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PREVALENCE OF ANEMIA AND ITS ASSOCIATED FACTORS IN CHILDREN AGED 6-59 MONTHS; IN AMHARA REGION, BASED

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PREVALENCE OF ANEMIA AND ITS ASSOCIATED FACTORS IN CHILDREN AGED 6-59 MONTHS; IN AMHARA REGION, BASED ON EDHS 2016.

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A THESIS RESEARCH SUBMITTED TO THE DEPARTMENT OF EPIDEMIOLOGY AND BIOSTATISTICS, SCHOOL OF PUBLIC HEALTH, COLLEGE OF MEDICINE AND HEALTH SCIENCES IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF PUBLIC HEALTH IN EPIDEMIOLOGY.

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ABSTRACT

Background: Anemia is a global public health problem affecting about 42.6% of children globally, both in developing and developed countries and is the most common micronutrient deficiency, especially affecting young children and women of reproductive age. It causes detrimental impacts on health, economic and social development such as learning disabilities, an increased risk of infection and diminished work capacity.

Objectives: To assess the prevalence of anemia and its associated factors in children in Amhara region based on data from Ethiopian demographic and health survey 2016.

Methods: Community based cross-sectional study design with multi stage sampling design was employed. Data on hemoglobin concentration among the children aged 6–59 months in Amhara region from Ethiopian demographic and health survey 2016 was used. The data was extracted and analyzed using STATA Version 14. Descriptive statistics was performed to describe the data by different characteristics. Weighted prevalence of anemia was presented in percent. Binary Logistic regression was performed to identify factors associated with anemia. A p-value of 0.05 was used to identify significant explanatory variables and their degree of association was expressed using odds ratio at 95% confidence interval.

Results: A total of 1861 children aged 6-59 months were involved in this analysis, with the overall weighted prevalence of anemia being 42.2%, of which the prevalence of mild, moderate and severe anemia were 22.6%, 17.3% and 2.2% respectively. Multivariable logistic regression showed that children from anemic mothers (AOR=1.76, 95% CI= 1.20-2.60) and those from mothers working at the time of the survey (AOR=1.74, 95% CI=1.19-2.53) had higher odds of anemia. Children aged 12-23 months had a lower odds of anemia (AOR=0.42, 95% CI=0.22-0.81) compared to children aged 6-11months and for the rest of age groups odds of anemia decreases as age of child increases.

Conclusions: Childhood anemia was found to be a severe public health problem (42.2%) in the region. Age of children, maternal anemia and maternal working status were found to be significant predictors of childhood anemia. An integrated approach from iron supplementation to awareness creation should be done.

Keywords: Anemia, prevalence, children, associated factor, Amhara region

ACRONYMS AND ABBREVIATIONS

AOR	Adjusted Odds Ratio
BMI	Body Max Index
CI	Confidence Interval
DHS	Demographic and Health Survey
EA	Enumeration Area
EAG	Empowered Action Group
EDHS	Ethiopian Demographic and Health Survey
g/dl	Gram per deciliter
HAZ	Height-for-Age Z-score
Hb	Hemoglobin
HHs	Households
IDA	Iron Deficiency Anemia
MUAC	Mid Upper Arm Circumference
OR	Odds Ratio
SSA	Sub-Saharan Africa
WHO	World Health Organization

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1. INTRODUCTION

1.1 Background

Anemia is a condition in which the number of red blood cells is insufficient to meet the body's physiologic need. Specific physiologic needs vary with a person's age, gender, residential elevation above sea level (altitude), smoking behavior, and different stages of pregnancy.(1, 2)

Iron deficiency is thought to be the most common cause of anemia globally, but other nutritional deficiencies (including foliate, vitamin B12 and vitamin A), acute and chronic inflammation, parasitic infections, and inherited or acquired disorders that affect hemoglobin synthesis, red blood cell production or red blood cell survival, can all cause anemia.(1, 3, 4) Anemia is the most common micronutrient deficiency, especially affecting young children and women of reproductive age. Uncorrected anemia can lead to learning disabilities, an increased risk of infection and diminished work capacity and to death of women during pregnancy and at childbirth.(3)

There are different diagnostic modalities for anemia and its severity classification is based on that. Based on hemoglobin levels to diagnose anemia at sea level in grams per litre WHO classifies anemia severity as non-anemia (110 or higher), mild (100-110), moderate (70-99) and severe (lower than 70).(1, 3, 5)

Public health significance of anemia in populations on the basis of prevalence estimated from blood levels of hemoglobin is as normal (less than or equal to 4.9%), mild (5.0-19.9%), moderate (20.0-39.9%) and severe (greater than or equal to 40%) and from this evidence we find as anemia is a severe public health problem in Ethiopian children.(4)

1.2 Statement of the problem

Anemia is a global public health problem affecting both developing and developed countries. It occurs at all stages of the life cycle, but is more prevalent in pregnant women and young children. (3, 5) One in four people in the world is affected by anemia. Two thirds of preschool-age children are affected in developing regions of Africa and South East-Asia, and about 40% of the world's anemic preschool-age children reside in South-East Asia. Of the 293.1 million

children who suffer from anemia worldwide, 83 million (28%) are in sub-Saharan Africa, representing 67% of the total population of children of this age group in the continent.(5)

In 2011, globally the highest prevalence of anemia was in children 42.6%. This prevalence translates to 273.2 million children, which shows a 19.9 million reduction compared to WHO 2008 report. In 2011, the WHO South-East Asia, Eastern Mediterranean and African Regions had the lowest mean blood hemoglobin concentrations and the highest prevalence of anemia across population groups, with more than half of children in the South-East Asia and African Regions (53.8% or more) classified as having anemia; severe anemia was highest in the African Region, with 3.6% of children affected. Children in the African Region represented the highest proportion of individuals affected with anemia, at 62.3%. Severe anemia is associated with substantially worse mortality and cognitive and functional outcomes.(2) In Ethiopia anemia is a severe public health problem affecting 57% of children.(6)

Anemia is an indicator of both poor nutrition and poor health.(7) The health implication of anemia is numerous. It is associated with impaired mental, physical, motor and language development; and poor cognitive skill, coordination, scholastic achievement and immune function.(5, 8-10) In addition, the outcomes of anemia can be considered from a variety of perspectives, including detrimental impacts on economic and social development. (11)

A number of factors are known to be associated with anemia in children such as maternal BMI, child age, child sex, wealth index, nutritional status of the child, number of children in the household, family size, maternal education, residence, maternal age, marital status, maternal current working status, maternal hemoglobin status, husband/partner's education, recent illness in the child, source of drinking water, vitamin-A supplementation, deworming and receiving iron pills/syrup.(12-27)

Despite implementation of control programmes including iron supplementation, deworming and insecticide-treated bed net distribution, anemia remains a major global concern in child health, especially in SSA.(22) The same is true for Ethiopia, between 2005 and 2016, the prevalence of anemia among Ethiopian children declined from 54% to 44% from 2005 to 2011, but increased to 57% in 2016. Even though, the region had the lowest prevalence of childhood anemia compared to other regions, it is still a severe public health problem. (6) (28, 29)

As far as we have searched there are no studies done at regional level that identifies factors associated with anemia in children even though it is a severe public health problem. Many similar studies have been done at country and district levels but population, geography and sample size matters. On all EDHSs the prevalence of anemia was determined, but specific risk factors were not identified at regional level. At a district level many such studies were conducted in and out of the region; but due to geography and different population it is less likely to generalize this studies to the region. Thus this study is intended to identify factors at regional level using representative samples from EDHS 2016.

1.3 Significance of the study

The result of this study will be used by other researchers. Programme managers and other stake holders working on the prevention and control of anemia will be merited from the results of this study to intervene accordingly. Finally the community will be benefited directly from the results of this study on identifying factors for anemia and indirectly from the interventions given by responsible bodies.

2. LITERATURE REVIEW

2.1 prevalence of anemia

Globally anemia affects one fourth of the population.(12) Different studies that have been done in different regions showed that anemia is a severe public health problem in children. In India among EAG states 3% of children were found to be severely anemic, 41% were moderately anemic, and about 27% were mildly anemic(30). In Bangladesh anemia was prevalent in 51.9% of children overall- 47.4 % in urban and 53.1 % in rural regions(25). In a study done In Pakistan and Lao people's democratic republic anemia was prevalent in 62.3% and 48.9% of children respectively. In Pakistan of those who were anemic 4.1% and 58.3% were severely and moderately anemic respectively. On the same study in Pakistan 33.2% of children had IDA based on low hemoglobin and ferritin levels.(26, 31)

In different studies done in some parts of Africa, anemia in children is found to be a severe public health problem. The prevalence of anemia in Lesotho was 47% in 2009 and 51% in 2014.(23) In different studies done in Cape Verde, Benin, Ghana and Togo; the prevalence of anemia was 51.8%, 82.4%, 78.4% and 70.9% respectively. In Ghana out of 78.4% children who were anemic; 7.8%, 48.0% and 22.6% had mild, moderate and severe anemia respectively.(13-15, 32)

A study done in SSA shows 23.6% of children were found to have mild anemia, 34.4% of children had moderate anemia and 3.39% of children had severe anemia .The prevalence of anemia (of any severity) ranged from 23.7% in Rwanda to 87.9% in Burkina Faso. In this study 23.6% of children were found to have mild anemia, 34.4% of children had moderate anemia and 3.39% of children had severe anemia (22)

Different studies done in SSA countries including Ethiopia showed that anemia is a severe public health problem. In Uganda, Namutumba district, overall 58.8% of children had anemia. The proportion of children who had severe, moderate and mild anemia was 1.3%, 27.7% and 29.8% respectively. Another study done in Uganda also revealed that prevalence of anemia was 61.4%.(17, 18) In a study done in rural Rwanda the prevalence of moderate to severe anemia was 7.0 %.(33) In a study done in Tanzania (district level) the overall prevalence of anemia was

85%.(16) In different studies done in Ethiopia, both at national and district levels, anemia was found to be a moderate to severe public health problem.(6, 19-21, 24, 27, 34)

2.2 Factors associated with anemia

2.2.1 Socio-demographic factors

Children less than 24 months of age were about 2 times more likely to be anemic than their counter parts as reviewed from different studies.(14, 18-20, 22-27, 31-33). In a study done in Pakistan and SSA being female was associated with lower risks of anemia. A study done in Ethiopia, the pooled effect of anemia among males was 1.11 times higher compared to females (21, 22, 31). In a study done in India among EAG states, in Togo and in Uganda (Namutumba) being Children of educated mothers was associated with reduced risks of anemia.(15, 18, 30)

In a study done in India adolescent mother's children were two times more likely to be moderately anemic as compared to children of older mothers.(30) On another study done in SSA, risk of anemia was found to be decreased as maternal age increased.(22) In Benin children of mothers aged 30-39 were found to be about 2 times more likely to be anemic compared to children of younger women. In this study Children of farming mothers had about a 3 times risk of being anemic compared with children of retired/student women.(32) A study done in Gondar revealed that being child of unmarried mother increases risk of anemia severity by about 2 times.(34) Additionally, mothers having work at the time of the survey and husbands/partners who completed secondary education and above, were significantly associated with reduced odds of childhood anemia.(19)

2.2.2 Child related factors

In different studies done in different parts of the world, stunting was found to be associated with childhood anemia. In different studies done in Bangladesh, Pakistan, SSA and Lesotho; stunted children were found to be about 1.5 times more likely to be anemic.(18, 22, 23, 25, 31) In a study done in Rwanda, risk of anemia was found to be about 2 times higher in underweight children.(33) In Ethiopia different studies revealed that nutritional status of a child is significantly associated with childhood anemia. In a study done in south central Ethiopia stunted children were found to be about 2 times more likely to be anemic.(27) In another study done in

northern Ethiopia, underweight children and children with MUAC less than 12 cm were about 2 and 3.35 times more likely to be anemic.(24) On a systematic review and meta-analysis done in Ethiopia, childhood anemia was about 2 times higher in stunted and wasted children.(21)

Recent (within 2 weeks prior to the survey) episodes of diarrhea was another factor that significantly associated with childhood anemia.(14, 22) In studies conducted in Lesotho and SSA, children with fever within two weeks prior to the survey were about 1.5 times more likely to be anemic.(22, 23) Children not receiving vitamin-A within six months prior to the survey were about 1.24 times more likely to be anemic based on a study done in Ethiopia.(20) A study done in SSA revealed that, risk of anemia increases by 6 % in those with no deworming status.(22) Additionally, children who received iron pills/syrup in the past seven days prior to the survey were found to be less likely to be anemic.(19)

2.2.3 Household related factors

Different studies revealed that children from the wealthier families are less likely to be anemic. Children from the middle and rich wealth index were about 0.6 times less likely to be anemic compared to children from poor wealth index based on a study conducted in Bangladesh. (25) Similarly In a study done in India, among EAG states, as we go from the poorest to the richest wealth index; the risk of mild, moderate and severe anemia were decreased.(30) On another study done in Rwanda, children from the middle and high socio-economic status were 0.6 times less likely to be anemic compared to those from low socio-economic status.(33) Studies conducted in Ethiopia also revealed that, as we go from poorest to richest wealth index HHs; risk of childhood anemia was decreased.(19, 20, 27)

Children from households (HHs) with unimproved water source were found to be more likely anemic in studies done in Bangladesh and Ethiopia.(19, 25) In a study conducted in Pakistan and Uganda, children from rural HHs were 0.77 times less likely to be anemic compared to children from urban HHs.(17, 31) In a study done in Uganda, children from HHs with number of children of 4 or more were less likely to be anemic compared to children from HHs with number of children less than or equal to 3.(18) In contrast; in a study done in Ethiopia, children from HHs with number of children 4-6 were 1.3 times more likely to be anemic compared to children from HHs with number of children less than or equal to 3.(19)

Family size was also found to be one of the factors significantly associated with childhood anemia. Children from HHs with family size 6-10 were found to be less likely to be anemic compared to HHs with family size less than or equal to 5, but the reverse was true for HHs with family size greater than 10.(18) Different studies done in SSA and Ethiopia also revealed that, risk of childhood anemia was increased as family size was increased.(20, 22)

2.2.4 Maternal related factors

In many studies maternal anemia was found to be significantly positively associated with childhood anemia. In Bangladesh, a study revealed that children of anemic mothers were 2 times at higher risk of anemia and in India; children of severely anemic mothers were about 16 times more likely to be severely anemic.(25, 30) In a study conducted in Pakistan, children of mothers with IDA were found to be about 1.7 times more likely to had IDA.(31)

A study done in Lesotho, Benin, Togo and SSA also revealed that maternal anemia was significantly positively associated with childhood anemia.(15, 22, 23, 32) A study done in Ethiopia also showed that maternal anemia of mild, moderate and severe anemia: were significantly positively associated with child hood anemia severity with odds ratio of 1.82, 2.16 and 3.73 respectively.(20) Studies conducted in Lesotho and SSA, showed that children of underweight mothers were 1.5 times more likely to be anemic compared to children of normal or overweight mothers. (22, 23).

3. CONCEPTUAL FRAMEWORK

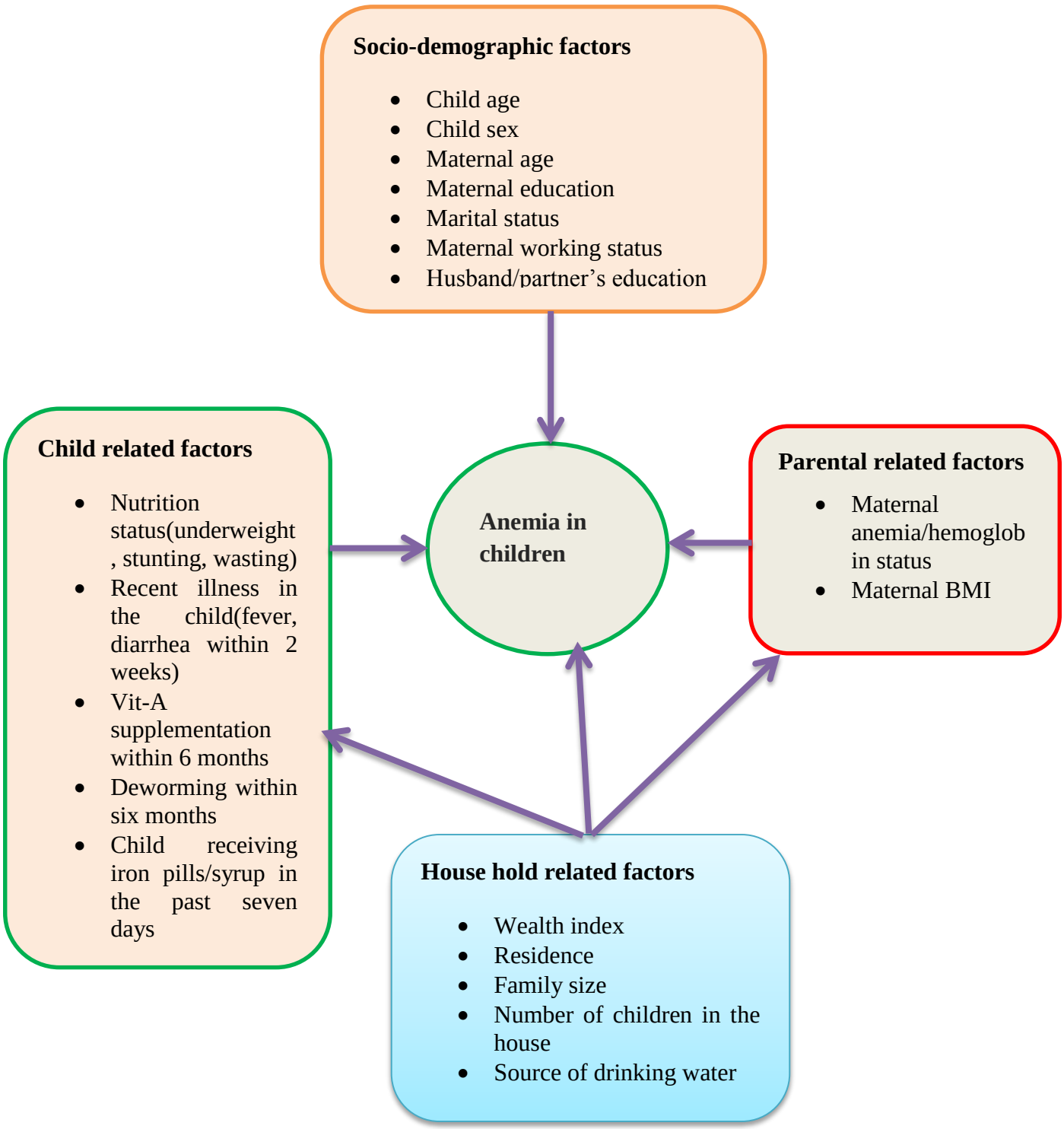

Figure 1 Conceptual frame work developed from different literatures.

4. OBJECTIVE OF THE STUDY

4.1 General objective

To assess the prevalence of anemia and its associated factors among children aged 6-59 months in Amhara region based on data from EDHS 2016.

4.2 Specific objectives

- To determine the prevalence of anemia in children aged 6-59 months in Amhara region
- To identify factors associated with anemia in children aged 6-59 months in Amhara region

5. METHOD AND MATERIALS

5.1 Study area

The study area is Amhara region, which is one of the administrative regions in Ethiopia. It has a population of 22,191,890, of this 81% live in rural areas and 19% live in urban areas. Children account 13.54% (3,004,782). The region has 15 zones, 181 woredas and 3,960 kebeles. (35) The region had 3,300 urban and 17,827 rural EAs, of which 11 urban and 60 rural EAs were selected for the 2016 EDHS. Additionally the region had 626,998 urban and 3,348,277 rural residential HHs, which accounts for 25.79% of residential HHs in Ethiopia.

5.2 Study design and study period

Community based cross-sectional study design was conducted from January 18, 2016 to June 27, 2016.

5.3 Source and study population

5.3.1 Source population

All children 6-59 months old in Amhara region

5.3.2 Study population

Children 6-59 months old who had lived in the selected households of each cluster

5.3.3 Study unit

Children who stayed in the HH on the night before the interview and who were tested for anemia for 2016 EDHS.

5.4 Variables

5.4.1 Dependent variable

- Anemia in children(present/absent)

5.4.2 Independent variables

Child age, child sex, maternal education, child nutritional status (underweight, stunting and wasting), maternal anemia/hemoglobin, wealth index, family size, number of children in the house hold, maternal age, residence, maternal BMI, marital status, recent illness in the child (fever, diarrhea within two weeks), Vitamin-A supplementation, husband/partner's education, maternal working status, taking iron pills/ sprinkles or syrup in the past 7 days, deworming status and source of drinking water.

5.5. Definition of terms

Anemia in children: hemoglobin concentration less than 11g/dl.

Mild anemia: hemoglobin concentration 10-11 g/dl.

Moderate anemia: hemoglobin concentration 7-9.9 g/dl

Severe anemia: hemoglobin concentration less than 7 g/dl and for this study hemoglobin concentration less than 11g/dl will be used to declare as anemia is present, otherwise no anemia.

Underweight: weight for age less than -2 z- score

Wasting: weight for height less than -2 z-score

Stunting: height for age less than -2 z-score

Body Mass Index: It is a person's weight in kilogram divided by his/her height in meter square and for this study; underweight is less than 18.5 kg/m^2 and not underweight greater than or equal to18.5 kg/m^2.

Improved water source: Piped water into dwelling, Piped water into yard/plot, Public tap/standpipes, Tube well/boreholes, Protected dug wells, protected springs (normally part of a spring supply), Rainwater collection, Bottled water, if the secondary source used by the household for cooking and personal hygiene is improved

Unimproved water source: Unprotected dug well, unprotected spring, cart with small tank/drum, tanker truck, and surface water (river, dam, lake, pond, stream, canal, irrigation channels).

5.6 Sampling techniques

5.6.1 Sampling frame

The sampling frame used for the 2016 EDHS is a complete list of 84,915 enumeration areas (EAs) created for the 2007 population and housing census. An enumeration area (EA) is a geographic area covering on average 181 households. The sampling frame contains information about the EA location, type of residence (urban or rural), and estimated number of residential households. With the exception of EAs in six zones of the Somali region, each EA has accompanying cartographic materials. These materials delineate geographic locations, boundaries, main access and landmarks in or outside the EA that help identify the EA.

5.6.2 Sample design and selection

The 2016 EDHS sample was stratified and selected in two stages. Each region was stratified into urban and rural areas, yielding 21 sampling strata. Samples of EAs were selected independently in each stratum in two stages. A household listing operation was carried out in all of the selected EAs and the resulting lists of households served as a sampling frame for the selection of households in the second stage. For Amhara region 11 urban and 60 rural EAs with a fixed number of 28 HHs per each EA resulting in a total of 1,988 HHs were included for 2016 EDHS.

All women age 15-49 and all men age 15-59 who were either permanent residents of the selected households or visitors who stayed in the household the night before the survey were eligible to be interviewed. In all of the selected households, height and weight measurements were collected from children age 0-59 months, women age 15-49, and men age 15-59. Anemia testing was performed on consenting women age 15-49 and men age 15-59 and on children age 6-59 months whose parent/guardian consented to the testing. For this study a total of 1,861(weighted number) children who were tested for anemia in Amhara region were included.

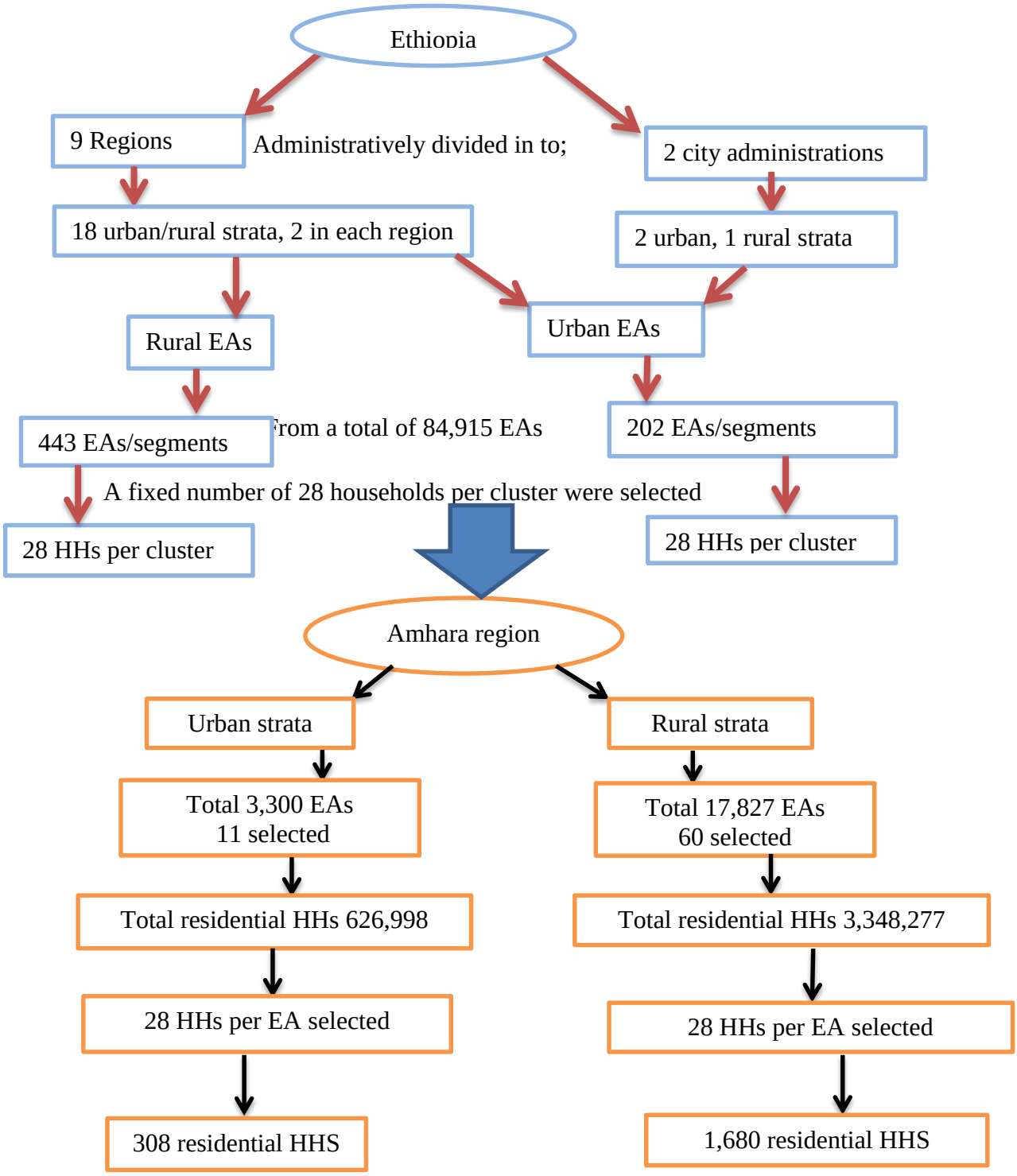

Figure 2 Schematic presentation of sample design and selection

5.7 Data processing and analysis

After obtaining access to EDHS datasets, data was extracted using STATA. Then, data was recoded, categorized and sorted to facilitate its analysis. The principal investigator analyzed the extracted data using STATA/SE version 14.0 software packages. Descriptive analysis was used to describe the percentage distributions of the respondents by socio-demographic characteristics and other relevant variables of the study. Weighted prevalence of anemia was expressed in percent. Sampling weights were applied to ensure the representativeness of the result by adjusting under and over sampling. A detailed description on weighting can be found on the EDHS final report. The result of descriptive statistics was presented in tables and pie chart. Binary Logistic regression was used to fit data in order to identify factors associated with prevalence of anemia.

All independent variables in bivariable analysis were included in the logistic models of multivariable analysis using p-value ($p<0.2$). Hosmer and lemeshow goodness of fit test was used to check model adequacy ($p=0.22$). A P-value less than 0.05 was considered to declare a result as statistically significant association in this study. To get wealth quantiles, Households were given scores based on the number and kinds of consumer goods they own, ranging from a television to a bicycle or car, in addition to housing characteristics such as source of drinking water, toilet facilities, and flooring materials. These scores were derived using principal component analysis. National wealth quintiles are compiled by assigning the household score to each usual (de jure) household member, ranking each person in the household population by her or his score, and then dividing the distribution into five equal categories, each comprising 20% of the population.

5.8 Ethical consideration

Ethical clearance was obtained from Bahir-dar University institutional ethical review board. The dataset of the 2016 EDHS was not available as a public domain survey dataset. The investigator requested and accessed to the dataset of the 2016 EDHS from Director of Central Statistics Agency of Ethiopia and the data was used for this research. Ethical clearance for the 2016 EDHS was provided by the Ethiopian Public Health Institute (EPHI) Review Board, the National Research Ethics Review Committee (NRERC) at the Ministry of Science and Technology, the Institutional Review Board of ICF International and the communicable disease control (CDC).

6. RESULTS

6.1 Descriptive statistics of selected variables

6.1.1 Socio-demographic characteristics

A total of 1,861 children aged 6-59 months were included in the analysis. Among those children incorporated to the analysis the male to female ratio was 0.97. The surveyed children had almost the same proportion (20%) in the age categories in which they fall, except for 6-11 months age category which accounts for 10% of children. The age range of mother's falls between 15 and 49 and 1,609 (94%) were married. About 1,254 (75%) of mothers and 1,120 (71%) of husbands/partners had no education. At the time of the survey 367(21.5 %) of mothers were not working. (**Table 1**)

Table 1 socio-demographic characteristics

Variables	Category	Weighted estimate count (percent)
Sex of a child	Male	917 (49.25)
	Female	944 (50.75)
Age of child in months	6-11	202 (10.84)
	12-23	390 (20.96)
	24-35	367 (19.71)
	36-47	417 (22.43)
	48-59	485 (26.06)
Age of mother in years	15-19	39 (2.30)
	20-24	263 (15.41)
	25-29	504 (29.55)
	30-34	328 (19.22)
	35-39	314 (18.40)
	40-44	174 (10.22)
	45-49	83 (4.89)
Mother's highest educational level	No education	1254 (73.51)
	Primary	346 (20.29)
	Secondary	62 (3.66)
	Higher	44 (2.55)
Current marital status	Married	1609 (94.33)
	Unmarried*	97 (5.67)
Maternal working status	not working	1338 (78.46)
	working	367 (21.54)
Husband/partner's educational level	No education	1120 (70.58)
	primary	356 (22.46)
	secondary	59 (3.73)
	higher	51 (3.23)

Unmarried* : Includes single, divorced and widowed**.**

6.1.2 Household related factors

Children from the richest HHs account for the smallest proportion 240 (13%) of children compared to children from the other wealth index categories, which had more or less related proportion of children. Only 35 (2%) of HHs had eleven or more family members, while 870 (47%) had 6-10 members and 955 (51%) had 1-5 members. More than half 1,020 (54.8%) of selected households had improved sources of drinking water and 1721 (93%) of HHs had 0-2 members of under five children. The surveyed children had rural and urban representation of 1621(87.1%) and 240 (12.9%) respectively. (**Table 2**)

Table 2 Descriptive statistics by household related factors

Variables	Category	Weighted estimate count (percent)
Residence	Urban	240 (12.90)
	rural	1621 (87.10)
Number of household members (categorized)	1-5	956 (51.35)
	6-10	870 (46.76)
	≥11	35 (1.88)
Number of children under 5 years	0-2	1721 (92.51)
	3-6	139 (7.48)
Source of drinking water	Improved	1020 (54.81)
	not improved	841 (45.19)
Wealth index combined	Poorest	394 (21.18)
	poorer	434 (23.33)
	middle	429 (23.05)
	richer	363 (19.52)
	richest	240 (12.92)

6.1.3 Maternal and child related factors

Anemia was present in 360 (21.2%) of mothers and 346 (20%) of mothers were underweight. Of the surveyed children 805(43.3%), 695(37.4%) and 151(8.1%) were stunted, underweighted and wasted respectively. Among children incorporated to the analysis, 221(13%) and 242(14%) had fever and diarrhea respectively. Nearly half 806(48%) of children were taken vitamin A six months prior to the survey. Only 99 (6%) of children were taken iron pills, sprinkles or syrup and 182(11%) were taken drugs for intestinal parasites. (**Table 3**)

Table 3 Descriptive statistics by maternal and child related factors

Variables	**Category**	Weighted estimate count (percent)
Any type of maternal anemia	Not anemic Anemic	1335 (78.77) 360 (21.23)
Maternal body mass index (in kg/m^2)	<18.5 ≥18.5	346 (20.33) 1356 (79.67)
Wasting	No Yes	1710 (91.89) 151 (8.11)
Under weight	No yes	1166 (62.65) 695 (37.35)
Stunting	No Yes	1056 (56.73) 805 (43.27)
Child had fever in last two weeks	No Yes	1478 (87.00) 221 (13.00)
Child had diarrhea recently	No Yes	1462 (85.79) 242 (14.21)
Vitamin A in last 6 months	No Yes	856 (51.53) 806 (48.47)
Taking iron pills, sprinkles or syrup	No Yes	1589 (94.14) 99 (5.86)
Drugs for intestinal parasites in last 6 months	No Yes	1448 (88.85) 182 (11.15)

6.2 Prevalence of anemia

Anemia was prevalent in 785(42.2 %) (95% CI 37.87- 46.61) of children, of which 22.6% had mild anemia, 17.3% had moderate anemia and 2.2% had severe anemia.

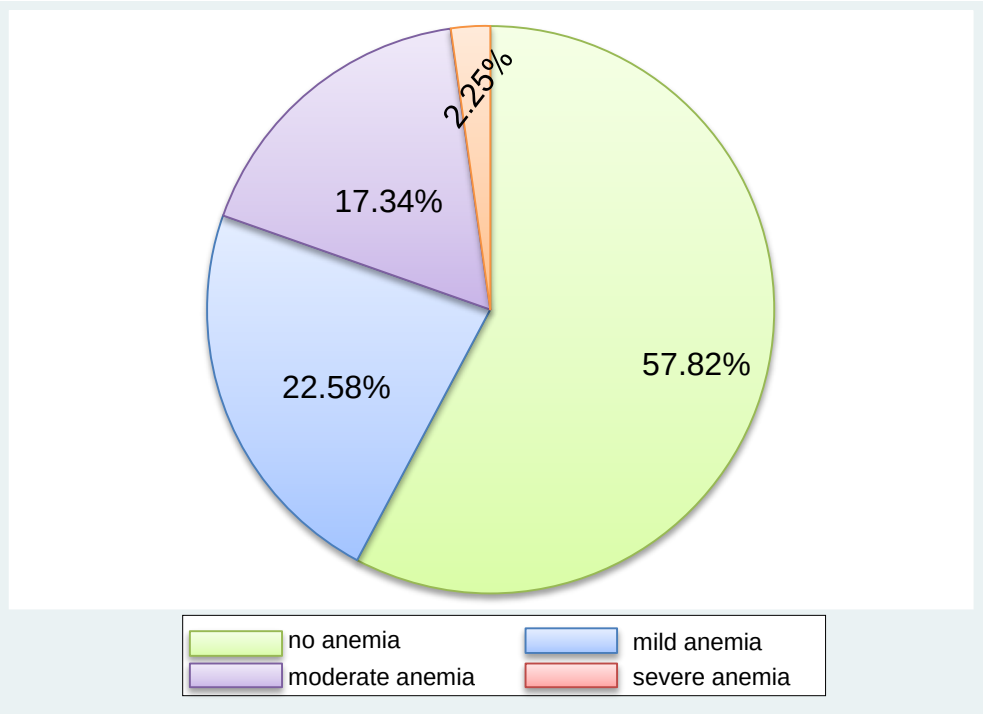

Figure 3 Pie chart of level of anemia in children aged 6-59 months in Amhara region

The prevalence of anemia significantly ($p<0.001$) varied by the age of a child. The percentage decreases as age of a child increases from 74.94% in children aged 6-11 months to 27.81% in children aged 48-59 months. It was significantly ($p=0.006$) prevalent in children from mothers who were working at the time of the survey, which was 52.39% in children from working mothers and 39.99% in children from not working mothers. The prevalence also varied significantly ($p<0.001$) in children from anemic (55.23%) and not anemic (39.15) mothers. Anemia prevalence was significantly ($p=0.016$, $p=0.006$) higher in underweight children than not underweight and stunted children than not stunted respectively. But we didn't find any significant difference in anemia prevalence among the wasted children.

There was a significant ($p=0.026$) difference in anemia prevalence in children who had fever and who had no fever (52.62% vs41.36%). (**Table 4**)

Table 4 prevalence of anemia by different factors

Variables	Weighted prevalence	95% CI	p-value*	Variables	Weighted prevalence	95% CI	p-value*
Sex of a child				Number of household members			
male	39.61	34.77-44.66	0.149	1-5	43.45	37.92-49.14	0.135
female	44.68	38.66-50.85		6-10	39.70	33.87-45.83	
				≥11	69.13	35.03-90.30	
Age of child in months				Number of children under 5 years			
6-11	74.94	64.78-82.95	<0.001	0-2	41.95	37.50-46.54	0.684
12-23	60.67	53.05-67.80		3-6	44.99	31.25-59.54	
24-35	38.26	29.65-47.67					
36-47	29.22	23.77-35.34					
48-59	27.81	21.80-34.75					
Age of mother in years				Source of drinking water			
15-19	60.66	41.33-77.14	0.212	improved	42.62	37.55-47.85	0.828
20-24	48.22	38.58-57.99		not improved	41.65	34.53-49.12	
25-29	44.48	36.66-52.59					
30-34	40.65	32.26-49.63					
35-39	38.16	30.23-46.76					
40-44	43.09	32.70-54.11					
45-49	29.54	17.08-46.03					
Mother's highest educational level				Under weight			
	41.43	36.20-46.86	0.651	no	39.33	34.99-43.84	0.016
No education	44.77	36.91-52.89		yes	46.97	40.51-53.52	
Primary	53.01	33.04-72.05					
Secondary	46.36	20.75-74.04					
Higher							
Current marital status				Wasting			
married	42.81	38.10-47.66	0.694	no	41.61	37.24-46.12	0.234
unmarried	40.03	27.68-53.80		yes	48.58	37.08-60.23	
Maternal working status				Stunting			
not working	39.99	34.97-45.22	0.006	no	38.54	33.46-43.87	0.006
working	52.39	44.68-59.99		yes	46.96	41.74-52.24	

Husband/partner's educational level				Child had fever in last two weeks			
No education	41.24	36.10-46.59	0.672	no	41.36	36.82-46.06	0.026
primary	46.34	37.37-55.56		yes	52.62	42.58-62.45	
secondary	49.14	29.68-68.85					
higher	42.13	22.45-64.68					
Any type of maternal anemia				Child had diarrhea recently			
not anemic	39.15	33.97-44.59	<0.00	no	41.93	37.24-46.78	0.304
anemic	55.23	48.35-61.91	1	yes	47.43	37.17-57.90	
Maternal body mass index (in kg/m^2)				Vitamin A in last 6 months			
				No	41.96	36.51-47.60	0.735
<18.5	48.45	39.84-57.14	0.134	Yes	43.13	37.15-49.32	
≥18.5	41.01	35.91-46.32					
Wealth index combined				Taking iron pills, sprinkles or syrup			
poorest	45.25	35.31-55.57	0.874	no	43.45	38.68-48.34	0.130
poorer	42.39	34.20-51.02		yes	33.40	22.74-46.08	
middle	42.22	35.81-48.91					
richer	39.18	31.90-46.97					
richest	41.22	30.89-52.38					
Residence				Drugs for intestinal parasites in last 6 months			
urban	46.30	33.69-59.40	0.497				
rural	41.57	37.01-46.28		no	43.08	38.06-48.23	0.478
				yes	39.15	30.13-48.97	

*p-value obtained from chi-square test of contingency table

6.3 Factors associated with childhood anemia

In the bivariable analysis age of children, stunting, underweight, fever, maternal working status, maternal anemia and maternal age were found to be significant predictors of childhood anemia ($p<0.05$). But those variables with p-value less than 0.2 were taken in to the multivariable analysis. In the multivariable analysis the age of children, maternal working status and maternal anemia remain significant predictors of childhood anemia and stunting become a border line insignificant variable.

The odds of childhood anemia progressively decreases as the age of children decreases. As compared to children aged 6-11 months, Children aged 12-23 months had a 56% reduction in likelihood of anemia (AOR=0.44, 95% CI=0.23-0.84). The reduction in the likelihood of anemia in the age groups 24-35moths, 36-47months and 48-59 months was by 83% (AOR=0.17, 95% CI=0.09-0.32), 86% (AOR= 0.14, 95% CI=0.08-0.24) and 87% (AOR=0.13, 95% CI=0.07-0.24) respectively compared to children in the 6-11months age groups.

Children from mothers who were working at the time of the survey were 1.69 times more likely to be anemic compared to children from mothers who were not working at the time of the survey (AOR=1.69, 95% CI=1.17-2.44). Children from anemic mothers were 1.72 times more likely to be anemic than those from not anemic mothers (AOR=1.72, 95% CI= 1.17-2.52). (**Table 5**)

Table 5 Factors associated with anemia in children aged 6-59 months in Amhara region, Ethiopia 2020

Variables	Category	Weighted frequency		COR(95%CI)	AOR(95% CI)	P-value
		Anemic	Not anemic			
Sex of a child	Male	363	554	1.00	1.00	
	Female	422	522	1.23 (0.95-1.64)	1.08 (0.78-1.48)	0.648
Age of child in months	6-11	151	50	1.00	1.00	<0.001
	12-23	237	153	0.52 (0.29-0.91)	0.44 (0.23-0.84)	0.013
	24-35	140	226	0.24 (0.12-0.37)	0.17 (0.09-0.32)	<0.001
	36-47	122	295	0.14 (0.08-0.23)	0.14 (0.08-0.24)	<0.001
	48-59	135	350	0.13 (0.77-0.22)	0.13 (0.07-0.24)	<0.001
Maternal working status	not working	535	803	1.00	1.00	
	working	192	175	1.65 (1.16-2.36)	1.69 (1.17-2.44)	0.006
Any type of maternal anemia	not anemic	523	812	1.00	1.00	
	anemic	198	161	1.92 (1.34-2.74)	1.72 (1.17-2.52)	0.006
Maternal body mass index (in kg/m^2)	<18.5	168	178	1.00	1.00	
	≥18.5	556	800	0.74 (0.50-1.10)	0.98 (0.61-1.55)	0.919
Under weight	No	458	707	1.00	1.00	
	Yes	326	369	1.37 (1.06-1.76)	1.16 (0.82-1.66)	0.392
Stunting	No	407	649	1.00	1.00	
	Yes	378	427	1.41 (1.12-1.80)	1.41(0.97-2.06)	0.072
Child had fever in last two weeks	No	611	867	1.00	1.00	
	Yes	116	105	1.57 (1.06-2.355)	1.23 (0.81-1.86)	0.323
Taking iron pills, sprinkles or syrup	No	690	898	1.00	1.00	
	Yes	33	66	0 .65 (0 .37-1.14)	0.69(0.35-1.38)	0.289
Age of mother in years	15-19	24	15	1.00	1.00	0.890
	20-24	127	136	0.60 (0.24-1.49)	0.89(0.27-2.92)	0.840
	25-29	224	280	0.52 (0 .23-1.17)	0.92(0.32-2.66)	0.874
	30-34	133	195	0.44 (0 .19-1.02)	0.81(0.28-2.30)	0.683
	35-39	120	194	0 .40 (0.16-0.99)	0.74(0.23-2.34)	0.606
	40-44	75	99	0.49 (0 .20-1.20)	0.94(0.31-2.88)	0.918
	45-49	25	59	0.27 (0 .10-0.73)	0.62(0.17-2.19)	0.450

*p< 0.05 was taken statistically significant association

7. DISCUSSION

Anemia was prevalent in 42.2% of children and the significant predictors were child age, maternal anemia and maternal working status. Even though the region had the lowest prevalence of childhood anemia compared to other regions, childhood anemia is still found to be a severe public health problem in the region. (6) A significant proportion of children had mild or moderate anemia while a few proportion fall in to severe anemia category. This finding is lower than the result of many similar studies done in developing countries, including Ghana, Cape Verde (West Africa), Togo, Tanzania, Uganda, Bangladesh, Benin and India, which had a prevalence of anemia ranging from 51.8% in Cape Verde to 84.6% in Tanzania. (13-18, 25, 30, 32) This may be due to diferrent population and geography.

On the other way, this finding is higher than the result of different studies done in kilto Awulaelo (Northern Ethiopia), Gondar town, Adamitulu district of Oromia region and in a systematic review and meta-analysis done in Ethiopia which was 37.3%, 28.6%, 36.8% and 31.14% respectively. The possible explanation for this difference may be due to difference in sample size, residence and study area. (21, 24, 27, 33) This high burden of anemia in the region calls for the establishment of new prevention and control strategies.

This study reveals that, children in the 6-11months age group are more likely to be anemic compared to children in the other age groups as well as the odds of anemia decreases as the age of children increases. This may be due to the fact that; a) The increased introduction and toleration of iron containing foods with increasing child age and b) Rapid growth of children at earlier age group, which in turn results in high demand for nutrients including iron, may contribute to this finding. C) In addition this may be due to low concentration of iron in breast milk, which could be insufficient to meet daily iron requirements for breast feeding children and this may contribute to this finding. (14, 18-20, 22-27, 31-33) Moreover this finding is consistent with the results of many other studies done in Ethiopia and elsewhere.

Maternal anemia is found to be highly associated with the occurrence of childhood anemia. Children from anemic mothers are 1.72 times more likely to be anemic than their counter parts. This may be due to; mothers and their children share common home environment, socio-economic and dietary conditions; which in turn may reflect the occurrence of anemia as a

reflection of common nutritional status of the household. The results of many similar studies done in Ethiopia or elsewhere also support this finding. (15, 22, 23, 25, 30-32)

Maternal working status is one factor which significantly associates with childhood anemia. Children from mothers who were working at the time of the survey are 1.69 times more likely to be anemic compared to children from not working mothers. This might be explained by mothers who were working may not have sufficient time to care for and feed their children properly even for breast feeding. This finding is in contrast to another study done in Ethiopia. (19)

8. STRENGTH AND LIMITATION

The limitations of this study are that possible child related predictor variables; such as feeding practices, parasitic infections and chronic illnesses were not included in the analysis and recall bias is likely. In general EDHS didn't identify the cause of anemia. Nevertheless due to the large sample size, representation of diverse population groups, wide geographic coverage and standardization of hemoglobin level for altitude will support the validity of our finding.

9. CONCLUSION

In summary, this study showed that anemia is a severe public health problem in Amhara region. Age of children in months, maternal anemia and maternal working status were the factors associated with childhood anemia. This finding supports the established interventions like drugs for intestinal parasites alone could not tackle the prevalence of anemia in the region and it necessitates the need for other integrated intervention modalities to be implemented.

10. RECOMMENDATION

Childhood anemia is a severe public health problem in the region. So that it needs an urgent prevention and control strategies to minimize the problem significantly. Here we forwarded the recommendations to tackle the problem in the region.

- To control the prevalence of anemia age specific iron supplementation should be started, mainly for those less than 24 months of age.
- The established iron supplementation for pregnant and lactating mothers should be encouraged and strengthen.
- Children's waiting room should be established at work sites
- A system for screening high risk groups and identifying the root causes of anemia should be established.

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12. APPENDIXES

Declaration form

I, the undersigned, declare that this thesis is my original work, where my work is indebted to the work of others, it has not been accepted or presented for a degree in this or any other university and that all sources of materials used for the thesis have been fully acknowledged.

Name of Investigator: Zelalem Asmare

Signature: _____

Name of the institution: Bahir Dar University

Date of submission: ____/____/_____

Approval sheet

Thereby certify that I have read and evaluated this thesis entitled "prevalence of anemia and its associated factors in children aged 6-59 months; in Amhara region, based on EDHS 2016" prepared under my guidance by Zelalem Asmare. I recommend that it to be submitted as fulfilling the thesis requirement.

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Date ____/____/_____

As a member of the Board of Examiners of MPH Thesis Open Defense Examination, I certify that I have read and evaluated the thesis prepared by Zelalem Asmare and examined the candidate. I recommend that the thesis to be accepted as fulfilling the thesis requirement for the degree of Master of public health in Epidemiology.

Name and Signature of the internal examiner:

Zelalem Alamirew (Assistant professor in Epidemiology)

Date _____/_____/_____