

## Research Article

# Socioeconomic, Demographic, and Environmental Determinants of Under-5 Mortality in Ethiopia: Evidence from Ethiopian Demographic and Health Survey, 2016

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Received 28 February 2019; Accepted 24 April 2019; Published 12 May 2019

Academic Editor: Randal X. Moldrich

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**Background.** Though Ethiopia has made impressive progress in reducing child mortality in the past two decades, the reduction of under-five mortalities is a major concern for the Sustainable Development Goals (SDGs) introduced in 2016 targeted to reduce under-5 mortality rate below 25 deaths of under-5 per 1,000 live births by 2030. This study aims to assess the risk factors attributed to under-five mortalities in Ethiopia region based on Ethiopian Demographic Health Survey 2016 dataset. **Methods.** The study was a secondary analysis of 2016, Ethiopian Demographic Health Survey and the information collected from 10,274 children born five years preceding the survey was considered in the study, and variables like maternal social and demographic characteristics, child demographic characteristics, and cultural and environmental factors were considered as determinants of under-five deaths. The study used descriptive statistics and logistic regression model to explore significant risk factors accredited to under-five deaths in Ethiopia. **Results.** Maternal education attainment, women age at first birth, women current age, child birth order, preceding birth interval, birth type, and occupation of mother were found significant predictors of under-five mortalities. Being born to mother with no education (OR=2.610, 95% CI: 1.598, 4.265), short birth spacing 1 to 18 months birth intervals (OR=2.164, 95% CI: 1.821, 2.570), birth order of five and above, and 11 to 17 years ages at birth (OR=1.556, 95% CI: 1.243, 1.949) were factors significantly associated with increased risk of under-five mortalities. **Conclusion.** The magnitude of under-five deaths in the study area was decreasing. However, under-five mortality rates have stayed higher in some regions. Therefore, interventions that focus on birth spacing, mothers living in Affar and Gambela, and uneducated mothers are required for improving child survival in Ethiopia.

## 1. Background

The Millennium Development Goal (MDG) 4 was targeted reduction of child mortality by two-thirds by 2015 and further the Sustainable Development Goals (SDGs) introduced in 2016 targeted to reduce under-5 mortality rate below 25 deaths of under-5 per 1,000 live births by 2030 [1]. To reach the 25 per 1,000 under-five mortality targets in 2030, Africa would need to achieve an average annual rate of decline of about 8 percent during 2015-2030 [2, 3]. Although there is global decline in the death rates of under-5 children, the risk of a child dying before celebrating their fifth birthday remains the highest in African especially sub-Saharan Africa [4].

More than 25 percent of all deaths among under-five children worldwide occur in Africa [5]. Among the African

countries Somalia (133 deaths per 1000 live births), Chad (127 deaths per 1000 live births), Central African Republic (124 deaths per 1000 live births), Sierra Leone (114 deaths per 1000 live births), Mali (111 deaths per 1000 live births), and Nigeria (104 deaths per 1000 live births) were the top six countries with under-5 mortality rate accounting for more than 50% under five deaths in sub-Saharan region and about one-fifth of under-five mortality worldwide in the year 2016 [6]. The sub-Saharan region has the highest rate of under-five mortalities with an average annual mortality rate of 81 deaths per 1000 live births [7]. Even though various actions have been taken to decrease under-five mortalities, most of the sub-Saharan countries show very high under-five mortality rates. For every 11 newborn children in sub-Saharan Africa one child will die before age of 5 [3].

Reduction of child mortality is one of the prime objectives of the Ethiopian government. Ethiopia has made impressive progress in the reduction of child mortality in the past two decades [8, 9]. Although the country achieved significant improvement, controlling the morbidity and mortalities of children and mothers, under-five mortalities are still a major public health issue. About one in every 21 children dies before the age of five, and one in every 15 children dies at the age infancy [10]. The latest Ethiopian Demographic and Health Survey (DHS) 2016 reported that, for the 5-year period prior the survey, the under-5 death rate was 67 deaths per 1,000 live births. This means that 1 in 15 children in Ethiopia dies before reaching age 5 [10]. The analysis of trends and causes of under-five mortalities obtained from six Health and Demographic Surveillance System (Butajira, Dabat, Gilgel Gibe, Kersa, Kilde-Awlaelo and Arba Minch) indicate under-five mortality rate trend were declining in the past five years and differ by causes of death in rural and urban areas [11]. Even though Ethiopia achieved a MDG4 of child mortality reduction, country trend for the past fifteen years showed Ethiopia is still experiencing high levels of under-five mortalities. Under-5 mortality declined from 166 deaths per 1,000 live births in 2000 to 67 deaths per 1,000 live births in 2016. This represents a 60% decrease in under-5 mortality over 16 years. Moreover, the mortality rates distribution differs by geographical regions [9, 10, 12], the highest in Affar (125 deaths per 1000 live births) and the lowest in Addis Ababa (39 deaths per 1000 live births); this may be probably due the nomadic life of Affar people and the high level of urbanization in Addis Ababa. Similarly, rural residents have the highest rate of under-5 mortality (83 deaths per 1000 lives), which is 1.25% times higher than that of urban residents (66 deaths per 1000 live births).

The determinants of child and under-5 mortalities are highly correlated with socioeconomic, demographic, and behavioral factors of households, health seeking behavior of mothers, and environmental factors. Several studies have investigated that maternal age and education be found to be strongly correlated with child mortality [9, 13–19]. Level of education is inversely associated with child mortality children of educated mothers having better survival than children of noneducated mothers [20–24].

Other determinants of child mortality may include place of residency [14, 19, 25–27], family size and parity [9, 21–23], birth order, birth intervals [19, 24], water source [21, 26], and toilet facility [16, 21]. Bearing many children increases the risk of maternal mortality and the death of the newborns as well [9, 11]. This was attributed to the malnutrition among children due to the lack of foods and other limited resources essential for child survival [28]. There is also a strong and positive association between availability of healthcare services and child mortality [22, 24]. Accesses to health care service increased the chance for child survival. Children of women who did not receive healthcare during pregnancy and postnatal care had a higher risk of under five deaths as compared to those of mothers who did receive the treatment. Most studies also found that sex of the household head, sex of the child [19, 24, 27], and household economic status (wealth index) were found to be significant [14, 19, 22, 25],

where male children are at higher risk of under-five mortalities.

According to WHO 2015 the global World health statistics 2015 estimates [29], the most important causes of under-five mortalities were preterm birth complications (17%), pneumonia (15%), birth asphyxia (11%), diarrhea (9%), malaria (7%), congenital anomalies (7%), and neonatal infections (15%). Removal of preventable child death requires information concerning the existing distribution of the major causes of deaths.

Despite the fact that a number of researches have been done on the identification of factors that are associated with under-five mortalities in Ethiopia, progress made on decreasing child mortality is still high and more effort is needed to remove barriers for under-five survivals. More researches therefore required to inform policy makers to implement appropriate health intervention programs to achieve the Sustainable Development Goals (SDGs) targeted to reduce under-5 mortality rate below 25 deaths of under-5 per 1,000 live births by 2030. To address this gap, we conducted an all-inclusive cross-sectional analysis from the recent 2016 Ethiopian Demographic Health Survey, to explore the major risk factors of under-five mortalities in Ethiopia, taking into consideration various demographic, socioeconomic, and environmental factors. Therefore, the main objective of this study is to assess the socioeconomic and demographic factors associated attributed to under-five child deaths in Ethiopia based on Ethiopian Demographic Health Survey, 2016 dataset.

## 2. Methods

*2.1. Study Population.* This study analyzed the secondary data from the Ethiopian Demographic Health Survey (EDHS), 2016, accessed from the Measure Evaluation Demography, Health Survey 2016 Ethiopia [30] which is freely available online [31] and contains information on a wide range of socioeconomic and demographic factors of the population nationwide. The country has nine regions and two administrative cities. The Ethiopian DHS 2016 utilized a two-stage sample design to select respondents for the study. In the first stage 645 enumeration areas (202 in urban areas and 443 in rural areas) were selected with probability proportional to size. Second stage involved selection of 28 households per cluster with an equal probability systematic selection from the newly formed household list. The EDHS 2016 has three parts: the household questionnaire, the woman's questionnaire, and the man's questionnaire. The data for child mortality and associated factors were taken from a woman's questionnaire. Data were collected by conducting face-to-face interviews with women who met the eligibility criteria (women aged 15–49 years).

*2.2. Measurement of Variables.* Determinants of under-five mortalities in this study were selected from the available similar studies on the subject; the main predictors explored for under-five mortalities are presented in Table 1. Interaction of all these variables with significant bivariate correlation was included in multivariate logistic regression model (Table 1).

TABLE 1: Operational definition and categorization of explanatory (covariates) variables.

Variables/Covariates	Definition and categorization
Geographic region of residents (Region)	1= Tigray, 2= Afjar, 3= Amhara, 4= Oromiya, 5= Somali, 6= Benishangul-Gumuz, 7= SNNPR, 8= Gambela, 9= Harari, 10= Addis Ababa, 11= Dire Dawa
Place of residence (Residence)	1 = Rural, 2= Urban
Mothers age at the time of first birth	1 = 11-17 years, 2= 18-24 years, 3= 25 years and higher
Current age of mother	1= 24 and less, 2=25-29, 3=30-34, 4=35-39, 5=40-44, 6= 45-49 years
Mother education	1= No education, 2= Primary, 3= Secondary, 4= Higher
Husband or Partner education	1= No education, 2= Primary, 3= Secondary, 4= Higher
Religion of mother	1= Coptic orthodox, 2= Protestant, 3= Muslim, 4= Others
Household Wealth index	1= Poorest, 2= Poorer, 3= Middle, 4= Richer, 5= Richest
Sex of child	1= Male, 2= Female
Sex of household head	1= Male, 2= Female
Preceding birth interval	1=1-18, 2=19-36, 3= greater than 36
Child birth order	1=1, 2=2,3 or 4, 3=5 and more
Birth type	1= Single birth, 2= Multiple birth
Mothers media access to contraceptive use	0 =No, 1=Yes
Women Marital status	1= Single/ formerly married, 2= Currently married
Mother occupation	1= Not working, 2= Professional, 3= Agricultural, 4= Skilled/manual, 5=Others
Husband occupation	1= Not working, 2= Professional, 3= Agricultural, 4= Skilled/manual, 5=Others
Sources of drinking water	1= Piped water, 2 Tube-well, 3=Others
Toile facility	0= No facility/bush/field, 1= with facility
Access to Electricity	0=No, 1=Yes
Sources of fuel for cooking	1= Electricity, 2= gas/kerosene, 3= Others
Household family size	1=1-5, 2= greater than five
Main floor material	1= Natural floor/dung, 2= Wood/parquet, 3= Cement
Main roof material	1= Natural roofing, 2= Rudimentary, 3= Finished roofing
Main wall material	1= Natural roofing, 2= Rudimentary, 3= Finished
Place of delivery	0 = health center, 1 = home
Birth weight	1 = Smaller, 2 = Average, 3 = Larger
Breastfeeding status	0 = No, 1 = Yes
Antenatal care visit ( Antenatal service received by the mother)	0 = No, 1 = Yes
Postnatal check up	0 = No and 1 = Yes
Contraceptive methods	1 = No method, 2 = Traditional, 3 = Modern
Under-five death	0 = No and 1 = Yes

**2.3. Statistical Analysis.** Descriptive characteristics of the subjects were presented as frequencies and percentages to summarize the distribution of selected background characteristics of mother and children aged below 5 years. To estimate the effect of socioeconomic and demographic factors on under-five deaths (odds ratios with their 95% confidence intervals), logistic regression analysis was performed using R statistical package. Bivariate analysis based on Pearson chi square test was used for testing association between the predictors and outcome variable under-five mortalities. All significant predictor variables ( $p < 0.05$ ) in the bivariate analysis were included in the multivariate logistic regression analysis. Multicollinearity between covariates was checked using the variance inflation factor (VIF) and VIF values greater than 10 indicates the existence of multicollinearity. The goodness of fit for the fitted models was checked using the likelihood ratio test (LRT).

### 3. Results

**3.1. Descriptive Statistics.** Out of the 10274 under-five children included in the dataset, 52.01% were males and 47.99% were females. About three-fourths of the children were from rural areas (73.41%) while the remaining 26.59% of the children were living in urban areas. According to Table 2, the regional distributions of sampled children show that children who came from the Oromiya region (13.3%), the Southern Nations, Nationalities, and Peoples' (SNNP) region (11.92%), the Amhara region (11.29%), and Tigray region (10.77%) contributed the largest percentage of respondents in the sample.

The majority of the respondents had not attained education (60.25%), about one-fourth of respondents had primary education, 8.5% had secondary education, and only 4.67% of respondents had attained higher education. Similarly, more than half (55.23%) of their partners had no formal education at all, 27% had primary education, and only 17.77% of husbands had secondary and higher education. About 40% were given their first birth before age of 17 years old, nearly half (51.45%) of the respondent had age of first birth between 18 and 24, and only 8.7% of respondents were observed to give first birth at age of at least 25 years old. As the current age of mothers is concerned, the highest percentage was observed in the age group 24-29 and the minimum percentage and only 9% was among mothers in older age groups (45-49).

As high as 86.03% were observed to be currently married, while 32.97% were never married/former married women. In regard to religious affiliation, 42.66% belong to Coptic Orthodox, 18.21% belong to Protestants, and 37.27% and 1.86% were Muslims and other religions followers, respectively. Concerning occupation, about half (51.15%) of respondents were not working, 22.85% were engaged in the agricultural sector, 18.2% were professional employed, and only 7.8% were engaged in manual or skilled work. The percentage of distribution also varies by partner's education level. The majority of partners (44.21%) were working in the farming sector, and only 9% had no work at all.

Results show that about 19.21% of the children were first children, 42.7% were second, third, or fourth child, and 38%

were children with birth order at least a fifth. According to the household wealth index, 44.55% were poor, 13.63% were within the middle class, and 41.834% were within the rich economic level. In terms of access to the media about contraceptive use, 70% of respondents reported having no media access. 36.68% of the children belonged to a household with piped water and 26.67% belonged to the household with a tube well source of drinking water while 39 of them belonged to households without toilet facilities or bush or fields.

The proportions of children belonging to the male household head are 72.4%. The majority of the children belonged to single birth type 98% and only 2% were having multiple births. Only 8.270% of them belonged to 1-18 months of preceding birth interval, about 54% of the children belonged to preceding birth interval of 19-36 months and 37.47% of them had at least three years (more than 36 months) preceding birth interval. Majority 68.97% of the children belonged to women with no electricity access while 91.56% of them belonged to a household who uses wood or animal dung or charcoal and agricultural crop as cooking fuel. 45% of the children were from women with 5-7 family sizes. About 75% of the children belonged to women who using a natural floor/dung for floor material. 56% of the children belonged to women who were using finished main roofing material, while 75% of them belonged to household's rudimentary walling materials.

The percentage of under-five mortalities is higher among home deliveries, which is about 27%. A child born with small birth weight has the highest chance of dying at an age less than five years. Concerning healthcare service utilization children whose mother had not attended antenatal care during pregnancy and no baby postnatal care have encountered the highest percentage of under-five mortalities. Similarly, children who were not currently breastfed had a relatively higher under five mortality percentages (8.9%) (Table 2).

The trends of under-five mortalities are displayed in Figure 1. The under-five mortality rates fell gradually from 116 deaths per 1,000 live born 15 years preceding to the survey to 95 deaths per 1,000 live born 10 years before the survey and in 67 deaths per 1,000 live born five years prior to the current Ethiopian DHS 2016. Similarly, neonatal mortality, postneonatal mortality, and infant mortality show a significant declining in the last 15 years. This shows that the child mortality in Ethiopia had a straight falling in the last years prior to the survey (Figure 1).

**3.2. Bivariate Analyses.** Table 2 presents the bivariate analysis of under-five deaths and underlying and predictor variables. Under-five deaths were high in the Affar (34.6%), Somali (32.5%), Southern Nations, Nationalities, and Peoples' (31.2%), Amhara (31%), and Benishangul-Gumuz (30.2%) regions of Ethiopia while the percentage of under-five deaths was minimum in Addis Ababa (8.3%). Regarding place of residence, a percentage of under-five deaths among children from rural areas (31.5%) were two times that of the urban center (15.5%). As maternal age was concerned a 33.8% percent of under-five mortalities were reported from mothers who gave first birth at a young age group (1-17 years old) while

TABLE 2: Background characteristics and bivariate analysis of under-five mortality (N=10274), EDHS, 2016.

Covariates/Determinants	Number (N)	Number (%)	Ever experienced an Under five death		P-value
			Yes n (%)	No n (%)	
Region					
Tigray	1107	10.77	266 (24)	841(76)	
Affar	835	8.13	289(34.6)	546(65.4)	
Amhara	1160	11.29	360(31)	800(69)	
Oromiya	1366	13.3	389(28.5)	977(71.5)	
Somali	1002	9.75	326(32.5)	676(67.5)	
Benishangul-Gumuz	804	7.83	243(30.2)	561(69.8)	<0.0001
SNNPR	1225	11.92	382(31.2)	843(68.8)	
Gambela	756	7.36	191(25.3)	565(74.7)	
Harari	605	5.89	127(20)	478(80)	
Addis Ababa	760	7.4	63(8.3)	697(91.7)	
Dire Dawa	654	6.37	166(25.4)	488(74.6)	
Rural	7542	73.41	2379(31.5)	5163(68.5)	
Urban	2732	26.59	423(15.5)	2309(84.5)	<0.0001
Maternal age at first birth					
11-17	4094	39.85	1373(33.5)	272(66.5)	
18-24	5286	51.45	1271(24)	4015(76)	<0.0001
25 and higher	894	8.7	158(17.7)	736(82.3)	
24 and less	1933	18.81	203(10.5)	1730(89.5)	
25-29	2300	22.39	423(18.4)	1877(81.6)	
30-34	2056	20.01	539(26.2)	1517(73.8)	
35-39	1805	17.57	645(35.7)	1160(64.3)	<0.0001
40-44	1239	12.06	521(42)	718(58)	
45-49	941	9.16	471(50)	470(50)	
No education	6190	60.25	2161(34.9)	4029(65.1)	
Primary	2731	26.58	504(18.5)	2227(81.5)	
Secondary	873	8.5	114(13)	759(87)	<0.0001
Higher	480	4.67	23(4.7)	457(95.3)	
No education	5674	55.23	1823(32)	3851(68)	
Primary	2774	27	729(26.3)	2045(73.7)	<0.0001
Secondary	1019	9.92	141(13.8)	878(86.2)	
Higher	807	7.85	109(13.5)	698(86.5)	
Coptic orthodox	4383	42.66	871(22.7)	2958(77.3)	
Protestant	1871	18.21	480(25.7)	1391(74.)	
Muslim	3829	37.27	1391(31.7)	2992(68.3)	<0.0001
Others	191	1.86	60(31.4)	131(68.6)	
Poorest	4577	44.55	1516(14.6)	361(85.4)	
Middle	1400	13.63	417(30)	983(70)	<0.0001
Rich	4297	41.83	1324(12.9)	348(87.1)	

TABLE 2: Continued.

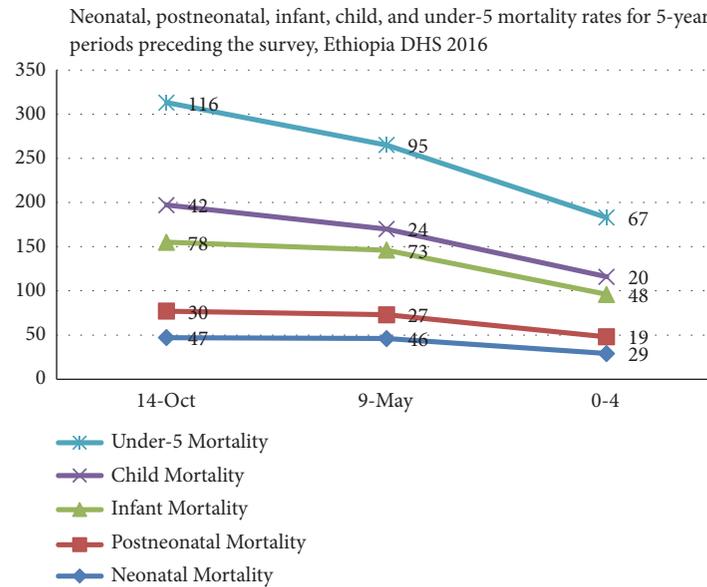
	Covariates/Determinants	Number (N)	Number (%)	Yes n (%)	No n (%)	P-value
Sex of child	Male	5344	52.01	1437(27)	3907(73)	0.188
	Female	4930	47.99	1365(27.7)	3565(72.3)	
Sex of household head	Male	7438	72.4	2086(28)	5352(72)	0.002
	Female	2836	27.6	716(25)	2120(75)	
Preceding birth interval	1-18	850	8.27	380(44.7)	470(55.3)	<0.0001
	19-36	5574	54.25	1361(24.4)	4213(75.6)	
Media access	greater than 36	3850	37.47	1061(27.6)	2789(72.4)	<0.0001
	No	7211	70.19	2115(29.3)	5096(70.7)	
Marital status	Yes	3063	29.81	687(22.4)	2376(77.6)	<0.0001
	Single formerly married	1435	13.97	356(3.4)	113(96.6)	
Mother occupation	Currently married	8839	86.03	2449(27.7)	6390(72.3)	<0.0001
	not working	5255	51.15	1427(27.2)	3828(72.8)	
Husband occupation	Professional	1870	18.2	417(22.2)	1453(77.8)	<0.0001
	Agricultural	2348	22.85	759(32.3)	1589(67.7)	
Birth order	skilled/manual	801	7.8	199(24.8)	602(75.2)	<0.0001
	not working	931	9.06	263(28.2)	668(71.8)	
Birth type	Agricultural	4542	44.21	1502(33)	3040(67)	<0.0001
	Professional	1405	13.68	254(18)	1151(82)	
Sources of water	skilled/unskilled manual	1073	10.44	215(20)	858(80)	<0.0001
	Others	2323	22.61	568(24.5)	1755(75.5)	
Toile facility	1	1974	19.21	94(4.8)	1880(95.2)	<0.0001
	2, 3 or 4	4387	42.7	792(18)	3595(8)	
Electricity	5 and more	3913	38.09	1916(49)	1997(51)	<0.0001
	Single birth	10114	98.44	2716(26.9)	7398(73.1)	
Fuel source	Multiple birth	160	1.56	86(53.8)	74(46.2)	<0.0001
	pipewater	3768	36.68	760(20)	3008(80)	
Family size	tube-well	2740	26.67	871(31.7)	1869(68.2)	<0.0001
	Others	3766	36.66	1171(31)	2595(69)	
Floor material	No facility/bush/field	4007	39	1258(31.4)	279(68.6)	<0.0001
	with facility	6267	61	1544(24.6)	4723(75.4)	
Wall material	No	7086	68.97	2253(31.8)	4833(68.2)	<0.0001
	Ye	3188	31.03	549(17.2)	2639(82.8)	
Roof material	Electricity	759	7.39	83(10.9)	676(89.1)	<0.0001
	gas/kerosene	108	1.05	20(18.5)	88(81.5)	
Sources of water	Others	9407	91.56	2699(28.7)	6708(71.3)	<0.0001
	At most 4	3767	36.67	822(21.8)	2945(78.2)	
Floor material	5-7	4648	45.24	1408(30.3)	3240(69.7)	<0.0001
	8+	1859	18.09	572(30.8)	1287(69.2)	
Roof material	natural floor/dung	7760	75.53	2406(31)	5354(69)	<0.0001
	wood/parquet	979	9.53	151(15.4)	828(84.6)	
Wall material	Cement	1535	14.94	245(16)	1290(84)	<0.0001
	natural roofing	3426	33.35	1065(31)	2361(69)	
Sources of water	Rudimentary	1074	10.45	364(33.9)	710(76.1)	<0.0001
	finished roofing	5774	56.2	1373(23.8)	4401(76.2)	
Floor material	natural wall	141	1.37	487(33)	984(67)	<0.0001
	Rudimentary	7654	74.5	2124(27.8)	5530(72.2)	
Wall material	finished wall	1149	11.18	191(16.6)	958(83.4)	<0.0001

TABLE 2: Continued.

	Covariates/Determinants	Number (N)	Number (%)	Ever experienced an Under five death		P-value
				Yes n (%)	No n(%)	
Place of delivery	Home	8984	87.4	2484 (27.6)	6500 (72.4)	0.013
	Health facility	1290	12.6	318 (24.7)	972 (74.3)	
Size of child at birth	Smaller	1714	28.6	112 (6.5)	1602 (93.5)	<0.0001
	Average	2333	38.9	86 (3.7)	2247 (96.3)	
	Larger	1945	32.5	61 (3.1)	1884 (96.9)	
Antenatal care visit	No	3521	58.7	154 (4.8)	3367 (95.2)	0.434
	Yes	2471	41.3	105 (4.3)	2366 (95.7)	
Postnatal check up	No	3236	5.4	152 (4.7)	3074 (95.3)	0.066
	Yes	2714	46	104 (3.8)	2610 (96.2)	
Breastfeeding status	No	3229	31.4	284 (8.9)	2945 (91.1)	<0.0001
	Yes	7039	68.6	227 (3.2)	6812 (96.8)	

TABLE 3: Overall model goodness of fit checking using likelihood ratio test.

	-2 Log likelihood	Likelihood Ratio Test	Df	P-value
Null model	12050.755	1872.922	59	< 0.001
Full model	10177.833			



Source: Ethiopian Demographic and Health Survey 2016

FIGURE 1

currently older women had reported the highest proportion of under-five mortalities (P value < 0.0001). Similarly, deaths among under-five children differed significantly with the level of mothers' education, with those of relatively higher education, having a lower chance of experiencing under-five deaths (P value < 0.001). The education of the father is also a major determinant factor of the under-five mortalities. Under-five mortality declines with increasing in partner's level of education. 34.9 percent of mothers whose husband has no education reported to experience under-five deaths while only 4.7 percent of those mothers whose partners have higher education reported under-five deaths (P value < 0.0001).

Also, high percentages of under-five deaths were reported among households with poor economic level, unlike minimum percent reported by rich households (P value < 0.001). Marital status was also highly associated with under-five deaths in bivariate analysis with mothers who were not currently married/formerly married at the time of the survey reported higher percent (32.9%) of the deaths of their children than mothers who were currently married (P value < 0.0001). Regarding the correlation between mother's occupation and under-five deaths, the result shows those mothers who were engaged in agricultural occupation reported a higher percentage of deaths of their children (32.3%); similarly looking at husband occupation high under-five mortalities are related to partner working in the agricultural sector (P value < 0.0001).

Also, preceding birth interval, child birth order, media exposure to contraceptive use, birth type, sources of drinking

water, access to toilet facilities, and family size household were all significant in the bivariate analysis (P value < 0.001). Those children with short birth intervals, whose mothers' have no access to media, fifth and higher birth order, large family size, and multiple births, whose family has no access to toilet had a higher chance of experiencing under-five deaths. As access to electricity and types of cooking materials used were concerned, the respondents without access to electricity and used wood or animal dung as cooking material had experienced the highest proportion of under-five deaths.

3.3. *Multivariate Analysis.* Binary logistic regression analysis was used to examine the effect of each covariate on the under five deaths. All covariates which were found to be significant in the bivariate analysis at 5% were included in the multiple logistic regression models. The result is presented in Table 4.

3.4. *Assessment of Goodness of Fit of the Model.* We start first by checking the overall goodness of fit using the likelihood ratio tests (LRT) goodness of fit test. We then proceed to test the significance of each covariate included in the model. Accordingly, the result summarized in Table 3, the likelihood ratio test based on chi-square distribution, provided a chi-square value of 1872.922 with p value < 0.0001, which would imply good fit for the model. Thus, the null hypothesis that there is no difference between the model with no covariate and the model with explanatory variables was rejected (Table 3).

TABLE 4: Determinants of under-five mortality (EDHS, 2016).

Covariates/Determinants	Odds ratio	Ever experienced an Under five death (n=10274) 95% Confidence Interval	P-value (P>Z)
Region(Addis Ababa)			
Tigray	1.332	.917, 1.935	.132
Affar	2.048	1.371, 3.058	<.0001
Amhara	1.864	1.281, 2.712	.001
Oromiya	1.447	1.002, 2.091	.049
Somali	1.412	.958, 2.080	.081
Benishangul-Gumuz	1.407	.952, 2.079	.087
SNNPR	1.916	1.305, 2.815	.001
Gambela	2.067	1.380, 3.095	<.0001
Harari	1.388	.942, 2.047	.098
Dire Dawa	1.971	1.338, 2.904	.001
Residence (Rural)			
Urban	.989	.788, 1.240	.920
Sex of household head( Female)			
Male	1.100	.958, 1.264	.177
Wealth index(Richest)			
Poorest	1.183	.871, 1.606	.402
Poorer	1.290	.971, 1.714	.282
Middle	1.160	.886, 1.520	.079
Richer	1.208	.939, 1.554	.280
Mother education (Higher)			
No education	2.610	1.598, 4.265	<.0001
Primary	2.271	1.398, 3.687	<.0001
Secondary	2.763	1.684, 4.534	<.0001
Sex of child (Female)			
Male	.956	.867, 1.054	.365

TABLE 4: Continued.  
Ever experienced an Under five death (n=10274)

Covariates/Determinants	Odds ratio	95% Confidence Interval	P-value (P>z)
Maternal age at first birth(25 and higher)			
11-17	1.556	1.243, 1.949	<.0001
18-24	1.200	.967, 1.489	.098
Maternal age(45-49)			
24 and less	.295	.227, .383	<.0001
25-29	.350	.285, .429	<.0001
30-34	.405	.337, .487	<.0001
35-39	.554	.464, .661	<.0001
40-44	.690	.573, .831	<.0001
Husband occupation (Others)			
not working	.679	.533, .864	.001
Agricultural	.951	.780, 1.159	.618
Professional	.783	.618, .991	.042
skilled/unskilled manual	.955	.747, 1.220	.711
Mother occupation( skilled/manual)			
not working	.816	.666, .999	.008
Professional	1.012	.808, 1.267	.049
Agricultural	.960	.776, 1.187	.917
Birth order(5 and more)			
1	.110	.084, .145	<.0001
2, 3 or 4	.382	.335, .436	<.0001
Preceding birth interval ( greater than 36)			
1-18	2.164	1.821, 2.570	<.0001
19-36	1.320	1.181, 1.474	<.0001
Fuel (Others)			
Electricity	1.031	.757, 1.404	.358
gas/kerosene	1.516	.858, 2.678	.848
Birth type (Multiple birth)			
Single birth	.355	.250, .505	.001

TABLE 4: Continued.  
Ever experienced an Under five death (n=10274)

Covariates/Determinants	Odds ratio	95% Confidence Interval	P-value (P>z)
Religion (Others)			<.0001
Coptic orthodox	.809	.557, 1.173	.263
Protestant	.713	.495, 1.026	.069
Muslim	1.040	.721, 1.499	.833
Place of delivery (Home)			
Health center	0.494	0.293, 0.832	0.008
Breastfeeding status (Yes)			
No	2.894	2.418, 3.464	<0.0001
Size of child at birth (larger)			
Smaller	1.907	1.325, 2.747	0.001
Average	1.082	0.751, 1.559	0.672
Sources of water*place of residence			
Wealth index*toilet facility	-.2296426	-.4244 -.0349	0.021
Wealth index*mother education	-.1654054	-.262 -.069	0.001
Wealth index*mother age	-.076356	-.150 -.0024	0.043
Mother education*mother age	0.199	0.103, 0.29	<0.0001
Preceding birth interval*birth order	-0.123	-.177 -.069	<0.0001
Preceding birth interval*birth type	.7549096	.545 .965	<0.0001

Reference categories are in parenthesis.

**3.5. Interpretation of Logistic Regression Results.** Table 4 presents the logistic regression analysis, containing parameter estimates associated with each socioeconomic and demographic factor, together with the estimates of the odds ratios (OR). The relationship between the probability of under-five deaths and the socioeconomic and demographic factors was explored using odds ratios.

The probability of under-five deaths was 2.048 times (OR=1.24, 95% CI: 1.371, 3.058) more likely to occur among children whose mother is from Affar region (OR=1.24, 95% CI: 1.371, 3.058), about 87% more likely to occur among children whose mother is from Amhara region (OR=1.867, 95% CI: 1.281, 2.712), 40% more likely to occur among children whose mother is from Oromiya region (OR=1.477, 95% CI: 1.002, 2.091), 91.6% more likely to occur among children whose mother is from SNNP region (OR=1.916, 95% CI: 1.305, 2.815), 2.067 times more likely to occur among children whose mother is from Gambela region (OR=2.067, 95% CI: 1.380, 3.095), and 97% more likely to occur among children whose mother is from Dire Dawa city (OR=1.971, 95% CI: 1.338, 2.904) compared with those whose mothers reside in Addis Ababa. Level of education had a statistically significant effect on the experience of under-five deaths. Children born to a mother with no education at all were associated with a 2.61% time increased risk of under-five deaths compared to being born to mother with higher education (OR=2.610, 95% CI: 1.598, 4.265); children from mother with only primary education were 2.27 times more likely to at the risk of under-five mortality (OR=2.271, 95% CI: 1.398, 3.687), while children born to mother with secondary education were 2.163 times more likely to die before celebrating their fifth birthday (OR=2.163, 95% CI: 1.184, 3.534) compared to being born to mother with higher education, keeping all other covariates constant.

Results in Table 4 indicate that age of respondents had a positive and statistically significant impact on under-five deaths. Children born from mothers whose age less than or equal to 24 have a significantly lower risk of under-five mortalities (OR=0.295, 95% CI: .227,.383) compared to those born from mothers whose age is between 45 and 49. The risk of under-five death was about 65% lower for births from mothers aged 25-29 (OR=0.35, 95% CI: .285, .429), 59.5% lower for births from mothers aged 30-34 (OR=0.405, 95% CI: 1.337, .487), 44.5% lower for births to mothers aged 35-39 (OR=0.554, 95% CI: .464, .661), and 31% lower for births to mother aged 40-44 (OR=0.690, 95% CI: .573, .831), compared with births to mother age group 45-49 years. Similarly, age of mother at first birth was significantly associated with under-five mortalities (P value < 0.0001). The risk of under-five mortality was about 55.6% higher for births to mother give birth at earlier age 11 to 17 years compared with births to mothers 25 and higher years old (OR=1.556, 95% CI: 1.243, 1.949) (Table 4).

Employment status of mothers and husband were identified as significantly associated factors with under-five deaths (P value < 0.05). The odds of under-five mortalities was 18.4% (OR=0.816, 95% CI: .666, .999) lower among women who were to working at all compared to those who were skilled or manual worker. The probability of child mortality, under-five,

was 32% (OR=0.679, 95% CI:.533, .864) and less likely to occur among women with an unemployed husband and 22% (OR=.783, 95% CI: .618, .991) less likely to occur among women whose husbands were professionally employed compared with those who were working as sales and others. Further Table 4 showed that children of higher birth order, of short preceding birth interval, and with multiple births have a significantly higher under-five mortality risk. Children with first birth order have an 89 percent (OR=.110, 95% CI: .084, .145) lower risk of under-five mortalities, while those children with birth order of second, third, or fourth were 62 percent (OR=.382, 95% CI: .335, .436) lower risk of under-five deaths than a child with birth order five and above. The odds of under-five death were 2.164 (OR=2.164, 95% CI: 1.821, 2.570) times higher for children with 1 to 18 months preceding birth interval, while it was 32% (OR=1.320, 95% CI: 1.181, 1.474) higher among children who had 19-36 months preceding birth interval compared with those who had 36 and higher months preceding birth interval. The findings of this study also show that single birth children were 64.5 percent (OR=0.355, 95% CI: .250, .505) less likely to die before fifth birthday compared to those who have multiple births.

Place of delivery was found significantly associated with under-five mortalities; the odds of under-five deaths were about 50% times lower among children born at health center than the home deliveries (OR = 0.494; 95% CI: (0.293, 0.832)). The study also reveals that availability of size of a child at birth had a negative impact of on under-five deaths. The odds of under-five mortalities were 90% times higher among babies born with small size than those with larger size (OR = 1.907; 95% CI: (1.325, 2.747)).

The significance of interaction terms was considered to examine the degree of association among the independent variables. As interaction effects are concerned the interaction between place of residence and source of drinking water, wealth index and toilet facility, wealth index and mother education, mother education and mother age, preceding birth interval and child birth order, and preceding birth interval and birth type were significantly associated with under-five mortalities. The coefficients associated with the interaction terms of the rest predictor variables were statistically insignificant (results not presented).

## 4. Discussion

This study utilized the Ethiopian Demographic and Health Survey 2016 dataset, exploring the effect of underlying socioeconomic, demographic, and cultural factors on under-five mortalities in Ethiopia. From multivariate logistic regression analysis, it was found in this study that the risk of under-five mortalities has significant associations with the region area of residence, educational level of the mother, current age of mother, mother's age at first birth, occupation of mother, partner's occupation, birth order, preceding birth interval, and birth type. It was found in this study that the risk of under-five mortalities was higher in Affar, Amhara, Oromiya, Somali, South Nations, Nationalities Peoples region, Gambela regions, and Dire Dawa than of residents in Addis Ababa. This study explicitly shows the existence of inconsistency in the

distribution of under-five mortalities among the regions of Ethiopia [9, 10, 12].

The findings of the study show that being born to a mother with education, schooling was associated with decreased risk of under-five deaths compared to being born to mothers with no education. Thus, educational level of mothers is an important and significant factor of under-five mortality risks in Ethiopia. Several studies in the literature reported a negative relationship between child death and mothers' education level [20–24]. They indicated that education improved the ability of mothers to implement simple health knowledge and facilitated their capacity to manipulate their environment, including healthcare facilities, and interact more effectively with health professionals. Furthermore, educated women have greater control over health choices for their children.

Maternal age at first birth and current age of mothers were identified as a strong predictor of under-five mortalities in both bivariate and multivariate analysis after controlling for the effects of other covariates. Results also show that children born from mothers whose age at first birth is below 17 years have a significantly higher risk of mortality compared to those born from mothers whose age at first birth is 25 and higher. This finding was consistent with the result of [9, 12–14] that mothers who gave birth at an earlier age had a high chance of experiencing child mortality. Moreover, children under the age of five from older age mothers were at a higher risk of experiencing death than those from mothers under 40 years old. According to [5, 8, 20] the highest odds, for under-five deaths, were among mothers who gave birth lately after 45 years old.

Other significant determinants of under-five deaths are birth order, birth interval, and birth type. The results from this study showed that children who were birth order 5 or above are at risk of dying. Previous literature also revealed that the high birth order had a favorable child death than first birth [19, 24, 29]. Similarly, short birth spacing highly correlated risk of under-five mortalities; this is consistent with available literature that states that birth interval is a strong predictor of child mortality [19, 24, 32, 33]. Children of multiple births had an increased risk for death compared to the reference category of a single birth. This finding is in agreement with studies which shows a significant association between type of birth of babies and under-five deaths [23, 29].

Place of delivery and size of baby at birth were found to have significant association with under-five mortalities, such that children born at home had an increased risk of death compared to those born at health facilities. On the other hand babies born with small size were more likely to experience under-five deaths. This finding consistent with prior studies by [16, 24, 32, 34] reported a significant association between place of delivery and birth weight with under-five mortalities.

Finally, a woman who had didn't work and whose husband has no work at all was found to have a higher risk of experiencing child mortality. This finding is consistent with [21, 33] while some researchers in literature found there is no significant association between under-five mortalities occupational status of mothers and fathers [22, 24].

## 5. Conclusions

The study has examined the factors that are associated with the risk of under-five mortalities in Ethiopia based on Ethiopian DHS 2016 dataset using logistic regression analysis. This result supports that under-five mortality is still an important public health issue in Ethiopia.

According to the results of multivariate logistic regression model, it was found that living in Affar, Amhara, Oromia, SNNP, Gambela, and Dire Dawa regions, child being born from illiterate mothers, mother with primary or secondary education, mother's age less than 17 at time of first birth, mothers having older age above 40 years of age, and having short birth interval, high birth order, multiple births, and having mothers with no work were significant determinants that increase the risk of under-five mortalities in Ethiopia. However, some socioeconomic and demographic factors of the mother and household such as wealth index, religion, sources of drinking water, sanitation services, and current marital status of mother were found to be insignificant factors of child mortality in this study.

In recent decades, Ethiopia has achieved significant declines in under-five and infant mortality rates. However, under-five mortality rates have stayed higher in some regions. Therefore, interventions that focus on birth spacing, mothers living in Affar and Gambela, and uneducated mothers are required for improving child survival in Ethiopia. Further research is required to enable an understanding of the distribution of under-five mortalities across all the different regions in Ethiopia.

The author recommended further investigation had to be conducted including variables not include in this study and to use spatial models to account spatial variation of experiencing under-five mortality since regional variations are significant.

*5.1. Strength and Limitations of the Study.* This study uses a nationally representative survey dataset, which enhances inferences for the entire country level. The major strength was that interaction effects were examined in the study. However, this study is based on secondary data the major limitation was that some important determinant factors of under-five mortalities like mode of delivery and mothers' HIV status were missed due to high missing values in the data. The other weakness of study was mother's recall of events that took place for the past five years preceding the survey which is subject to recall bias.

## Abbreviations

CSA:	Central Statistics Agency
DHS:	Demographic and Health Survey
EDHS:	Ethiopia Demographic and Health Survey
LRT:	Likelihood Ratio Test
MDG:	Millennium Development Goal
SDGs:	Sustainable Development Goals
USAID:	United States Agency for International Development

VIF: Variance Inflation Factor  
 WHO: World Health Organization.

## Data Availability

The data used to support the findings of this study are available from the corresponding author upon request.

## Disclosure

The author's full address is Department of Statistics, College of Natural and Computational. The author declares that the research is their original work, and all sources of materials used have been duly acknowledged.

## Conflicts of Interest

The author declares that they have no conflicts of interest.

## Authors' Contributions

Berhanu Teshome Woldeamanuel planned and prepared the overall manuscript and analyzed, interpreted, and finalized the article.

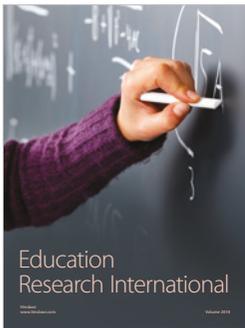
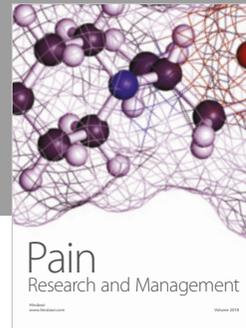
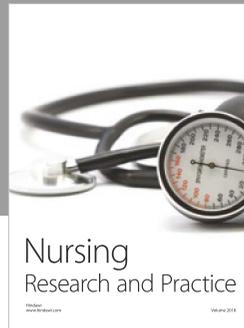
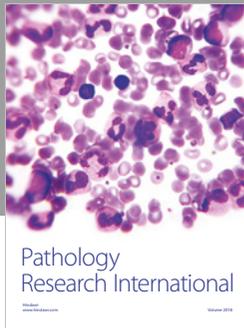
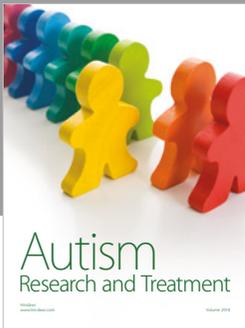
## Acknowledgments

The authors are grateful to ICF macro (Calverton, USA) for providing the 2016 DHS data of Ethiopia.

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