the rural parts of different countries including Ethiopia.

Abbreviations

ANC
Antenatal Care
EDHS

Ethiopian Demographic and Health Survey

PH

Proportional Hazard

SDGs

Sustainable Development Goals

SNNPR

South Nation Nationality People Region

WHO

World Health Organization

Declarations

Funding

N/A

Competing interest

The authors declare that there is no competing interests.

Availability of data and materials

Data is available in https://www.dhsprogram.com/data/dataset_admin/login_main.cfm DHS database and the extracted datasets is available from the corresponding author on reasonable request.

Code availability

N/A

Authors' contributions

Lema Abate conceived research idea, designed methodology, conducted analysis, and drafted the manuscript. Samuel Getachew reviewed and edited the manuscript. Both authors contributed to interpretation and discussion of the study findings, and agreed with the findings presented in the paper. Both authors have read and approved the final manuscript.

Ethics approval

Ethical clearance for this study was obtained from Ethiopian Health and Nutrition Research Institute (EHNRI) Review Board, the National Research Ethics Review Committee (NRERC) at the Ministry of Science and Technology, the Institutional Review Board of ICF International, and the communicable disease control (CDC). The author requested access to the data from demographic health survey program team and access was granted to use the data for this study.

Consent to participate

N/A (The secondary data was taken from the DHS data base)

Consent for publication

N/A

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Tables

Table 1: Descriptive summaries of under-five children mortality and associated risk factors in rural parts of Ethiopia in EDHS, 2016

Status of children				
Variable	Categories	Number of death (%)	Number of alive (%)	Total (%)
<i>Child related variables</i>				
Sex of child	Female	192(40.3)	3358(49.2)	3550(48.6)
	Male	284(59.7)	3467(50.8)	3751(51.4)
Place of Delivery	Health center	74(15.5)	1472(21.6)	1546(21.2)
	Home	395(83.0)	5243(76.8)	5638(77.2)
	Other place	7(1.5)	110(1.6)	117(1.6)
Weight of child at birth	Bigger than average	120(25.2)	2021(29.6)	2141(29.3)
	Average	192(40.3)	2771(40.6)	2963(40.6)
	Lesser than average	164(34.5)	2033(29.8)	2197(30.1)
<i>Parental related variables</i>				
Sex of household head	Male	404(84.9)	5726(83.9)	6130(84.0)
	Female	72(15.1)	1099(16.1)	1171(16.0)
Age of household head	Less than 30	119(25.0)	1583(23.2)	1702(23.3)
	30 and above	357(75.0)	5242(76.8)	5599(76.7)
Age of mother at first birth	19 and less	302(63.4)	4473(65.5)	4775(65.4)
	20 and above	174(36.6)	2352(34.5)	2526(34.6)
Marriage to first birth	Less than 2 year	294(61.8)	4236(62.1)	4530(62.0)
	2 year and above	182(38.2)	2589(37.9)	2771(38.0)
Current marital status	Single	4(1.7)	84(1.2)	92(1.3)
	Married	464(96.6)	6487(95.1)	6947(95.2)
	Others	8(1.7)	254(3.7)	262(3.5)
Mother Education	No education	362(76.1)	4929(72.2)	5291(72.5)
	Primary	92(19.3)	1608(23.6)	1700(23.3)
	Secondary & above	22(4.6)	288(4.2)	310(4.2)
Father Education	No education	253(53.1)	3410(50.0)	3663(50.1)

	Primary	85(29.0)	1242(31.8)	1327(18.2)
	Secondary & above	138(17.9)	2173(18.2)	2311(31.7)
ANC visit	Less than 4	395(83.0)	5697(83.5)	6092(83.4)
	4 and above	81(17.0)	1128(16.5)	1209(16.6)
Contraceptive method use	No	288(60.5)	3785(55.5)	4073(55.8)
	Yes	188(39.5)	3040(44.5)	3228(44.2)
<i>Household related variables</i>				
Region	Tigray	33(6.9)	626(9.2)	659(9.0)
	Afar	73(15.3)	769(11.3)	842(11.5)
	Amhara	39(8.2)	720(10.5)	759(10.5)
	Oromia	69(14.5)	1212(17.8)	1281(17.5)
	Somali	73(15.3)	961(14.1)	1034(14.2)
	Benishangul	50(10.5)	632(9.3)	682(9.3)
	SNNPR	58(12.2)	956(14.0)	1014(13.9)
	Gambela	32(6.7)	396(5.8)	428(5.9)
	Harari	30(6.3)	320(4.7)	350(4.8)
	Dire Dawa	19(4.0)	233(3.4)	252(3.5)
Family size	1-3	177(37.2)	2772(40.6)	2949(40.4)
	4 and above	299(62.8)	4053(59.4)	4352(59.6)
Religion	Orthodox	100(21.0)	1738(25.5)	1838(25.2)
	Protestant	70(14.7)	1245(18.2)	1315(18.0)
	Muslim	287(60.3)	3663(53.7)	3950(54.1)
	Other	19(4.0)	179(2.6)	198(2.7)
Number of under-five children	No	31(6.5)	185(2.8)	216(3.0)
	1-2	380(79.8)	5183(75.9)	5563(76.2)
	3 and above	65(13.7)	1457(21.3)	1522(20.8)
Economic status	Poorer	333(70.0)	4409(64.6)	4742(65.0)
	Middle	65(13.6)	1120(16.4)	1185(16.2)
	Richer	78(16.4)	1296(19.0)	1374(18.8)

Toilet availability	No	346 (72.7)	4949 (72.5)	5295 (72.5)
	Yes	130(27.3)	1876 (27.5)	2006 (27.5)
Source of drinking water	Piped	158 (33.2)	1996 (29.2)	2154 (29.5)
	Others	318 (66.8)	4829 (70.8)	5147 (70.5)

Table 2: Log rank test of association among variables and survival time

Variable	Log Rank Test		
	Chi-square	df	p-value
Gender of child	11.730	1	0.001
Place of Delivery	6.570	2	0.037
Weight of child at birth	4.539	2	0.103
Gender of household head	0.020	1	0.887
Age of household head	0.958	1	0.328
Family size	5.700	1	0.017
Age of mother at first birth	1.776	1	0.183
Marriage to first birth	0.030	1	0.863
Current marital status	1.709	2	0.426
Father Education	2.895	2	0.035
Region	26.018	9	0.002
Mother Education	5.436	2	0.046
Religion	18.238	3	0.000
Number of under-five children	9.250	2	0.010
Wealth index	7.934	2	0.019
ANC visit	0.083	1	0.773
Contraceptive method use	7.356	1	0.007
Toilet availability	0.015	1	0.901
Source of drinking water	4.335	1	0.037

Source: Ethiopian Demographic Health Survey, 2016, df: degree freedom

Table 3: Multivariable Analysis result of Cox PH model of under-five year children death

*HR: hazard ratio, CI: confidence interval, * significance at 5%*

Variables	Categories	Estimates (Std. error)	HR [95% CI for HR]	p-value
Gender of child	Male	<i>Ref.</i>		
	Female	-0.317 (0.094)	0.728 [0.606, 0.875]	0.001**
Place of delivery	Home	<i>Ref.</i>		
	Health facility	-0.304 (0.129)	0.738 [0.572, 0.951]	0.019*
	Other place	-0.268 (0.382)	0.765 [0.361, 1.619]	0.483
Family size	1-3	<i>Ref.</i>		
	4 and above	0.228 (0.096)	1.256[1.040, 1.517]	0.018*
Mother's Education level	Not educated	<i>Ref.</i>		
	Primary	-0.042 (0.118)	0.959 [0.761, 1.208]	0.720
	Secondary & above	-0.768 (0.220)	0.464[0.301, 0.714]	0.000*
Number of under-five child	No	<i>Ref.</i>		
	1-2	-0.531(0.187)	0.588 [0.408, 0.849]	0.005*
	3 and above	0.550 (0.223)	1.733 [1.120, 2.682]	0.014*
Contraceptive method use	No	<i>Ref.</i>		
	Yes	-0.227 (0.167)	0.797 [0.662, 0.960]	0.017*
Source of drinking water	Piped	<i>Ref.</i>		
	Others	0.265 (0.113)	1.303 [1.044, 1.627]	0.041*