Factors affecting under-five mortality in Ethiopia: a multi-level negative binomial model

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Abstract

Introduction: Under-five mortality is a key indicator of countries' developmental status. Even though remarkable declines in under-five mortality rates, nearly 5.6 million children still die annually worldwide before their fifth birthday. The 2016 Ethiopian Demographic and Health Survey (EDHS) report revealed that 67 children per 1,000 live births died before the fifth birthday. This study was aimed at determining factors affecting under-five mortality in Ethiopia using EDHS, 2016.

Methods: The data was retrieved from the EDHS 2016. A total weighted number of 11,023 under-five children were included in this study. Descriptive statistics were done and reported using tables, graphs, and texts. The multilevel negative binomial regression model was fitted to identify significant factors of under-five mortality. Adjusted Incidence rate (AIRR) with a 95% confidence interval (CI) and p-value <0.05 in the multivariable model were reported. The goodness of fit was checked using the deviance test.

Results: Mother attained higher education (AIRR=0.25, 95% CI: 0.10-0.66); female-headed household (AIRR=1.32, 95%CI:1.05-1.66); age of household head (AIRR=1.07, 95%CI: 1.03,1.11); preceding birth interval ≥48 months (AIRR=0.51, 95%CI: 0.42-0.61); child's had history of diarrhea (AIRR=1.23, 95% CI:1.08-1.41); multiple birth type (AIRR=1.80, 95% CI:1.34-2.42); mothers delivered in health facility (IRR=0.86, 95% CI:0.73,0.94), residents of Addis Ababa (AIRR=0.52, 95%CI: 0.28-0.98), and Amhara region (AIRR=1.43, 95%CI: 1.09, 1.88) were statistically significant factors to under-five mortality in Ethiopia.

Conclusion: In this study, under-five mortality remains a public health problem in Ethiopia. Mothers education level, women delivered at health institution, preceding birth interval 24-35 and ≥48, and residents of Addis Ababa have reduced the incidence of under-five mortality. On the other hand, being a female household head, age of mother at first giving birth, being employment, having multiple births and having childhood diarrhea was associated with a higher incidence of under-five mortality. This finding suggests that enhancing opportunities to female education, addressing regional disparities, and encouraging mothers to deliver at health institutions will help to combat the burden of under-five mortality.

Keywords: Under-five mortality, negative binomial, multilevel analysis, Ethiopia

Background

Under-five mortality is defined as the probability of dying between birth and the fifth birthday. Child mortality is one of the most vital components of population change hence demographers are highly interested to study the trend and prevalence of infant and child mortality. Approximately 9.7 million infants and children under five years of age die each year, with large variations in under-five mortality rates and trends across regions and countries (1). Worldwide, the number of under-five deaths has declined from more than 12 million in 1990 to 7.6 million in 2010. Therefore, the global under-five mortality rate has dropped 35 percent from 88 deaths per 1,000 live births in 1990 to 57 in 2010. However, children in developing countries are still more likely to die before their fifth birthday compared to children

in rich countries; in 2011 the under-five mortality rate in developing regions was more than 8 times the rate in developed regions (2).

Childhood mortality rates continue to pose a major public health concern in sub-Saharan Africa (SSA). A report shows more than 10.5 million children died each year and approximately 4.4 million such deaths occur in SSA (3). Research findings indicate that childhood mortality could remain relatively high because of the clustering of deaths in certain pockets of the population despite overall declines in mortality levels (4).

Due to the continuous implementation of health interventions, the trend of child mortality rate in Ethiopia is relatively decreasing (5). Even though this implementation is done consistently, the under-five mortality rate shows the highest trend in Ethiopia. From 2000, 2005 to 2011 Ethiopian Demographic and Health Survey (EDHS), it was found that the under-five mortality rate shows a decline. For 2011 the under-five mortality rate was found to be 88 per 1000 live births. Similarly, one in 11 Ethiopian children dies before the fifth birthday (6).

Despite there is a reduction in under-five mortality, still many children have died before their fifth birthday in Ethiopia. Therefore, this study was aimed at determining both individual and community-level factors of under-five mortality in Ethiopia.

Methods

Study design, area and period

A population-based cross-sectional study was employed from January 18 to June 27, 2016. Ethiopia is located in the Eastern tip of Africa and bordered by Eritrea to the North, Djibouti, and Somalia to the East, Sudan and South Sudan to the West, and Kenya to the South. It is the second-most populous nation in Africa, with over 100 million populations (CSA, 2012). The country covers 1.1 million square kilometers (Km2) and has a great geographical diversity, which ranges from 4,550 meters (m) above sea level down to the Afar depression to 110 m below sea level. Administratively, it is divided into nine regions and two city administrations subdivided into 68 zones, 817 districts and 16,253 kebeles (lowest administrative unit in the country).

Population and sample

All under-five children within 5 years preceding the survey were the source population. On the other hand, all under-five children found in selected enumeration areas within five years preceding the survey were the study population. The EDHS 2016 sample was selected using a two-stage stratified cluster sampling. Each region was stratified into urban and rural areas, yielding 21 sampling strata. Samples of enumeration areas (EAs) were selected independently in each stratum. The sampling frame used for the 2016 EDHS is the Ethiopia Population and Housing Census (PHC), which was conducted in 2007 by the

Ethiopia Central Statistical Agency. The census frame is a complete list of 84,915 EAs. An EA is a geographic area covering on average 181 households (7).

In the first stage, 645 clusters (202 urban and 443 rural) were selected. In the second stage, a fixed number of 28 households per cluster were selected. Finally, a representative sample of 15,683 women age 15–49 in 16,650 households from 645 clusters were selected. A total of 10,641 (weighted 11,023) women were interviewed to provide under-five children information (7).

Variables of the Study

The number of under-five children death was defined as the death of children less than 60 months in the last five years preceding the survey. Both individual and community-level factors were assessed. Individual-level factors include: sex, age of mother, age of mother at first birth, marital status, preceding birth interval, birth order, size of child, number of children, media exposure, education level of mother, mothers' occupation, partner's occupation, economic status, employment status of mother, religion, diarrhea status, contraceptive method, delivery status, place of delivery, type of birth, immunization coverage. Whereas, community-level factors include: a source of water supply, place of residence, region, community poverty level, community immunization status, and availability of toilet facility.

Data collection tools and procedures

A structured and pre-tested questionnaire was used as a tool for data collection. Tablet computers were used to record responses during the interviews. The tablets were equipped with Bluetooth technology to enable remote electronic transfer of files (7). Due to the non-proportional allocation of the sample across the regions, sampling weights were used to ensure the representativeness of the finding. The sampling weights for under-five child mortality are calculated in a similar way, although the normalization of the under-five child mortality weights is different. The individual under-five child mortality weights are normalized at the national level for women.

Data processing and analysis

Initially, data were extracted from the women's data set. Then coding and recoding were done. Summary statistics and cross-tabulation were performed to describe the study population. STATA version 14 was used for analysis. In EDHS, women within a cluster are more likely similar than women from other clusters. This indicates the use of traditional models may not be appropriate. Hence, a model that accounts for the cluster effect should be considered. Multilevel or hierarchical modeling explicitly accounts for the clustering of the units of analysis, individuals nested within groups. Since the outcome variable is count, Poisson regression is used as a standard model for analyzing it. However, the observation should be independent over time and the mean and the variance should be equal. Furthermore, an overdispersion test was performed to evaluate the adequacy of the negative binomial model over the Poisson regression model. When the ratio of variance to mean of the Poisson distribution

value α greater than 1 indicate overdispersion, that is, the true variance is bigger than the mean, whereas values smaller than 1 indicate under dispersion, that is, the true variance is smaller than the mean.

In this study the variance was greater than the mean, it indicates an overdispersion. Hence the negative binomial model is preferred over the poison model. In addition, the number of zeros was also checked to determine whether zero-inflated poison models (ZIP) or the zero-inflated negative binomial models (ZINB) would be chosen. In this study, four models were constructed to estimate the mortality level of children in Ethiopia per woman under the consideration of EA variation. The first model was an empty model (a model without any explanatory variables) is used to assess the extent of the cluster variation on Variance partition coefficient (VPC) or Intra-class correlation (ICC). The second model adjusted for the individual-level variables, the third model adjusted for community-level variables while the fourth model adjusted for both the individual and community-level variables simultaneously. Therefore, a multilevel model was chosen over the traditional count models. Akaike information criteria (AIC), Bayesian information criteria (BIC), and log-likelihood were used to choose the best-fitted model. Hence, a model with the lowest AIC and BIC and the highest log-likelihood was used.

A P-value of <0.05 was used to define the statistical significance of independent variables. The adjusted incidence rate (AIR) corresponding with 95% confidence intervals (CIs) were calculated to identify the independent predictors of the number of deaths. ICC, Median Rate Ratio (MRR) and Proportional Change in Variance (PCV) statistics were calculated to measure the variation among clusters. ICC was used to explain cluster variation while MRR is a measure of unexplained cluster heterogeneity (8). The PCV measures the total variation attributed by individual-level factors and area-level factors in the multilevel model.

Ethical Considerations

Ethical clearance was obtained from the Ethical Review Board of the University of Gondar. Written consent was obtained from the Measure DHS International Program which authorized the data-sets. All the data used in this study were publicly available. However, there is no personal identifying information that can be linked to individuals, communities, or study participants. Confidentiality of data was maintained anonymously and permission was taken from the Measure DHS International to use the data for secondary analysis.

Results

Characteristic of the study participants

Of all, 9219 (83.63%) of respondents were from Oromia, Amhara, and SNNP. A majority, 88.9% of study subjects were from rural areas. Nearly one-third of respondents were in the age group between 25–29 years. Nearly two-thirds, 66.08 % of mothers had no formal education. The poorest wealth quintile comprises nearly one fourth (23.92 %) of the total respondents. Regarding media exposure, 7376 (66.91%) of mothers had no media exposure. Eight thousand one hundred thirty-one (73.76%) of

mothers/caregivers delivered at home. A total of 7621 (69.13%) of children had incomplete immunization status. Only 7.46% of the households have improved latrine while 10.36 % used piped water as a source of drinking water *(Table 1).*

Nearly 70% of mothers/caregivers had no under-five death in their lifetime. On the other hand, 3.43% of them experienced 3 or more deaths *(Figure 1).*

Model compressions of count data analysis

Different models (Poisson, negative binomial, zero-inflated Poisson, zero-inflated negative binomial, multi-level Poisson, and multi-level negative binomial) were computed. Accordingly, the multilevel negative binomial model had the smallest LL, AIC, BIC and deviance value. Therefore, the multilevel negative binomial regression model was the best fit for the data *(Table 2).*

The variance of the random part with its standard deviation was 0.23 for the final fitted model. Intra-class correlation showed that 12% variability was explained by the full model. The risk of under-five mortality was increased by 58% if we moved from the Tigray region to other regions except for Addis Ababa. The Deviance test was decreasing across model one to model 4. This indicates the 4th model (model with the lowest deviance) was the best-fitted model *(Table 3).*

Analysis of multilevel negative binomial regression model

Mother's education, sex of household head, age of household head, partner's occupation, and types of birth, place of delivery, child's diarrhea status, birth interval, and regions had a significant association for under-five mortality in the final model. The incidence rate of under-five mortality among primary, secondary, and higher education levels of mothers was decreased by 45 (AIRR = 0.55, 95%CI: 0.45–0.67), 60 (AIRR = 0.4, 95%CI: 0.24–0.67), and 75% (AIRR = 0.25, 95%CI: 0.10–0.66), respectively compared with uneducated. Being a female-headed household increase the rates of experiencing under-five mortality by 32% (AIRR = 1.32, 95% CI: 10.5–1.66). History of diarrhea five years preceding the survey was increased the incidence of under-five mortality by 23% (AIRR = 1.23, 95% CI: 1.08–1.41). Besides, multiple birth type of child was 80% increase the risk of under-five mortality compared with a single birth type (AIRR = 1.80, 95% CI: 1.34–2.42). On the other hand, mothers delivered at health facilities decreased the incidence of child death by 14% compared to home delivery (AIRR = 0.86, 95% CI: 0.73, 0.94) and living in Addis Ababa decreases the incidence of under-five mortality by 48% (AIRR = 0.52, 95%CI: 0.28–0.98)compared with Tigray region*(Table 4).*

Discussion

This study showed that individual and community level determinants of under-five mortality in Ethiopia based on 2016 EDHS. A multilevel negative binomial model was used to identify possible factors of under-five mortality. According to 2016 EDHS, nearly one-third (30.5%) of mothers/caregivers lost a minimum of one child within the study period. In this study mothers' education primary and above,

female household head, age of household head, occupation of mothers, having multiple births, place of delivery, preceding birth interval, childhood diarrhea, and region were significantly affect under-five mortality in Ethiopia.

The findings of this study showed that mothers' education is associated with a reduction in the incidence of under-five mortality. This finding was supported by studies from Zimbabwe and Indonesia, respectively (9, 10). In addition, findings from Gilgel Gibe, Ethiopia showed that children born from illiterate mothers were at higher risk of child mortality (11), Ghana (12), Ethiopian (13), Columbia (14) and Pakistan (15). This could be educated mothers will have better knowledge and good practice in basic health services including: immunization, disease treatment, preventive care, hygiene, nutrition, and change the traditional balance of familial relationships with profound effects on childcare Moreover, a study from India showed that educating females have lower incidence of under-five mortality (16). This finding illustrate that educating females is a powerful strategy to combat under-five mortality.

The female household head was associated with an increase in the incidence of under-five mortality. This finding was in agreement with a study done in Uganda (17) and Indonesia (10). This is due to female-headed households are at high risk of food insecurity and more likely to be not fully immunized (18): prone to vaccine-preventable disease and death. This indicates that female-headed households will make difficulties to made decisions on child health and well busy for other responsibilities in the house and social cases.

Partners who are working are at a higher incidence of under-five mortality than non-working. However, it is in contrast with a study conducted in Nigeria (19) showed that being employment reduced the risk of under-five mortality. Employment generates income that aids the mother/caregiver to seek health care at any time when the child was sick. On the other hand, being employed would decrease prompt visits to health facilities while the child was sick. This could result in a delay in seeking health care since the partner could be busy. Therefore, the finding suggests that there is a need for further research in order to overcome the confusion. The result of this study showed that the preceding birth interval has an inverse relationship with under-five mortality. Children born after 24–35, 36–47, and more than 47 months of the preceding birth intervals had a lower risk of child mortality relative to children born less than 24 months. This finding was consistent with a study conducted in Ethiopia (20), Kenya (21) and India (22). This could be shorter birth intervals are associated with maternal nutritional reduction and the child would prone to malnutrition and then end up with death.

The incidence of under-five mortality was higher among children with diarrheal disease. This finding was in line with a study done in Nigeria (23). This is because the diarrheal disease causes water and electrolyte loss that resulted in dehydration and electronic imbalance that further resulted in death (24). The study also revealed that multiple births were contributed to a high risk of under-five mortality. This result was supported by studies done in Ethiopia (25), Cambodia (26) and Ghana (27). This could be due to the fact that multiple births are at higher risk of fetal and neonatal complications and usually needs special intervention which is costly and unaffordable (28). Therefore, enhanced and comprehensive

health care service is recommended to mothers/caregivers during pregnancy, delivery and the postpartum period.

In this study, an increase in the age of mothers/caregivers was associated with an increase in the incidence of under-five mortality. A study from Columbia (14), Pakistan (15), and India (29) showed that an increase in mothers/caregivers of age by one year was associated with a decrease in under-five mortality. This could be young mothers/caregivers are incapable to tolerate pregnancy-related complications and incompetent to take proper care of children in terms of feeding and handling. The results of the multilevel negative binomial model showed that the incidence of under-five death was declined among mothers deliver at health institutions. This result is supported by a study done in Pakistan (30) showed that there was higher under-five mortality during home deliveries because of postpartum complications. In addition, home delivery will result in no vaccination and child will suffer from repeated vaccine-preventable diseases and can cause death.

Under-five mortality was lower in Addis Ababa and higher in other regions compared with the Tigray region. This finding is in agreement with a study from Mozambique showed that the distribution of disease among regions was quite different because of difference in basic infrastructure distribution like health coverage and regional variations in economic development (31). Furthermore, the finding was in line with a study from Nigeria (32) which showed that regional variation has significantly affect under-five mortality. Therefore, this finding demonstrates that providing an equal and fair distribution of wealth and health service coverage will tailor the variation observed among different regions of Ethiopia.

The strength of this study was an incorporation of multi-center sites of the region. This could enhance the generalization of the study findings to the whole region. Besides, the study was aimed at determining individual and community factors among under-five mortality in Ethiopia. However, this study also faces some limitations. It is obvious that it is difficult to establish a temporal relationship because of the cross-sectional nature of the data. This study might also affected by misclassification and recall bias during the data collection at the inception.

This study has played an important role in determining the number of under-five mortality and factors affecting among under-five children in Ethiopia. This could be used as baseline information for researchers to conduct further prospective studies. Moreover, the study will be valuable for policymakers, decision-makers, planners, and implementers working on the field.

Conclusion

In this study, under-five mortality remains a public health problem in Ethiopia. Mothers education being primary and above, women delivered at health institution, preceding birth interval 24–35 and ≥48, and residents of Addis Ababa have reduced the incidence of under-five mortality. On the other hand, being a female household head, age of mother at first giving birth, being employment, having multiple births and having childhood diarrhea was associated with a higher incidence of under-five mortality. This finding suggests that enhancing opportunities to female education, addressing geographical disparities, and

encouraging mothers to deliver at health institutions will help to combat the burden of under-five mortality.

Declarations

Ethics approval and consent to participate

Permission to use the EDHS data was obtained from the Measure DHS international program. The data is publicly available and has no personal identifiers

Consent for publication

Not applicable

Availability of data and materials

Data is available on https://dhsprogram.com/data/available-datasets.cfm

Competing interest

Authors declare that they have no conflict of interest

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No funding was obtained for this study.

Authors' contributions

Conceptualization: BMG, KAG, AWM, TYA, and AGB

Data curator: BMG

Formal analysis: BMG, KAG, AWM, TYA, AGB

Investigation: BMG, KAG, AWM, TYA, AGB

Methodology: BMG, KAG, AWM, TYA, AGB

Resources: BMG, KAG

Software: BMG, KAG, AWM, TYA, AGB

Validation: BMG, KAG, AWM, TYA, AGB

Visualization: BMG, KAG, AWM, TYA, AGB

Writing original draft: BMG, KAG, AWM, TYA, AGB

Writing review & editing: BMG, KAG, AWM, TYA, AGB

Finally, all authors have read and approved the manuscript.

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Abbreviations And Acronyms

AIC: Akaike Information Criteria, AIRR: Adjusted Incidence Rate Ratio, BIC: Bayesian Information Criteria, CSA: Central Statistical Agency, DHS: Demographic and Health Survey, EA: Enumeration Area, EDHS: Ethiopian Demographic and Health Survey, GPS: Global Positioning System, ICC: Intra-class correlation, IGME: Inter-agency Group for Child Mortality Estimation, IMR: Infant Mortality Rate, IRR: Incidence Rate Ratio, LISA: Local Indicators of Spatial Association, LL: Log-Likelihood, MDGs: Millennium Development Goals, NB: Negative Binomial, OR: Odds Ratio, PHC: Population and Housing Census, PR: Poisson Regression, SNNP: South Nation, Nationalities and People, SA: Sub-Saharan Africa, TFR: Total Fertility Rate, U5CD: Under Five Child Death, U5CM: Under Five Child Mortality, U5M: Under Five Mortality, U5MR: Under Five Mortality Rate, UNICEF: United Nations International Children Emergency Fund, UNPD: United Nations Population Division, USAID: United States Agency for International Development, WHO: World Health Organization, ZIP: Zero Inflated Poisson

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Tables

Table 1: Weighted socio-demographic and economic characteristics of respondents EDHS 2016 (N=11,023)

Variables	Frequency	Percentages (%)
Region		
Tigray	716	6.49
Afar	114	1.03
Amhara	2,072	18.79
Oromia	4,851	44.01
Somalia	508	4.61
Benishangul	122	1.11
SNNP	2,296	20.83
Gambella	27	0.24
Harari	26	0.24
Addis Ababa	244	2.21
Dire Dawa	47	0.44
Residence		
Urban	1,216	11.03
Rural	9,807	88.97
Mothers age		
15-19	378	3.43
20-24	2,068	18.76
25-29	3,353	30.42
30-34	2,489	22.58
35-39	1,772	16.08
40-44	723	6.56
45-49	240	2.17
Mothers educational level		
Illiterate	7,284	66.08
Elementary	2,951	26.77
Secondary	514	4.66
Tertiary	274	2.49

Wealth index		
Poorest	2,636	23.92
Poor	2,520	22.86
Middle	2,780	20.68
Richer	1,999	18.13
Richest	1,588	14.41
Media exposure		
No	7,376	66.91
Yes	3,647	33.09
Age at first birth		
Less than 15	687	6.24
15-24	7,405	67.18
Above 24	2931	26.58
Types of birth		
Single	10,730	97.35
Multiple	293	2.65
Marital status		
Unmarried	684	6.2
Married	10,339	93.8
Place of delivery		
Home	8,131	73.76
Institute	2,892	26.24
Religion		
Christian	6,101	55.35
Muslim	4,561	41.38
Others	361	3.27
Diarrhea		
No	8,951	81.2
Yes	2,072	18.8

Sex of household head		
Male	9,494	86.13
Female	1,529	13.87
Sex of child		
Male	5,725	51.94
Female	5,298	48.06
Source of Water		
Piped water	2,931	26.58
Other improved	3,185	28.9
Un improved	4,907	44.53
Number of under-five children		
One	4,079	37.0
Two	4,779	43.36
Three	1,578	14.32
Four and above	587	5.32
Size of a child at birth		
Very large	1,957	17.75
Larger than average	1,528	13.87
Average	4,580	41.55
Smaller than average	2,958	26.83
Immunization status		
Incomplete	7,621	69.13
Complete	3,402	30.87

Table 2: Model Comparison of under-five children in Ethiopia, EDHS 2016

Model	Observation	LL	AIC	BIC	Deviance
Poisson	10,641	-6755.04	13,572.09	13,794.80	13,510.08
Negative binomial	10,641	-6654.96	13,373.93	13,603.82	13,309.92
Zero inflated Poisson	10,641	-6572.56	13,265.11	13,696.16	13,145.12
Zero inflated negative binomial	10,641	-6556.61	13,235.23	13,673.46	13,113.22
Multilevel Poisson	10,641	-6587.16	13,238.32	13,468.21	13,174.32
Multilevel negative binomial	**10,641***	**-6486.21***	**13,183.11***	**13,420.18***	**12,972.42***

Table 3: random parameter estimates among under-five children, EDHS, 2016

Measure of variation	Model 1[a]	Model 2[b]	Model 3[c]	Model 4[d]
Variance (SE)	0.456(0.675) *	0.254(0.504) *	0.28(0.53) *	0.23 (0.479) *
Explained variation ICC %	20	18.3	21.3	12
MRR	1.90	1.61	1.66	1.58
Model fit statistics				
DIC (−2log likelihood)	18519.48	16010.72	18267.85	12,972.42

Table 4: Multilevel negative binomial regression analysis of individual and community-level factors associated with the number of under-five child death in Ethiopia, EDHS 2016 (N=11,023)

	Null	Individual-level	Community-level	Adjusted by both
Number of deaths per mothers		Adjusted IRR 95%CI	Adjusted IRR 95%CI	Adjusted IRR 95%CI
Mothers Educational				
Illiterate		1		1
Primary		0.54(0.45,0.66)*		0.55(0.45, 0.67) *
Secondary		0.39(0.23, 0.65)*		0.40(0.24, 0.67) *
Higher		0.24(0.10, 0.62)*		0.25(0.10, 0.66) *
Age of respondents at first birth		1.08(1.03, 1.10)*		1.07(1.03, 1.11) *
Sex of household head				
Male		1		1
Female		1.36(1.09,1.70)*		1.32(1.05, 1.66) *
Age of household head		1.02(1.02, 1.03)*		1.02(1.02, 1.03) *
Mother's Working status				
Not working		1		1
Working		1.19(1.00, 1.41)*		1.16(0.98, 1.38)
Partners occupation				
Not working		1		1
Working		1.18(0.97, 1.42)		1.22(1.01, 1.47) *
Type of birth				
Single		1		1
Multiple		1.74(1.31, 2.32)*		1.80(1.34, 2.42) *
Cesarean section delivery				
No		1		1
Yes		1.32(0.72, 2.40)		1.72(0.72, 2.52)
Marital status				
Unmarried		1		1
Married		1.52(1.06,2.19)*		1.39(0.96, 2.03)
Place of delivery				

Home	1	1
Institutional	0.87(0.74,1.02)	0.86(0.73, 0.94) *
Preceding birth interval		
<24	1	1
24-35	0.81(0.68, 0.96)*	0.81(0.68, 0.96) *
36-47	0.87(0.72, 1.05)	0.84(0.69, 1.02)
>=48	0.52(0.43, 0.63)*	0.51(0.42, 0.61) *
Child diarrhea status		
No	1	1
Yes	1.19(1.04, 1.37)*	1.23(1.08, 1.41)*
Media exposure		
Unexposed	1	1
Exposed	0.91(0.76, 1.09)	0.92(0.76, 1.12)
Immunization coverage		
Complete	1	1
Incomplete	1.17(0.96, 1.42)	1.12(0.91, 1.39)
Household Wealth index		
Poorest	1	1
Poor	1.15(0.85, 1.55)	1.15(0.85, 1.57)
Middle	1.18(0.92, 1.53)	1.20(0.91, 1.60)
Richer	1.27(0.94, 1.71)	1.20(0.87, 1.64)
Richest	1.17(0.70, 1.96)	1.00(0.50, 2.00)
Source of water		
Piped water	1	1
Other improved water	1.05(0.81, 1.35)	1.03(0.78, 1.36)
unimproved water	1.05(0.84,1.31)	1.03(0.83, 1.29)
Place residence		
Urban		1
Rural		0.86(0.48, 1.55)
Region		

Tigray		1	1
Afar		1.95(1.45, 2.63)*	1.62(1.14, 2.29)*
Amhara		1.47(1.13, 1.92)*	1.43(1.09, 1.88)*
Oromia		1.25(0.97, 1.60)	1.08(0.82, 1.35)
Somali		1.47(1.12, 1.92)*	1.31(0.95 1.80)
Benishangul		1.58(1.18, 2.10)*	1.47(1.10, 1.97)*
SNNPA		1.46(1.11, 1.91)*	1.48(1.13, 1.93)*
Gambella		1.07(0.82, 1.40)	1.39(1.00, 1.93)*
Harari		1.18(0.85, 1.64)	1.17(0.84, 1.64)
Addis Ababa		0.45(0.25, 0.80)*	0.52(0.28, 0.98)*
Dire Dawa		1.61(1.20, 2.16)*	1.50(1.13, 2.00)*
Latrine facility type			
Improved	1		1
Un improved	1.12(0.82,1.53)		1.10(0.80, 1.51)
Community poverty level			
Low		1	1
High		1.01(0.82, 1.24)	1.9(0.52, 2.31)
Community water source			
Improved		1	1
Unimproved water		1.34(1.06, 1.70) *	0.97(0.75, 1.26)
Community immunization			
Complete		1	1
Incomplete		1.11(0.85, 1.44)	0.98(0.86, 2.51)
Community media exposure			
Unexposed		1	1
Exposed		0.99(0.78, 1.25)	1.09(0.87, 1.36)

*p<0.05

Figures

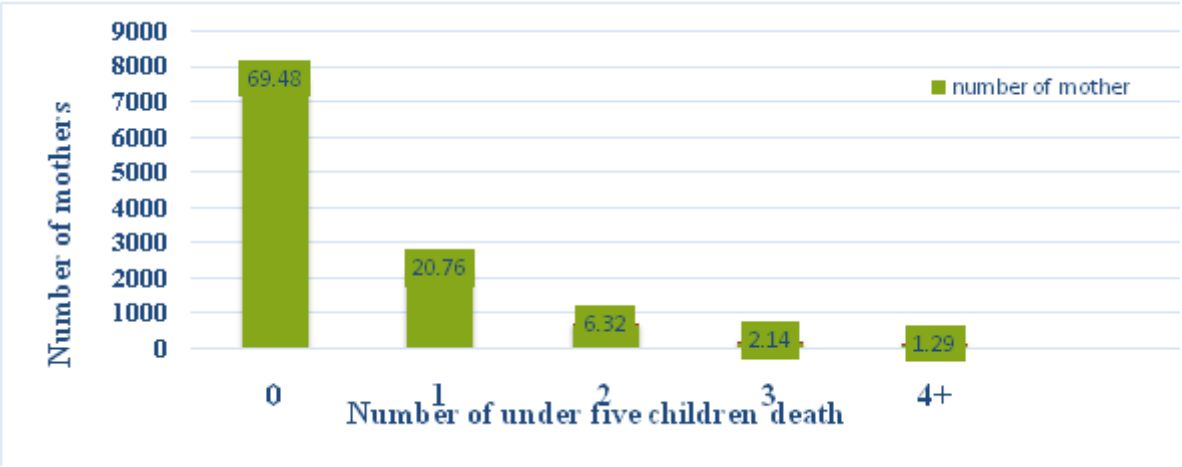

Figure 1

Number of under-five children death in Ethiopia, evidence from EDHS 2016