Factors associated with anemia among children 6-59 months in Ethiopia, using Ethiopia Demographic and Health Survey data, 2016

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Research article

Keywords: Anemia Associated, Children, EDHS 2016, and Ethiopia

Posted Date: August 4th, 2020

DOI: https://doi.org/10.21203/rs.3.rs-30843/v2

Abstract

Background: Anemia is the most common nutritional problem and a wide spread micronutrient deficiency disorder even at global scale. In Ethiopia, child hood anemia is highly prevalent and a big public health concern. This study aimed to identify factors associated with anemia among 6-59 months children in Ethiopia.

Method: The data was extracted from 2016 Ethiopia Demographic and Health Survey. We found a data record for 8603 children aged 6-59 months in the EDHS 2016 data set. After excluding 448 children due to their incomplete record, 8155 children were included in the final analysis. Pearson's Chi-square test was used to assess an association between each factor and categorical outcome variables. Multivariable logistic regression analyses were done to determine factors associated with anemia and the significant association was declared at $p < 0.05$ for the final model.

Results: more than half (51.5%) of the children were males and the overall mean $\pm$ SD age of the children was 31.85$\pm$15.66 months. The mean $\pm$ SD of hemoglobin concentration was 10.37$\pm$17.55 g/dl. The overall prevalence of anemia was 56.6% with 3.7%, 30.4%, and 22.5% for severe, moderate, and mild anemia respectively. Increased child age, decreased maternal age, poorest rank of wealth index, mother living alone, mother engaged in outside work, increased birth order, decreased birth interval, one ANC visit, severe stunting, and severe underweight were positively significantly associated with anemia.

Conclusion

The prevalence of anemia in this study was the highest from all EDHS reports. It was increasing from the preceding report (EDHS 2011) and remains the main public health concern in Ethiopia. Comprehensive intervention strategies should be in place tailored to different government hierarchies (national, regional and district level) including household and individual level interventions for combating child hood anemia by giving an emphasis on the identified risk factors.

Background

Globally, anemia is the most common nutritional concern and wide spread public health micro-nutrient deficiency disorder that affects more than 2 billion people. According to the world health organization (WHO), it is one of the ten most health concern in the world [1, 2]. It affects both developed and developing countries with major consequences on human health as well as social and economic developments [3, 4].

Childhood anemia is a condition where a child has insufficient hemoglobin (less than 11 grams per deciliter (g/dL)) level to provide adequate oxygen to the body tissues [5]. In children, anemia results in low oxygenation of brain tissues, which in turn to an impaired cognitive function, growth and psychomotor development. It leads to reduced academic achievement and low income earning potential in their adulthood life [6]. Although anemia can occur at any time and at all stages of the life cycle [7], anemia in under-five children is a special case in its significance to support a range of morbidities and mortalities [8].

Globally, 43% of preschool-age children were anemic [9]. A study conducted in sub-Saharan Africa revealed that the prevalence of anemia among 6-59 months children was 59%, ranging from 23.7% in Rwanda to 87.9% in Burkina Faso [10]. In Ethiopia, childhood anemia is a big public health concern. The trend of anemia among children 6-59 months declined from 54% in 2005 to 44% in 2011, but increased to 56.6% in EDHS 2016 [11].

Even though several pocket studies were conducted in various settings of the country, most shreds of evidence lack consistency, use unrepresentative sample, use poor laboratory test method (shaliheillage method) for hemoglobin determination and un inclusiveness of the associated factors in the collected data. Having a high prevalence of childhood anemia in Ethiopia, identifying and addressing the associated factors could be an important step in order to design successful interventional strategies at national level. Therefore, this study was designed to assess the factors associated with anemia among children aged 6– 59 months in Ethiopia and to inform health authorities at different levels of the government hierarchies on the type of risk factors to be targeted and type of measures to be taken to prevent and control child hood anemia.

Methods And Materials

Data source, study setting, study design and population:

EDHS are periodical surveys with five years interval. The 2016 EDHS is the fourth and the most recent DHS in Ethiopia, following the 2000, 2005 and 2011 EDHS surveys. The 2016 EDHS was conducted on a nationally representative sample of nine regional states and two city administrations of the country. Subdivided into 68 zones, 817 districts and 16,253 kebeles (lowest local administrative units of the nation).The full data set of EDHS 2016 is available and accessible on the DHS program website:http://dhsprogram.com/data/dataset/EthiopiaStandard-DHS_2016.cfm. Children 6-59 months of age, with hemoglobin level record, were included in this study. Community based cross sectional study design was used. Randomly selected children aged 6-59 months with hemoglobin data in their data record in the archive of EDHS 2016 data were included as study participants.

Sample size determination and sampling procedure:

The study participants selected using a stratified, two stage cluster design, and enumeration areas were the sampling units for the first stage. In the first stage, 645 enumeration areas were randomly selected: 202 in urban areas and 443 in rural areas. In the second stage, a fixed number of 28 households per cluster were selected randomly for each enumeration areas. The 18,060 households were randomly selected and 16,650 households were eligible and interviewed. Additional information about the methodology of EDHS 2016 can be accessed in the published report of the main findings of the survey [11].

Every child in the selected households was included and data were collected on various health and nutrition variables, in addition to measurement of hemoglobin level for children aged 6 to 59 months. As our focus in this study was in 6-59 months aged children, we extracted the EDHS 2016 data set. We found a data record for 8603 children aged 6-59 months in the EDHS 2016 data set. After excluding 448 children due to their incomplete record, 8155 children were included in the final analysis (Figure 1).

Variables and measurements:

Dependent variable:

The outcome variable was anemia status of children aged 6 to 59 months.

Independent variables:

The selection of the independent variables was guided by the literature and availability of the variables in the data set. Some of the independent variables for anemia among children 6-59 months are:

Maternal characteristics: maternal age, maternal educational status, maternal antenatal care follow up, whether the mother is currently living with her husband or not, whether the mother is engaged in income generating work or not, and deworming during pregnancy.

Household characteristics: wealth index ranked in to five (poorest, poorer, middle, richer and richest), number of household members, number of under five children in the household, sex of household head, and residence.

Child characteristics: child age, birth order, birth interval, birth status (single/multiple), recent diarrhea, stunting, wasting, underweight, and vitamin A supplementation in the preceding six months.

Hematologic measurement:

Blood sample for hemoglobin test was drawn from a finger or a heel prick and hemoglobin level for each child was measured adjusted to altitude using the HemoCue®201 analyzer (Sweden). Anemia was defined as hemoglobin level of less than 11.0 g/dL. It was further categorized into mild, moderate, and severe anemia with a hemoglobin range of 10-<11g/dl, 7-<10g/dl, and <7g/dl respectively [11].

Anthropometric measurements:

The length of children aged < 24 months was measured during the EDHS in a recumbent position to the nearest 0.1 cm using a length measuring board with an upright wooden base and movable headpieces. Children ≥24 months were measured while standing upright. Data collectors have used stadimeter for height measurement, with the subjects positioned at the Frankfurt plane and the four points (heel, calf, buttock, and shoulder) touching the vertical stand and without shoes.Weight was measured using a digital scale with light closes and without shoes. The validity of the weighing scale was checked before starting in the morning and between each measurement using a known weight. The height and weight measuring devices were placed on a level surface. All anthropometric measurements were donein triplicate and the average values were used for furtheranalyses. Underweight, stunting, and wasting were calculated using the World Health Organization Child Growth Standards and defined as WAZ < −2.0, HAZ < −2.0, and WHZ < −2.0 standard deviations (SD) respectively [12].

Wealth index

A wealth index in the EDHS survey was calculated based on household asset data to categorize individuals into five wealth quintiles (poorest, poorer, medium, richer and richest). Variables included in the wealth index were ownership of selected household assets (television, bicycle or car), size of agricultural land, quantity of livestock and materials used for house construction [13].

Data Analysis

After data were extracted, we have checked or its completeness and consistency and we did preliminary analysis. Sample weights were applied in all analysis due to the two stage cluster sampling design in the EDHS dataset to reimburse for the unequal probability of selection between the strata [11]. Data analysis was carried out using STATA version v.14. Descriptive statistics was done to describe the data like frequencies and percentages.

Logistic regression analysis was used to identify factors associated with childhood anemia. Bivariate analysis was performed to see the crude association of each independent variable with the outcome variable (anemia status). Those explanatory variables with P-value less than 0.05 in the bivariate analysis were included in the final multivariable logistic regression analysis to adjust for confounding and to identify the final factors associated with anemia. Backward logistic regression method was used during the multivariable logistic regression analysis. Before inclusion of predictors to the final logistic regression model, the multi-collinearity was checked using VIF<10/Tolerance >0.1 for continuous independent variables. The goodness of fit of the final logistic model was tested using Hosmer and lemeshow test at p value of >0.05. Outcome measures have been indicated by odds ratio with 95% confidence interval. The significant association was declared at p< 0.05 for the final logistic regression model.

Ethical Considerations:

The study proposal got ethical approval from Tigray health research institute and formal letter of permission was obtained from measure DHS project website to access the dataset (http://www.measuredhs.com).

Results

Sociodemographic and other characteristics of the mothers:

Half (49.6%) of the mothers/caregivers of the children were within the age group of 20-29 years and around two third (64.7%) were Illiterate. Majority (81.9%) of mothers were rural residents and more than two-third of the mothers (71.4%) were not currently working to generate income. More than one third (36.7%) of households were grouped under poorest rank of wealth index. One-third (33.6%) of mothers did not visit antenatalcare and 37.1% mothers reported the recommended number of ANC visit (four and above) during their recent pregnancy. One-fourth (24.7%) of mothers were underweight and one out of ten (9.3%) were overweight and obese. Half (50.8%) of the households had 4-6 family members and more than three quarter (79.1%) were male-headed (Table1).

Table 1: socio demographic and other characteristics of the mother, EDHS 2016 (n = 8,155)

Variables		Frequency	Percent
Maternal age (years)	<20	243	3.0%
	20-24	1592	19.5%
	25-29	2456	30.1%
	30-34	1864	22.9%
	35-39	1299	15.9%
	40-44	535	6.6%
	>=45	166	2.0%
Maternal educational status	No education	5277	64.7 %
	Primary	2065	25.3%
	Secondary	525	6.4%
	Tertiary	288	3.5%
BMI of the mother	Underweight	2016	24.7%
	Normal	5383	66.0%
	Overweight	578	7.1%
	Obese	171	2.1%
ANC follow up	Zero	1803	33.6%
	One	245	4.6%
	Two	395	7.4%
	Three	933	17.4%
	Four and above	1995	37.1%
Engaged in income generating work	Yes	2330	28.6%
	No	5825	71.4%
Residence	Rural	6681	81.9%
	Urban	1474	18.1%
Number of household members	<4	876	10.7%
	4-6	4143	50.8%
	7-9	2626	32.2%
	>=10	510	6.3%
Sex of household head	Male	6447	79.1%
	Female	1708	20.9%
Wealth index	Poorest	2996	36.7%

Poorer	1416	17.4 %
Middle	1175	14.4%
Richer	1005	12.3%
Richest	1563	19.2%

BMI: Body Mass Index, ANC: Antenatal Care

Characteristics of 6-59 months aged children:

Data for 8,155 children were included in the analysis. More than half (51.5%) of the study participants were males and the overall mean±SD age of the children was 31.85±15.66 months with no significant mean age difference between gender (p=0.107). Around 81.9% children were rural residents. More than one third (36.5%) of children had first and second birth order. The overall mean ± SD birth interval of the children was 38.29±22.15 with significantly higher (38.66±22.06) among females than males (37.93±22.24) (p=0.001).More than one-third (35.5%) of the households had only one under five child and 45.6% households had two under five children. The prevalence of stunting, underweight, and wasting was 38.0%, 24.0%, and 10.0% respectively. The prevalence of stunting was significantly higher (39.4%) among males compared with females (36.6%) (p=0.014). The prevalence of wasting was also significantly higher (10.8%) among males compared with females (9.1%) (p=0.026). Less than half (47.9%) of the study participants had been supplemented with vitamin A capsule in the preceding 6 months and only 2.4% children had multiple birth status. Around 11.8% children reported recent diarrhea (Table 2).

Table 2: Characteristics of 6-59 months children stratified by sex in Ethiopia (n = 8,155)

Variables		All n(%)	Male n(%)	Female n(%)	Chi-square	p-value
Sex		8155 (100.0%)	4197 (51.5%)	3958 (48.5%)	**NA**	**NA**
Age in months (mean±SD)		31.85±15.66	32.12±15.59	31.56±15.73	t=1.614	0.107
Age (months)	6-11	963 (11.8%)	486 (11.6%)	477 (12.1%)	4.986	0.289
	12-23	1813 (22.2%)	897 (21.4%)	916 (23.1%)		
	24-35	1772 (21.7%)	931 (22.2%)	841 (21.2%)		
	36-47	1736 (21.3%)	901 (21.5%)	835 (21.1%)		
	48-59	1871 (22.9%)	982 (23.4%)	889 (22.5%)		
Residence	Rural	6681 (81.9%)	3432 (81.8%)	3249 (82.1%)	0.136	0.712
	Urban	1474 (18.1%)	765 (18.2%)	709 (17.9%)		
Birth order	First	1594 (19.5%)	826 (19.7%)	768 (19.4%)	3.129	0.680
	Second	1386 (17.0%)	705 (16.8%)	681 (17.2%)		
	Third	1211 (14.8%)	606 (14.4%)	605 (15.3%)		
	4^{th} and 5^{th}	1920 (23.5%)	1010 (24.1%)	910 (23.0%)		
	6^{th} and 7^{th}	1287 (15.8%)	651 (15.5%)	636 (16.1%)		
	8^{th} and above	757 (9.3%)	399 (9.5%)	358 (9.0%)		
Recent diarrhea	Yes	961 (11.8%)	519 (12.4%)	442 (11.2%)	2.811	0.094

	No	7182 (88.2%)	3672 (87.6%)	3510 (88.8%)		
Number of under five children in the Household	1	2880 (35.5%)	1521 (36.4%)	1359 (34.6%)	3.369	0.186
	2	3696 (45.6%)	1868 (44.8%)	1828 (46.5%)		
	3 and more	1528 (18.9%)	784 (18.8%)	744 (18.9%)		
Birth interval (mean±SD) in months		38.29±22.15	37.93±22.24	38.66±22.06	t=3.398	0.001*
Birth interval	First order	1603 (19.7%)	829 (19.8%)	774 (19.6%)	8.224	0.084
	<24 months	1594 (19.5%)	823 (19.6%)	771 (19.5%)		
	24-35 months	2109 (25.9%)	1132 (27.0%)	977 (24.7%)		
	36-47 months	1304 (16.0%)	650 (15.5%)	654 (16.5%)		
	48-59 months	1545 (18.9%)	763 (18.2%)	782 (19.8%)		
Stunting	Severe	1332 (17.3%)	727 (18.4%)	607 (16.2%)	8.524	0.014*
	Moderate	1593 (20.7%)	829 (21.0%)	765 (20.4%)		
	Normal	4772 (62.0%)	2393 (60.6%)	2376 (63.4%)		
Underweight	Severe	576 (7.6%)	302 (7.7%)	274 (7.4%)	5.911	0.052
	Moderate	1245 (16.4%)	673 (17.3%)	572 (15.5%)		
	Normal	5776 (76.0%)	2922 (75.0%)	2854 (77.1%)		
Wasting	Severe	196 (2.3%)	106 (2.7%)	90 (2.4%)	7.303	0.026*

	Moderate	561 (7.4%)	314 (8.1%)	247 (6.7%)		
	Normal	6842 (90.0%)	3474 (89.2%)	3368 (90.9%)		
Vitamin A supplementation in the last 6 months	Yes	3686 (47.9%)	1894 (47.9%)	1792 (48.0%)	0.052	0.975
	No	3879 (50.5%)	1995 (50.5%)	1884 (50.4%)		
	Don't know	124 (1.6%)	65 (1.6%)	59 (1.6%)		
Birth status	Single	7503 (97.6%)	3857 (97.5%)	3646 (97.6%)	0.04	0.841
	Multiple	186 (2.4%)	97 (2.5%)	89 (2.4%)		

SD: Standard deviation, NA: Not Applicable

Prevalence of anemia among 6-59 months children stratified by gender:

The overall prevalence of anemia was 56.6% with 3.7%, 30.4%, and 22.5% for severe, moderate, and mild anemia respectively (Figure 2). The mean $\pm$ SD hemoglobin concentration was 10.37$\pm$17.55 with no significant difference among gender ($p = 0.355$). Anemia was most prevalent in Somali regional state followed by Afar and Oromiaregional states with a prevalence of 73.9%, 70.4%, and 62.4% respectively and the lowest prevalence (41.2%) was found in Amhara regional state (Figure 3). The prevalence of anemia among children significantly decreased with age ($p<0.001$) with a prevalence of 73.5% among the lowest age range (6-11 months) and 40.0% among the highest (48-59 months) age range. That means, as child age increases, hemoglobin concentration also increases ($r = \sim 0.3$) (Figure 4). Anemia prevalence was also significantly decreased with increasing birth interval of the child ($p<0.001$). The prevalence was 52.6%, 63.0% and 50.0% amongfirst birth order children,thelowest birth interval (<24 months), and the highest birth interval (>=48 months) respectively. Anemia prevalence was significantly increased with increasing birth order of the child ($p<0.001$) with a prevalence of 52.7% among first birth order children and 59.8% among the highest birth order (eighth order and above).Anemia prevalence significantly increased with increasing number of under five children in the household ($p<0.001$)

with a prevalence of 50.6%, 58.1%, and 64.9% in households with 1, 2, and 3 and over under five children respectively.

Children with recent diarrhea had significantly higher (61.9%) anemia prevalence compared to children without recent diarrhea (55.9%) ($p<0.001$).Children who had been supplemented with vitamin A in the preceding 6 months had significantly lower (54.0%) anemia prevalence compared to children who did not supplemented (59.1%) ($p<0.001$).Anemia prevalence among children was also significantly increased with increasing severity of stunting, underweight, and wasting ($p<0.001$). Considering the nutritional status of children, the highest prevalence of anemia was documented among severely wasted children followed by severely underweight and severely stunted children with 73.2%, 71.1%, and 64.9% respectively.

Significantly higher prevalence of anemia was documented among rural children (58.4%) compared to urban children (48.3%) ($p<0.001$). Anemia significantly consistently decreased with increasing maternal age ($p<0.001$) with the highest (68.3%) prevalence among the lowest age range (<20 years) and the lowest (44.0%) prevalence among the highest age range (>=45 years). As level of literacy of the mother increased, anemia prevalence among children was consistently significantly decreased (($p<0.001$) with a prevalence of 59.2%, 54.8%,47.6%, and 39.6% among mothers who cannot read and write, with primary, secondary, and tertiary education respectively.Anemia was significantly decreased with increasing wealth index of the household ($p<0.001$). The highest prevalence (65.7%) was documented in the poorest household and the lowest prevalence (46.6%) in the richest household. As nutritional status of the mother (indicated by BMI) increased, the prevalence of anemia among children was significantly decreased ($p<0.001$). But a slight shift was observed for obese mothers. The prevalence was highest (61.4%) among children of underweight mothers followed by normal (55.8%), overweight (48.6%), and then slightly increased (51.5%) among children of obese mothers (Table 3, Figure 5).

Table 3: Anemia status of 6-59 months children stratified by sex in Ethiopia (n = 8,155)

Variables		Anemia			Chi-square	p-value
		All n(%)	Male n(%)	Female n(%)		
Sex		4617 (56.6%)	2391 (57.0%)	2226 (56.2%)	0.440	0.507
Hemoglobin in g/dl (mean ± SD)		10.37±17.55	10.35±17.69	10.39±17.39	0.925	0.355
Anemia	Severe	303 (3.7%)	157 (3.7%)	146 (3.7%)	3.415	0.332
	Moderate	2483 (30.4%)	1313 (31.3%)	1170 (29.6%)		
	Mild	1831 (22.5%)	921 (21.9%)	910 (23.0%)		
Age (months)	6-11	708 (73.5%)	356 (73.3%)	352 (73.8%)	466.730	p<0.001*
	12-23	1250 (68.9%)	627 (69.9%)	623 (68.0%)		
	24-35	1040 (58.7%)	540 (58.0%)	500 (59.5%)		
	36-47	870 (50.1%)	461 (51.2%)	409 (49.0%)		
	48-59	749 (40.0%)	407 (41.4%)	342 (38.5%)		
Residence	Rural	3905 (58.4%)	2009 (58.5%)	1896 (58.4%)	50.604	p<0.001*
	Urban	712 (48.3%)	382 (49.9%)	330 (46.5%)		
Birth order	First	840 (52.7%)	460 (55.7%)	380 (49.5%)	24.248	p<0.001*
	Second	746 (53.8%)	371 (52.6%)	375 (55.1%)		
	Third	705 (58.2%)	358 (59.1%)	347 (57.4%)		
	4^{th} and 5^{th}	1106 (57.6%)	580 (57.4%)	526 (57.8%)		
	6^{th} and 7^{th}	767 (59.6%)	391 (60.1%)	376 (59.1%)		
	8^{th} and above	453 (59.8%)	231 (57.9%)	222 (62.0%)		
Recent diarrhea	Yes	595 (61.9%)	325 (62.6%)	270 (61.1%)	12.468	p<0.001*
	No	4015	2063	1952		

		(55.9%)	(56.2%)	(55.6%)		
Number of under five children	1	1456 (50.6%)	787 (51.7%)	669 (49.2%)	89.146	p<0.001*
	2	2146 (58.1%)	1085 (58.1%)	1061 (58.0%)		
	3 and more	992 (64.9%)	507 (64.7%)	485 (65.2%)		
Birth interval	First order	843 (52.6%)	462 (55.7%)	381 (49.2%)	78.291	p<0.001*
	<24 months	1005 (63.0%)	523 (63.5%)	482 (62.5%)		
	24-35 months	1275 (60.5%)	672 (59.4%)	603 (61.7%)		
	36-47 months	721 (55.3%)	344 (52.9%)	377 (57.6%)		
	>=48 months	773 (50.0%)	390 (51.1%)	383 (49.0%)		
Stunting	Severe	864 (64.9%)	476 (65.5%)	389 (64.1%)	52.968	p<0.001*
	Moderate	902 (56.6%)	481 (58.0%)	422 (55.1%)		
	Normal	2567 (53.8%)	1285 (53.7%)	1281 (53.9%)		
Underweight	Severe	410 (71.1%)	217 (71.1%)	193 (70.5%)	83.292	p<0.001*
	Moderate	752 (60.4%)	411 (61.1%)	341 (59.6%)		
	Normal	3107 (53.8%)	1577 (54.0%)	1532 (53.7%)		
Wasting	Severe	143 (73.2%)	83 (78.2%)	60 (67.4%)	48.612	p<0.001*
	Moderate	361 (64.4%)	204 (64.9%)	157 (63.8%)		
	Normal	3777 (55.2%)	1925 (55.4%)	1852 (55.0%)		
Vitamin A supplementation in the last 6 months	Yes	2095 (54.0%)	1084 (54.3%)	1011 (53.6%)	21.448	p<0.001*
	No	2450 (59.1%)	1267 (59.3%)	1183 (58.8%)		
Birth status	Single	4504	2328	2176	0.955	0.329

		(56.5%)	(56.8%)	(56.3%)		
	Multiple	113 (60.1%)	63 (64.9%)	50 (54.9%)		
Maternal age (years)	<20	166 (68.3%)	83 (69.2%)	83 (67.5%)	49.378	p<0.001*
	20-24	952 (59.8%)	507 (61.0%)	445 (58.5%)		
	25-29	1416 (57.7%)	729 (57.8%)	687 (57.5%)		
	30-34	1051 (56.4%)	547 (57.5%)	504 (55.3%)		
	35-39	697 (53.7%)	354 (52.8%)	343 (54.6%)		
	40-44	262 (49.0%)	134 (49.6%)	128 (48.3%)		
	>=45	73 (44.0%)	37 (40.2%)	36 (48.6%)		
Maternal educational status	No education	3122 (59.2%)	1617 (59.5%)	1505 (58.8%)	68.113	p<0.001*
	Primary	1131 (54.8%)	587 (55.2%)	544 (54.3%)		
	Secondary	250 (47.6%)	124 (45.8%)	126 (49.6%)		
	Tertiary	114 (39.6%)	63 (42.9%)	51 (36.2%)		
Sex of household head	Male	3616 (56.1%)	1851 (55.9%)	1765 (56.2%)	3.487	0.062
	Female	1001 (58.6%)	540 (60.8%)	461 (56.2%)		
Wealth index	Poorest	1968 (65.7%)	1034 (66.8%)	934 (64.5%)	189.483	p<0.001*
	Poorer	802 (56.6%)	411 (56.4%)	391 (56.9%)		
	Middle	608 (51.7%)	330 (53.7%)	278 (49.6%)		
	Richer	511 (50.8%)	236 (47.2%)	275 (54.5%)		
	Richest	728 (46.6%)	380 (47.1%)	348 (46.0%)		
BMI of the mother	Underweight	1238 (61.4%)	620 (61.5%)	618 (61.3%)	37.197	p<0.001*
	Normal	3004 (55.8%)	1562 (56.3%)	1442 (55.2%)		
	Overweight	281 (48.6%)	151 (48.1%)	130 (49.2%)		

Obese	88 (51.5%)	53 (54.1%)	35 (47.9%)

g/dl: gram per deciliter, SD: Standard deviation, BMI: Body Mass Index

Factors Associated with Anemia among Children Aged 6– 59 Months:

In multivariable logistic regression analysis, increased child age, decreased maternal age, poorest rank of wealth index, mother living alone, mother engaged in outside work, increased birth order, decreased birth interval, one ANC visit, severe stunting, and severe underweight were identified as significant predictors of anemia (Table 4).

The odds of developing anemia among children in the age range of 6-11, 12-23, 24-35, and 36-47 months were around 6.2 (AOR: 6.194, 95% CI: 4.622,8.301), 4.2 (AOR: 4.202, 95% CI: 3.267,5.404), 2.2 (AOR: 2.155, 95% CI: 1.667,2.787), and 1.5(AOR: 1.499, 9S% CI: 1.141,1.968)times respectivelymore likely compared with children in the highest age range (48-59 months).Children in the fourth and fifth, sixtieth and seventieth, and eightieth and above birth order had around 37% (AOR: 1.368, 95% CI: 1.086, 1.723), 50% (AOR: 1.504, 95% CI: 1.140,1.984), and 80% (AOR: 1.795, 95% CI: 1.290,2.495) respectively more odds of developing anemia compared with first birth order children. The odds of developing anemia among children with a birth interval of <18, 18-23, and 24-35 months were also around 1.7 (AOR: 1.715, 95% CI: 1.259,2.336), 1.6 (AOR: 1.593, 95% CI: 1.223,2.075), and 1.4 (AOR: 1.425, 95% CI: 1.174,1.730) times respectively more likely than children with the highest birth interval (>=48 months). Severely stunted and severely underweight children were around 1.5 (AOR: 1.467, 95% CI: 1.142, 1.885) and 1.5(AOR: 1.458, 95% CI: 1.044, 2.035) times respectively more likely to be anemic compared to normal children.

Children from mothers with an age range of <20, 20-29, and 30-39 years were 3.4 (AOR, 3.409, 95% CI: 1.143, 10.726), 1.6 (AOR: 1.643, 95% CI: 1.211, 2.229), and 1.3 (AOR: 1.293, 95% CI: 1.006, 1.662) times more likely to be anemic compared to children whose mothers were in the highest age range (40-49 years).The odds of developing anemia among children whose mothers were not living with their husband was 1.3 (AOR: 1.308, 95% CI: 1.024, 1.670) times more likely compared to children whose mothers were living with their husband. Children frommothers engaged in income generating work were 1.3 (AOR: 1251, 95% CI: 1.073, 1.462) times more likely to be anemic than children of housewives. The odds of developing anemia among children whose mothers had only one ANC visit during their recent pregnancy was 1.5 (AOR: 1.501, 95% CI: 1.017, 1.216)) times more likely than children whose mothers had the recommended number of ANC visit. Considering wealth index of the household, the odds of anemia among children from the poorest household was around 1.6 (AOR: 1.552, 95% CI: 1.235, 1.950) times more likely than children from the richest household (Table 4).

Table 4: Factors associated with anemia using bivariate and multivariable logistic regression model (n = 8,155)

Variables		Anemia		COR (95% CI)	p-value	AOR (95% CI)	p-value
		Yes n (%)	No n (%)				
Age of child in months	6-11	708 (73.5)	255 (26.5)	4.717 (3.923,5.671)	<0.001*	6.194 (4.622,8.301)	<0.001*
	12-23	1250 (68.9)	563 (31.1)	3.328 (2.890,3.832)	<0.001*	4.202 (3.267,5.404)	<0.001*
	24-35	1040 (58.7)	732 (41.3)	2.139 (1.866,2.453)	<0.001*	2.155 (1.667,2.787)	<0.001*
	36-47	870 (50.1)	866 (49.9)	1.500 (1.310,1.719)	<0.001*	1.499 (1.141,1.968)	0.004*
	48-59	749 (40.0)	1122 (60.0)	1		1	
Sex	Male	2391 (57.0)	1806 (43.0)	1.037 (0.947,1.136)	0.435		
	Female	2226 (56.2)	1732 (43.8)	1		1	
Maternal age	<20years	166 (68.3)	70 (31.7)	2.618 (1.877,3.652)	<0.001*	3.409 (1.143,10.726)	0.038*
	20-29	2368 (58.5)	1680 (41.5)	1.537 (1.301,1.816)	<0.001*	1.643 (1.211,2.229)	0.001*
	30-39	1748 (55.3)	1415 (44.7)	1.337 (1.128,1.585)	0.001*	1.293 (1.006,1.662)	0.044*
	40-49	335(47.8)	366 (52.2)	1		1	
Residence	Urban	712 (48.3)	762 (51.7)	1		1	
	Rural	3905 (58.4)	2776 (46.1)	1.339 (1.188,1.510)	<0.001*	1.432 (0.078,26.408)	0.809
Maternal educational status	Illiterate	3122 (59.2)	2155 (40.8)	1.832 (1.413,2.375)	<0.001*	1.440 (0.077,26.789)	0.807
	Primary	1131	934	1.506	0.003*	1.164	0.919

		(54.8)	(45.2)	(1.151,1.970)		(0.063,21.635)	
	Secondary	250 (47.6)	275 (52.4)	1.191 (0.874,1.624)	0.269	1.349 (0.068,26.680)	0.844
	Higher	114 (39.6)	174 (60.4)	1		1	
Number of HH members	<4	494 (56.4)	382 (43.6)	1			
	4-6	2262 (54.6)	1881 (45.4)	0.871 (0.745,1.017)	0.080		
	7-9	1555 (59.2)	1071 (40.8)	1.037 (0.881,1.221)	0.662		
	>=10	306 (60.0)	204 (40.0)	1.124 (0.889,1.421)	0.330		
Sex of HH head	Male	3616 (56.1)	2831 (43.9)	1		1	
	Female	1001 (58.6)	707 (41.4)	1.202 (1.072,1.348)	0.002*	1.128 (0.863,1.473)	0.378
Wealth index	Poorest	1968 (65.7)	1028 (34.3)	2.182 (1.911,2.491)	<0.001*	1.552 (1.235,1.950)	<0.001*
	Poorer	802 (56.6)	614 (43.4)	1.317 (1.133,1.530)	<0.001*	1.001 (0.784,1.278)	0.993
	Middle	608 (51.7)	567 (48.3)	1.050 (0.898,1.228)	0.539	0.802 (0.628,1.025)	0.079
	Richer	511 (50.8)	494 (49.2)	1.022 (0.868,1.204)	0.796	0.831 (0.646,1.070)	0.151
	Richest	728 (46.6)	835 (53.4)	1		1	
Currently living with husband	Yes	3802 (56.2)	2960 (43.8)	1		1	
	No	581 (63.0)	341 (37.0)	1.454 (1.248,1.693)	<0.001*	1.308 (1.024,1.670)	0.032*
Mother	Yes	1172	1158	0.702	<0.001*	1.251	0.006*

currently		(50.3)	(49.7)	(0.632,0.771)		(1.073,1.462)	
working	No	3445	2380	1		1	
		(59.1)	(40.9)				
Birth order	1st	840	754	1		1	
of the child		(52.7)	(47.3)				
	2nd	746	640	1.010	0.893		
		(53.8)	(46.2)	(0.869,1.175)			
	3rd	705	506	1.158	0.066	1.258	0.057
		(58.2)	(41.8)	(0.990,1.355)		(0.994,1.592)	
	4th& 5th	1106	814	1.148	0.052	1.368	0.008*
		(57.6)	(42.4)	(0.999,1.321)		(1.086,1.723)	
	6th& 7th	767	520	1.263	0.003*	1.504	0.004*
		(59.6)	(40.4)	(1.081,1.475)		(1.140,1.984)	
	8th& above	453	304	1.288	0.007*	1.795	0.001*
		(59.8)	(40.2)	(1.072,1.548)		(1.290,2.495)	
Birth status	Single	4504	3463	1			
		(56.5)	(43.5)				
	Multiple	113	75	1.031	0.842		
		(60.1)	(39.9)	(0.765,1.388)			
Birth	<18months	427	237	1.958	<0.001*	1.715	0.001*
interval of		(64.3)	(35.7)	(1.608,2.385)		(1.259,2.336)	
the child	18-23	578	352	1.810	<0.001*	1.593	0.001*
		(62.2)	(37.8)	(1.521,2.154)		(1.223,2.075)	
	24-35	1275	834	1.582	<0.001*	1.425	<0.001*
		(60.5)	(39.5)	(1.380,1.814)		(1.174,1.730)	
	36-47	721	583	1.266	0.002*	1.115	0.308
		(55.3)	(44.7)	(1.088,1.475)		(0.904,1.374)	
	>=48	773	772	1		1	
		(50.0)	(50.0)				
Number	Zero	1112	691	1.445	<0.001*	1.115	0.258
ANC follow		(61.7)	(38.3)	(1.261,1.655)		(0.923,1.345)	
up	One	165	80	1.903	<0.001*	1.501	0.041*

		(67.3)	(32.7)	(1.408,2.572)		(1.017,1.216)	
	Two	248 (62.8)	147 (37.2)	1.398 (1.111,1.758)	0.004*	1.156 (0.862,1.549)	0.333
	Three	565 (60.6)	368 (39.4)	1.227 (1.044,1.444)	0.013*	1.152 (0.933,1.422)	0.187
	Four & above	1070 (53.6)	925 (46.4)	1		1	
Deworming during pregnancy	Yes	181 (56.2)	141 (43.8)	1		1	
	No	2953 (58.9)	2061 (41.1)	1.182 (0.936,1.492)	0.161		
Recent diarrhea	Yes	602 (61.9)	371 (38.1)	1.201 (1.042,1.385)	0.011*	0.928 (0.756,1.139)	0.475
	No	4015 (55.9)	3167 (44.1)	1		1	
Vitamin A in last 6months	Yes	2095 (54.0)	1788 (46.0)	1		1	
	No	2450 (59.1)	1697 (40.9)	1.302 (1.187,1.428)	<0.001*	1.029 (0.886,1.195)	0.705
Level of stunting	Severe	864 (64.9)	468 (35.1)	1.609 (1.414,1.830)	<0.001*	1.467 (1.142,1.885)	0.003*
	Moderate	902 (56.6)	691 (43.4)	1.122 (0.999,1.259)	0.052	1.178 (0.973,1.425)	0.092
	Normal	2567 (53.8)	2205 (46.2)	1		1	
Level of underweight	Severe	410 (71.1)	166 (28.9)	2.187 (1.819,2.628)	<0.001*	1.458 (1.044,2.035)	0.027*
	Moderate	752 (60.4)	493 (39.6)	1.315 (1.166,1.484)	<0.001*	1.041 (0.840,1.289	0.714
	Normal	3107 (53.8)	2669 (46.2)	1		1	
Level of	Severe	143 (73.2)	53	2.312	<0.001*	1.380	0.227

wasting			(26.8)	(1.698,3.148)		(0.818,2.326)	
	Moderate	361 (64.4)	200 (35.6)	1.487 (1.254,1.764)	<0.001*	1.088 (0.813,1.456)	0.570
	Normal	3777 (55.2)	3065 (44.8)	1		1	

*Significant association, **Abbreviations**: COR: Crude Odds Ratio, AOR: Adjusted Odds Ratio, HH: Household, ANC: Antenatal care,

Discussion

This study assessed factors associated with anemia among children aged 6 to 59 months in Ethiopia. Anemia in children is a major public health problem and most common causes of child death in Ethiopia [14].The overall prevalence of anemia in the present study was 56.6%with 3.7%, 30.4%, and 22.5% for severe, moderate, and mild anemia respectively.Even though high rate of breastfeeding had been reported in Ethiopia, breast milk is poor in iron content. Cereal(plant) based food is commonly consumed in Ethiopia, which is low in iron content and poor in bioavailability due to phytate(which can mask iron observation) and other inhibiters [11].The magnitude of anemia reported in this study showed severe public health problem according to WHO classification[15].The present finding is in agreement with those of related studies done in developing countries. The present study finding was almost similar to study reported from Uganda (58.8%) [16], Bangladesh national representative data (51.9%) [17], higher than study done in Gonder, Ethiopia (28.6%)[18], and Honduran (39%)[19]among children.However, the result of the present study is lower than studies conducted in Togo demographic and health survey (84.6%) [20], and Ghana demographic and health survey (78.4%) [21].The difference in the prevalence might be due to variation in sample size, socio-demographic status of parents, geographic location, sampling techniques, socioeconomic status, the type of diet consumed by children, and other associated factors.

With an increase in child age, the risk of childhood anemia decreases in all age categories. The similar effect of the age of the child on anemia had been observed in the previous studies [17, 18, 20-23].The possible reason for the elevated level of anemia with in younger age children might be low balanced dietary intakes that may not be sufficient to satisfy the relatively higher iron requirement due to rapid growth [24]. Additional reason could be, younger children in Ethiopia mostly depends on breast milk, which is poor in iron content and the complementary food is entirely plant based which is poor in bioavailability and rich in absorption inhibiters like phytate. The other possible reason might be the poor infant and young child feeding practices [25] andiron stores are generally depleted by the age of six months while the blood volume doubles from 4 to 12 months after birth. Thus, the dietary sources of iron are very important to keep up with this rapid rate of red blood cell synthesis and anemia may result if the dietary sources are inadequate [26- 27]. In addition frequent childhood infection, due to high susceptibility to infection, could lead to iron malabsorption, which leads to anemia.

Children born from younger mothers were at high risk of childhood anemia.This finding was consistent with previous study findings[28, 29].This might be due to inattention to feed diversified foods for their children according to the recommended standard and their high iron requirement due to incomplete growth could lead to competition to the limited intake of iron.Severely stunted and underweight children were more likely to be anemic than their normal counter parts.Thisfinding is similar to studies conducted elsewhere[17, 23, 30, 31].This could be due to anemia and under nutrition often have a synergism association in relation to socioeconomic status, sanitation, infections, parasitic diseases and diet in the same individuals [32].

Children from poorest households were 1.6 times more likely to develop anemia than their richest counterparts. Itis in line with study in Bangladesh and Eastern Amhara, Ethiopia. Children from poor family and food insecurehouseholds were at higher risk of developing anemia than their counterparts [17, 31, 33].In contrary children from the richest and middle-class households had a lower average hemoglobin concentration than those from the poorest households [34]. The reason could be poorest households cannot afford iron rich animal based foods, and may have poor personal hygiene and environmental sanitation which leads to infection and micronutrient mal-absorption. Increasing birth order of children was significantly associated with child hood anemia,which was in line with previous studies conducted elsewhere [35-38].This might be due to distribution of scarce resources within the family and related to maternal exhaustion of micronutrients. Mild maternal iron deficiency and anemia have few significant repercussions on the iron status of the newborn but severe anemia does have a strong influence.

Birth interval of children was negatively associated with childhood anemia. The higher the birth interval, the lower the risk of developing anemia among children. This was in line with the study findings in African countries. The effect of the preceding birth interval variable on the index child's hemoglobin level was positive and with every increase of one month of the preceding birth interval, there is a gain of 0.15 g/dl hemoglobin level[39-41].This might be due to short birth interval between births might cause sharing problems among living siblings and parents can't take better care of their children and compromise the breastfeeding duration of the former child [42].The mother herself may be biologically exhausted from too frequent births, and this could also negatively affect the nutritional status and hemoglobin level of the newborn baby as a result of the intergenerational link [43].

Children born from mothers with only one ANC visit were 1.5 times more likely to be anemic than children from mothers with the recommended number of ANC visit (four times and above).Study conducted in Gonder city (Ethiopia) found that home delivery was significantly associated with childhood anemia[18].Since maternal anemia is associated with childhoodanemia [17] and study conducted in Addis Abeba, Ethiopia indicated no antenatal care visit was significantly associated with maternal anemia [44]. This could be due to the benefit of the recommended number of ANC visit for early diagnosis and treatment of maternal anemia; maternal folate and iron supplementation; provision of de-worming medication; malaria prevention, diagnosis, and management; and provision of nutrition counseling all of which could have significant impact on childhood anemia. Therefore, mothers should attend the recommended number of ANC visit during the entire period of pregnancy to minimize the risk of child hood anemia.

Limitation of the study:

The limitation of this study was its cross-sectional design, which does not allow the identification of the precedence in time between exposure and outcome (chicken egg dilemma). There were some missing values for some variables in the dataset .Therefore, the authors might be fail to consider some important factors which could affect the interpretation of the results and the retrospective nature of the data and maternal verbal reports, recall bias might have been introduced.

Conclusion

This analysis provides evidence that morethan half of the children aged 6–59 months were diagnosed to be anemic by having hemoglobin level below 11g/dl. Increased child age, decreased maternal age, poorest rank of wealth index, mother living alone, mother engaged in outside work, increased birth order, decreased birth interval, one ANC visit, severe stunting, and severe underweight were identified as significant predictors ofchildhood anemia. The prevalence of anemia in this study was the highest from all EDHS reports. It was increased from the preceding report (EDHS 2011) and remains the main public health concern in Ethiopia. Comprehensive intervention strategies should be in place tailored to different government hierarchies (national, regional and district level) including household and individual level interventions for combating child hood anemia by giving an emphasis on the identified risk factors. We advise health authorities at different hierarchies to design different nutrition intervention activities like multi-mineral supplementation (mineral sprinkle), nutrition education and continuous monitoring of nutritional status of children.In addition, further longitudinal study is needed to rule out the cause and effect relationship between childhood anemia and different explanatory variables.

Abbreviations

ANC: Antenatal care, BMI: Body Mass Index, EDHS: Ethiopia Demographic and Health Survey, g/dL: gram per deciliter, HH: Household, SD: Standard Deviation, WHO: World Health Organization

Declarations

Acknowledgements:

Not applicable.

Funding:

Not applicable.

Availability of data and materials

All data supporting our findings will be shared upon request.

Authors' contributions:

A.G contributed to the concept, data extraction tool, conducted data extraction, analysis andinterpretation of data, and wrote the first draft of the manuscript and revised it.GG, AA2,AA3,and TWcontributed to the concept and participated in protocol development and KFreviewed assessment tool, reviewed analysis findings, and revised the draft and final manuscript. Allauthors read and approved the final manuscript.

Competing interests:

The authors declare that they have no competing interests.

Consent for publication:

Not applicable.

Ethics approval and consent to participate

Not applicable.

References

1. Micronutrient deficiency: Battling iron deficiency anemia: the challenge.2004. Available from: http://www.who.int/nut/ida.htm[Accessed on December 11, 2019]
2. Black RE, Allen LH, Bhutta ZA, Caulfield LE, De Onis M, Ezzati M, Mathers C, Rivera J, Maternal and child undernutrition study group. Maternal and child undernutrition: global and regional exposures and health consequences. The *lancet*. 2008;371(9608):243–60.
3. The global prevalence of anaemia in 2011. Geneva: World Health Organization; 2015; Available from: http://www.who.int/iris/handle/10665/177094 [Accessed on December 10, 2019.
4. Chatterjee A, Bosch RJ, Kupka R, Hunter DJ, Msamanga GI, Fawzi WW. Predictors and consequences of anaemia among antiretroviral-naïve HIV-infected and HIV-uninfected children in Tanzania. *Public Health Nutr*. 2010;13(2):289-296.
5. Haemoglobin concentrations for the diagnosis of anaemia and assessment of severity Vitamin and Mineral Nutrition Information System. Geneva: World Health Organization; 2011.
6. Walter T, de Andraca I, Chadud P, Perales CG. Iron deficiency anemia: adverse effects on infant psychomotor development. *Pediatrics*.1989;84(1):7-17.
7. McLean, M. Cogswell, I. Egli, D. Wojdyla, and B. De Benoist, "Worldwide prevalence of anaemia, WHO Vitamin and Mineral Nutrition Information System, 1993–2005.*Public Health Nutrition.*2009 ;12(4): 444–454.
8. Allen LH, De Benoist B, Dary O, Hurrell R, World Health Organization. Guidelines on Food Fortification with Micronutrients.Geneva: World Health Organization; 2006. [Accessed on May 10, 2019]
9. Scott SP, Chen-Edinboro LP, Caulfield LE, Murray-Kolb LE. The impact of anemia on child mortality: an updated review. Nutrients. 2014;6(12):5915 http://apps.who.int/iris/bitstream/10665/43894/1/9789241596657_eng.pdf [Accessed on December 9, 2019].
10. Moschovis PP, Wiens MO, Arlington L, et al. Individual, maternal and household risk factors for anemia among young children in sub-Saharan Africa: a cross sectional study. *BMJ Open* 2018;8:e019654.
11. Ethiopia Demographic and Health Survey, 2016. Addis Ababa: Ethiopian Central Statistical Agency.
12. [WHO Multicentre Growth Reference Study Group, WHO Child Growth Standards: Length/Height-for-Age, Weight-forAge, Weight-for-Length, Weight-for-Height and Body Mass Index-for-Age: Methods and Development, Geneva, Switzerland, 2006.]
13. RutsteinSO: The DHS Wealth Index: Approaches for Rural and Urban Areas. DHS Working Papers. Demographic And Health Research 2008(60). Available at http://www.dhsprogram.com/pubs/pdf/WP60/WP60.pdf. Accessed 20 Oct 2013)
14. Awoke M, Tilahun NH, Kebede D, Gizachew AT, Amare D. National mortality burden due to communicable, non-communicable, and other diseases in Ethiopia, 1990–2015: findings from the Global Burden of Disease Study. *Population Health Metrics.* 2015; 15(29): pmid:28736507
15. World Health Organization. Iron deficiency anemia: assessment, prevention, and control. *A guide for programme managers*. Geneva:WHO 2001 *(WHO/NHD/01.3)*.

16. Kuziga et al. Prevalence and factors associated with anaemia among children aged 6 to59 months in Namutumba district, Uganda:a cross- sectional study .*BMC Pediatrics*. 2017; 17:25.
17. JahidurRahman Khan, Nabil Awan, FarjanaMisu. Determinants of anemia among 6–59 months aged children in Bangladesh:evidence from nationally representative data.*BMC Pediatrics*. 2016; 16:3
18. Mulugeta Melku1 , Kefyalew Addis Alene , BetelihemTerefe , BamlakuEnawgaw , BeleteBiadgo , MollaAbebe et al. Anemia severity among children aged 6–59 months in Gondar town, Ethiopia: a community-based cross-sectional study .*Italian Journal of Pediatrics*.2018; 44:107
19. Ashley Stoltenburg , Teresa M. Kemmer , Megan Lauseng , Vinod K. Gidvani , Julia Lynch , Douglas Lougee et al. Mapping of Anemia Prevalence in Rural Honduran Children Ages 6 to 60 Months. *J Hum Nutr Food Sci*.2016 4(3):108
20. Nambiema A, Robert A, Yaya I. Prevalence and risk factors of anemia in children aged from 6 to 59 months in Togo: analysis from Togo demographic and health survey data, 2013–2014. *BMC Public Health*.2019;19:215
21. Ewusie JE, AhiadekeC, Beyene J, Hamid JS. Prevalence of anemia among under-5 children in the Ghanaian population: estimates from the Ghana demographic and health survey.*BMC Public Health*.2014;14:626
22. Gebreweld A, Ali N, Ali R, Fisha T. Prevalence of anemia and its associated factors among children under five years of age attending at Guguftu health center, South Wollo, Northeast Ethiopia. *PLoSONE*. 2019; 14(7): e0218961.
23. Gebreegziabiher G, Etana B, Niggusie D. Determinants of Anemia among Children Aged 6–59 Months Living in KilteAwulaeloWoreda, Northern Ethiopia. *Anemia*. 2014; doi: 1155/2014/245870
24. Pita GM, Jiménez S, Basabe B, García RG, Macías C, Selva L, et al. Anemia in children under five years old in Eastern Cuba, 2005–2011. *MEDICC Rev*.201416(1):16–23.
25. Disha A, Tharaney M, Abebe Y, Alayon S, Winnard K. Factors associated with Infant and young child feeding practices in Amhara region and nationally in Ethiopia: analysis of the 2005 and 2011 demographic and health surveys.Washington, DC: Alive and Thrive; 2015
26. Leal LP, Batista Filho M, Lira PIC, Figueiroa JN, Osório MM. Prevalence of anemia and associated factors in children aged 6–59 months in Pernambuco, Northeastern Brazil. *Rev SaudePublica*. 2011;45(3):457–66.
27. Cardoso MA, Scopel KK, Muniz PT, Villamor E, Ferreira MU. Underlying factors associated with anemia in Amazonian children: a population-based, cross-sectional study. *PLoS One*. 2012;7(5):e36341
28. Hurtado EK, Claussen AH, Scott KG. Early childhood anemia and mild or moderate mental retardation*. Am J ClinNutr*.1999;69:115–9
29. Moschovis PP, Wiens MO, ArlingtonL,Antsygina O, Hayden D, DzikW,et al. Individual, maternal and household risk factors for anaemia among young children in sub-Saharan Africa: a crosssectional study. *BMJ Open*. 2018;8:e019654
30. NkulikiyinkaR, Binagwaho A, Palmer K. The changing importance of key factors associated with anaemia in 6- to 59-month-old children in a sub-Saharan African setting where malaria is on the decline: analysis of the Rwanda Demographic and Health Survey 2010. *Tropical Medicine and International Health*. 2015,20(12) 1722–1732
31. Engidaye G, Melku M, Yalew A, Getaneh Z , AsrieF,Enawgaw B. Under nutrition, maternal anemia and household food insecurity are risk factors of anemia among preschool aged children in Menz Gera Midir district, Eastern Amhara, Ethiopia: a community based cross-sectional study .*BMC Public Health.* 2019 19:968

32. Oliveira m, MartorellR, Nguyen P. Risk factors associated with hemoglobin levels and nutritional status among Brazilian children attending daycare centers in Sao Paulo city, Brazil.*ARCHIVOS LATINOAMERICANOS DE NUTRICION*.2010;60:(1)23.
33. Assefa S, Mossie A, Hamza L. Prevalence and severity of anemia among school children in Jimma Town, Southwest Ethiopia. *BMC Hematology*. 2014, 14:3
34. AghoKH, DibleyMJ, D'EsteC, Gibberd R. Factors Associated with Haemoglobin Concentration among Timor-Leste Children Aged 6-59 Months. *J HEALTH POPUL NUTR*.2008 ;26(2):200-209
35. Ray S, Chandra J, Bhattacharjee J, Sharma S, Determinants of nutritional anemia in children less than five years age.*Int J ContempPediatr*.2016;3(2):403-408
36. Kotecha PV. Nutritional anemia among young children withfocus on Asia and India. *Indian J Community Med*. 2011;36:8-16.
37. Sinha N, Deshmukh PR, Garg BS. Epidemiological Correlates Of Nutritional Anemia Among Children (6-35 Months) In Rural Wardha, Central India. Indian J Med Sci. 2008 Feb;62(2):45-54.
38. Czajka-Narins DM, Haddy TB, Kallen DJ. Nutrition and social correlates in iron deficiency anemia. *Am J ClinNutr.* 1978;31:955-60
39. Afeworki R, Smits J, Tolboom J, van der Ven A. Positive Effect of Large Birth Intervals on Early Childhood Hemoglobin Levels in Africa Is Limited to Girls: Cross-Sectional DHS Study. *PLoSONE*. 2015; 10(6)
40. Dessie ZB, Fentie M, Abebe Z, Ayele TA, Muchie KF. Maternal characteristics and nutritional status among 6–59 months of children in Ethiopia: further analysis of demographic and health survey .*BMC Pediatrics*. 2019;19:83
41. Endris N, Asefa H, Dube L. Prevalence of Malnutrition and Associated Factors among Children in Rural Ethiopia. *BioMed Research Internationa*2017: https://doi.org/10.1155/2017/6587853
42. Ethiopia Health and Nutrition Research Institute (EPHI). Ethiopia. Determinants of Nutritional Status of Women and Children in Ethiopia.AddisAbaba:EPHI; 2004. Available from: https://dhsprogram.com/pubs/pdf/FA39/02-nutrition.pdf [Accessed on December 8, 2019]
43. GIRMA W, Genbo T. Determinants of nutritional status of women and children in Ethiopia. Calverton, Maryland, USA: ORC macro; 2002
44. JufarAH, Zewde T. Prevalence of Anemia among Pregnant Women Attending Antenatal Care at TikurAnbessa Specialized Hospital, Addis Ababa Ethiopia. *J HematolThromb Dis.* 2014,2:1

Figures

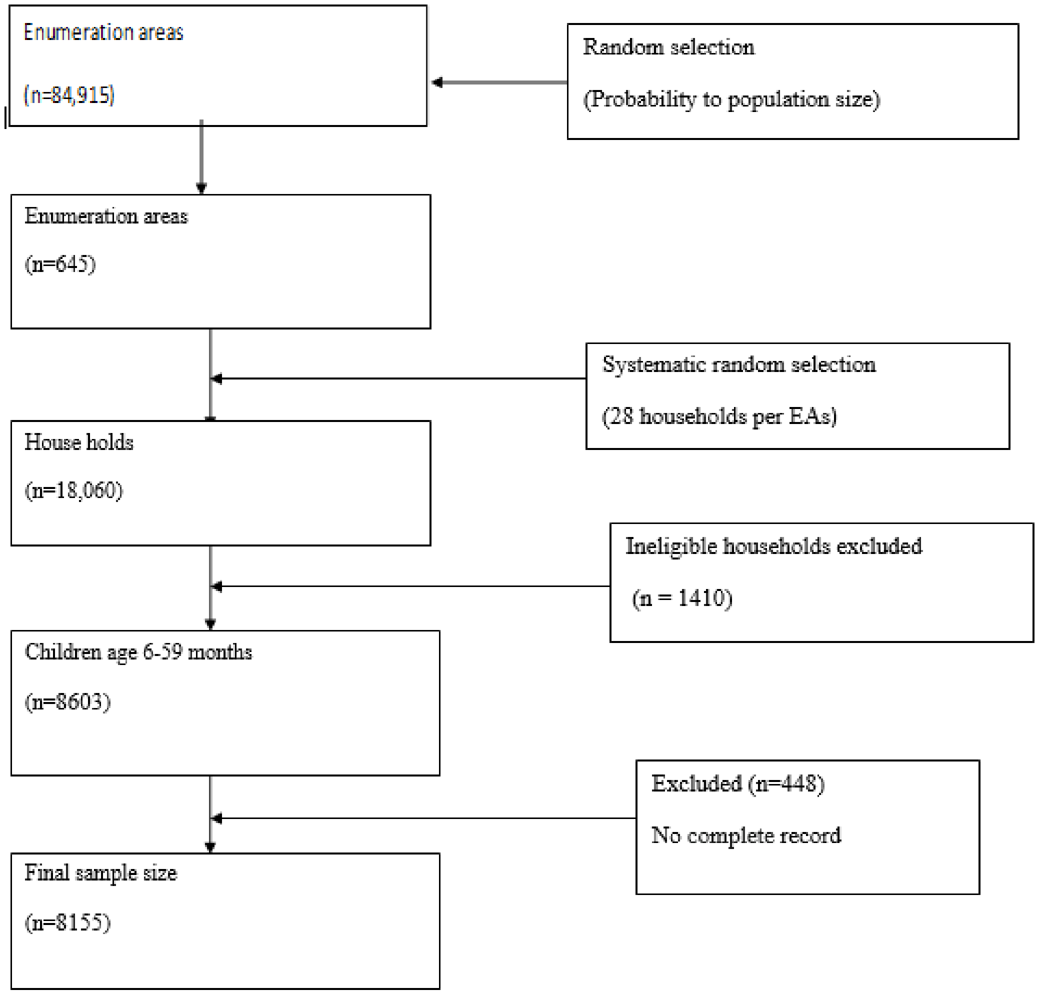


Figure 1

Flow chart of sample selection technique,EDHS 2016(n = 8,155).

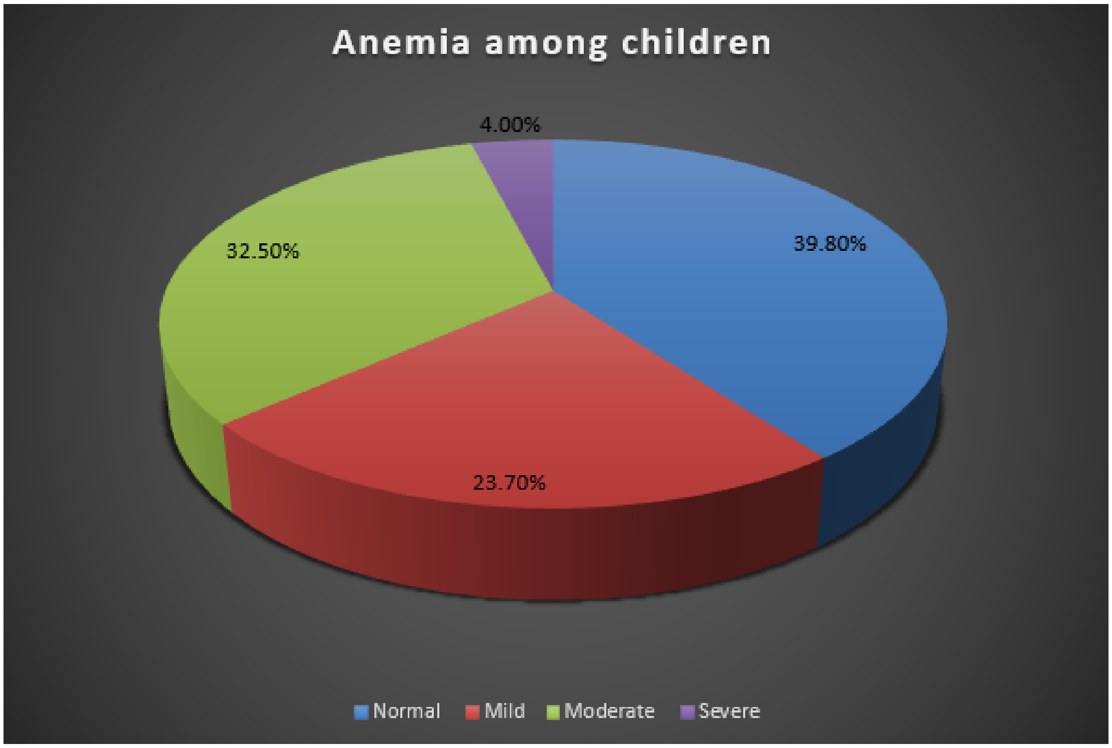


Figure 2

Severity of anemia among children 6-59 months of ageEDHS 2016(n = 8155)

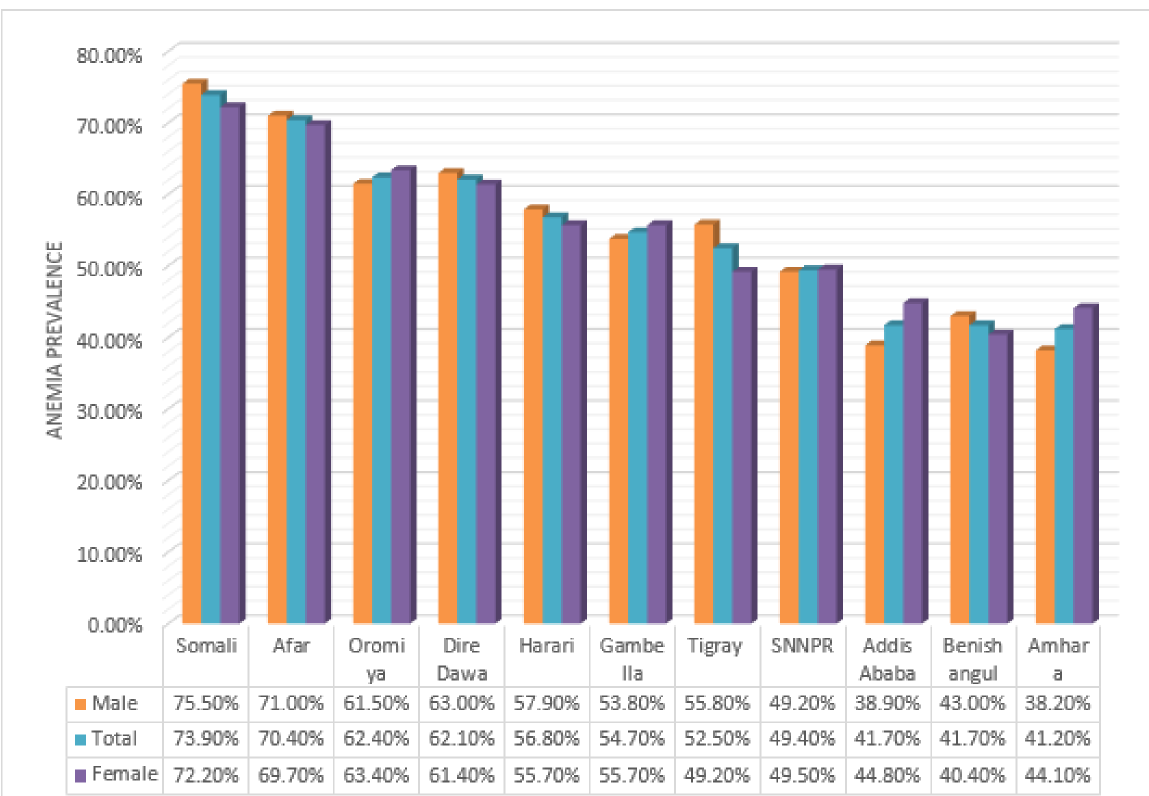


Figure 3

Anemia distribution among 6-59 months aged children in the regional states of Ethiopia stratified by gender,EDHS 2016(n = 8155)

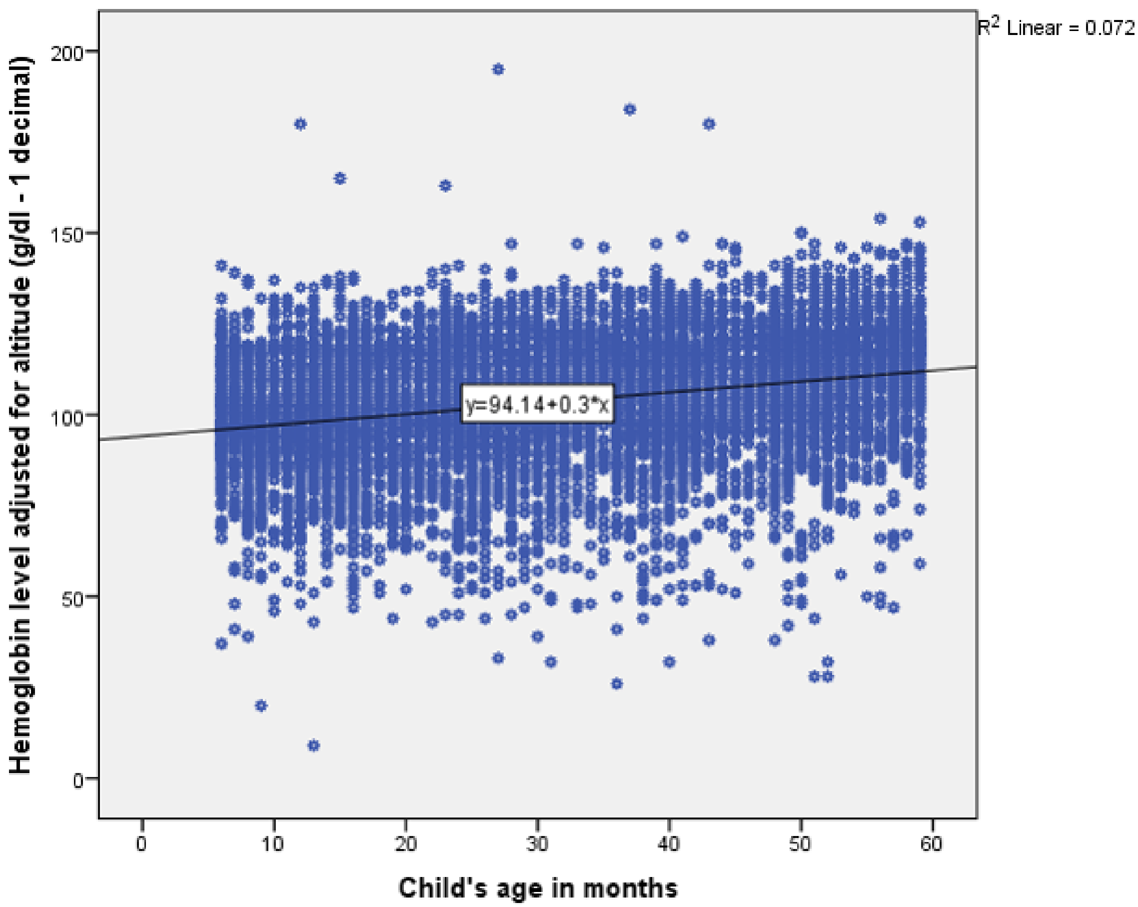
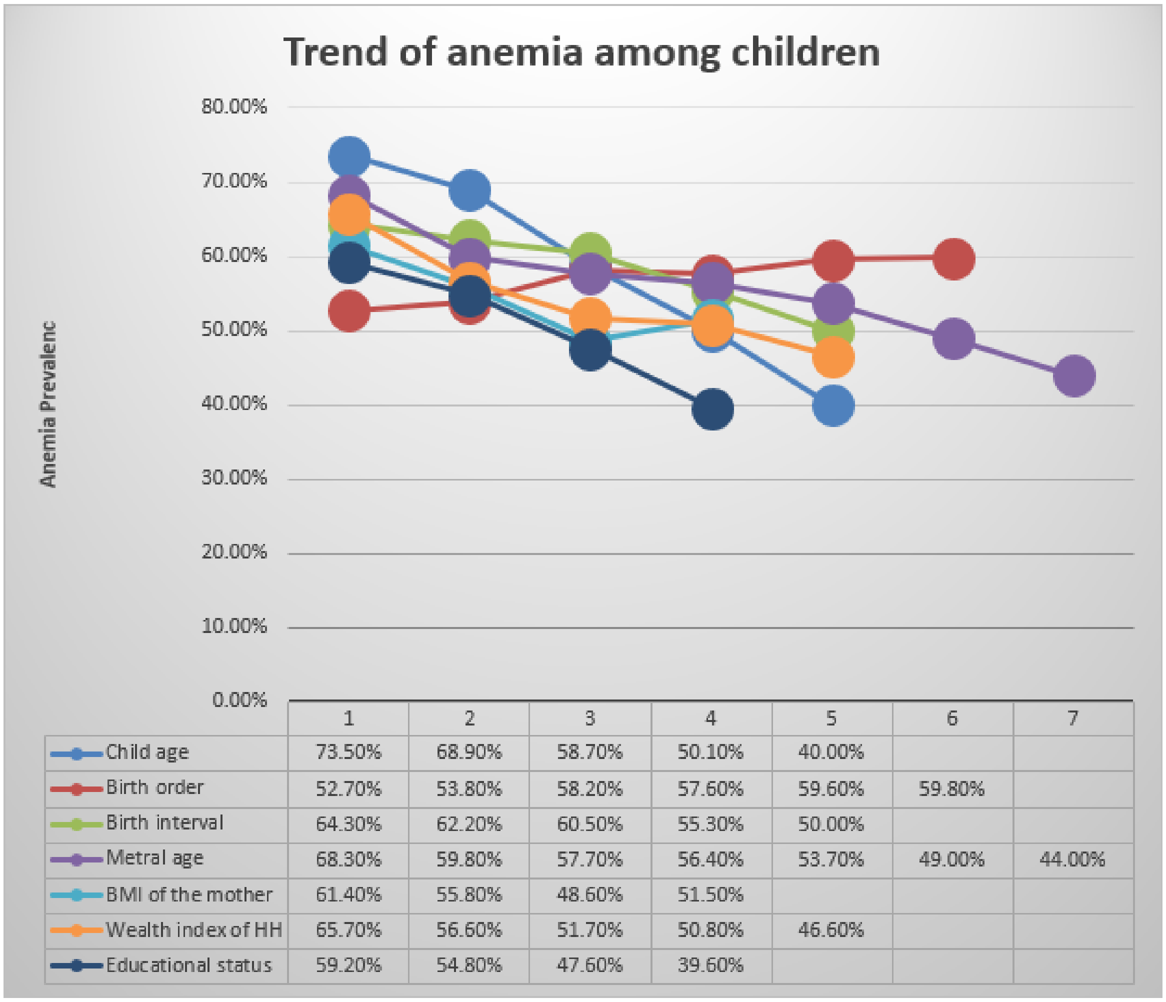


Figure 4

trend of hemoglobin concentration with age among 6-59 months children, EDHS 2016(n = 8155)



	1	2	3	4	5	6	7
Child age	73.50%	68.90%	58.70%	50.10%	40.00%		
Birth order	52.70%	53.80%	58.20%	57.60%	59.60%	59.80%	
Birth interval	64.30%	62.20%	60.50%	55.30%	50.00%		
Metral age	68.30%	59.80%	57.70%	56.40%	53.70%	49.00%	44.00%
BMI of the mother	61.40%	55.80%	48.60%	51.50%			
Wealth index of HH	65.70%	56.60%	51.70%	50.80%	46.60%		
Educational status	59.20%	54.80%	47.60%	39.60%			

Figure 5

trend of anemia with respect to child, maternal and household factors among children 6-59 months of ageEDHS 2016(n = 8155)