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Original Article

Multilevel Modeling on the Anemia status of Women in Ethiopia

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ABSTRACT

Introduction: Anemia is the most common public problem caused by nutritional deficiency diseases among women of reproductive age. The main objective of this study was determining the regional variation and associated factors of anemia status among women of reproductive age in Ethiopia.
Methods: A cross-sectional study was conducted among 14,489 women who enrolled in Ethiopia demographic and health survey data of 2016. Binary and multilevel logistic regression was carried out for variables to determine associated factors with anemia status of women and its regional variations at ascertained of 5% level. This study was used information criteria to compared candidates models.
Results: This finding shows that women who use improved source of drinking water (OR=1.98, 95%CI=1.05, 3.72), being in middle wealth index (OR=0.25, 95%CI=0.10, 0.63), being in rich wealth index (OR=0.42, 95%CI=0.19, 0.94), having age at 1st birth in 20-24 years(OR=0.24, 95%CI=0.11, 0.53), having number of living children 1-2(OR=3.68, 95%CI=3.48, 4.98), having number of living children 3-4(OR=3.03, 95%CI=2.48, 4.05) and women who used government health center for place of delivery(OR=0.96, 95%CI=0.22, 1.70) were significantly related to anemia status of women.
Conclusion: This finding concluded that there is a significant variation of anemia status of women between regions in Ethiopia. Women in the middle and rich wealth index was less likely to be anemic than poor. Women having age at 1st birth in 20-24 years and women who used government health center for place of delivery were less likely to be anemic. But women having number of living children 1-2 and 3-4 were more likely to be more anemic than no child. Likewise, women who use improved source of drinking water were more likely to be anemic as compared to an unimproved source of drinking water. It is recommended that health workers should begive attention to these proximate determinants on anemia at regional level.

Introduction

Anemia is a major health problem as worldwide. It is the most common nutritional deficiency disease health issue with disproportionately high prevalence in women.[1] Anemia affects the lives of over 30% of the world's population occurring at all stages of the life cycle and adolescent females are the most vulnerable groups of anemia whereas

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the problem is higher in pregnant women particularly in developing countries.[2-3] The proportion of women with anemia is different from country to country and across regions this were evidenced by study reported prevalence 28% in East Africa,[4] 49.5%-69% in India.[5-7] 37.6% in Nepal,[8] 41.3% in Bangladesh,[9] 36-40% in some parts of Ethiopia[10, 11] and 40% in Korea.[12] The reason for risk of developing anemia among women of reproductive age is source of drinking water, contraception use, smoking status and body mass index.[13] In East Africa, the most important public health issue is anemia during pregnancy because the potentially adverse effects on maternal and child health where the predominant cause of anemia was body mass index, shortage of iron contents, vitamin B12 and infectious diseases which are varying greatly by geographical location, season and dietary practices.[16-18]The researcher used multilevel logistic regression since the response variable for this study is the binary outcome with the logit link function. To model the hierarchical population variations in which one of successive sampling from each level, multilevel logistic regression is an appropriate model.[21] Multilevel model was used to the hierarchically structured data in which the units at one level are clustered by units of the next higher level by allowing the simultaneous examination of the effects of group and individual level variation dependence of observations within and between groups' variations.[22] In multilevel model, the sample data are a sample from hierarchical population data structure. Even if several studies have been done on assessment and examined anemia using summary measure of statistics, cox and binary logistic regression model to identify determinants of women anemic under reproductive age by ignoring unobservable heterogeneity and conducted at small scale geographical area and hospital to identify the determinants of anemic women which may not invite for interventions as national wide. In this study, the lower levels are women as units that were nested within units at higher level (regions). The national geographical area with nine regions and two administrative cities that have multi-culture and ethnic setting in Ethiopia were considered and multilevel model was used to estimate the effect of both individual characteristics and cluster characteristics of women with anemia.

Methods and Materials

Study Area, Design and Period

This study conducted in Ethiopia which found in the horn of Africa. The geographical location of Ethiopia is bordered by Kenya to the South, Somalia and Djibouti to the East, Eritrea to the North and Sudan and South Sudan to the west. The country has nine regional states of Federal and two administrative cities. A cross-sectional study conducted to assess determinants that associated with anemia status among women enrolled in Ethiopia demographic and health survey 2016 during the census from January 18, 2016, to June 27, 2016.

Source of the Data and Sampling design

The data were obtained from Ethiopian Demographic and Health Survey which conducted by Central Statistical Agency. The principal objective of the survey was to give reliable data on marriage, fertility, family planning, child, adult and maternal mortality, nutrition, maternal and child health, knowledge of HIV/AIDS and prevalence of

anemia. The sample for Ethiopia demographic and health survey was designed to provide population and health indicators at the national (urban and rural) and regional levels. To select the samples, sampling frame were taken from the 2007 Population and Housing Census that conducted by Ethiopian central statistical Agency. Two-stage Stratified sampling in which each region was stratified into urban and rural areas, giving 21 sampling strata in the first stage and samples of Enumeration Areas (EAs) were selected independently in each stratum in the second stage. Based on the 2007 census a total of 645 enumerations Areas including 443 in rural and 202 in urban areas were selected with probability relative to the enumeration area size. An equal probability systematic selection was applied in the second stage to select a fixed number of 28 households per cluster. The data has hierarchical structure and its hierarchy follows individuals or hemoglobin tested woman of the reproductive age as level-one and region as level-two in which individual women are nested under regions. The target populations were all women in the reproductive age (15-49 years) which have tested with hemoglobin levels during Ethiopia demographic and health survey since 2016.

Variables Description and Measurement

Response variable

The dependent variable is woman anemia status. One question from used to examine the dependent variable, which is woman of the reproductive age at the time of interview "having anemia or normal." The response was binary which have two categories, namely: having anemia or normal (non-anemic) and coded as zero if woman is normal and coded as 1 if woman had anemia. Independent Variables included in our study is source of water supply, duration of current pregnancy, region, number of tetanus injection before birth, wealth index, place of residence, age groups of mothers, place of delivery, educational level of woman, number of household members, succeeding birth interval (months), age of woman at 1st birth, menstruated in last six weeks, number of living children, at health facility, told of family planning, number of prenatal visits during pregnancy and birth in last five years.

Statistical Analysis

To illustrate and determine the factors associated with women anemia status from the Ethiopian Demographic Health Survey (EDHS), 2016 data set, multilevel logistic regression and ordinary logistic regression were applied. In order to explore the regional variation of women with anemia, multilevel logistic regression model was employed. Logistic regression is a popular modeling approach when the dependent variable is dichotomous and a set of predictor variables continuous, discrete, categorical, or a mixture of any of these. The most commonly used method for estimating the parameters of a logistic regression model, are maximum likelihood estimation that estimates unknown parameters which maximize the probability of obtaining the observed set of data. The goodness of fit of a model can be tested using person's X^2 statistic, Wald test and the likelihood-ratio test.

The structure of the data plays a central role to identify which models is appropriate in-lined with objectives of the study. For data having hierarchical structure and a sample from such

a population which has the multistage sample, the multilevel regression model is appropriate which assumes a hierarchical data set with one single dependent variable is measured at the lowest level and explanatory variables at all existing levels. Multilevel modeling provides a convenient framework for studying how covariates at various levels of a hierarchical structure affect the outcome variable and used to correct the biases in parameter estimates as well as biases in their standard errors resulting from clustering. Multilevel binary logistic regression model would be adapted to the variations of anemia status of women within regional states of Ethiopia. The data structure of the two-level logistic regression is a collection of N groups (regions) and with group j (j=1, 2, …., N), a random sample of level-one units (women) Random intercept only model is used to model unobserved heterogeneity between groups in the overall response which permissible to know how the variability of the over all probability of anemia status seems across regions and compare the performance of the regions in anemia status. This can be done by obtaining the odds ratio for each region. In addition, Random Coefficient Logistic Regression Model was used to explain unobserved heterogeneity in the effects of explanatory variables on the response variable. The multilevel analogue, random coefficient logistic regression, is based on linear models for the log-odds that include random effects for the groups or other higher-level units. The other fundamental reason of using multilevel analysis is the existence of intra-class (intra-regional) correlation arising from similarity of anemic women in the same region compared to those of different regions. The intra-class correlation coefficient (ICC) measures the proportion of variance in the outcome explained by the grouping structure that can be calculated using an intercept-only model.

Results

Out of 14489 women, 27.1% had anemia whereas 72.9% were non-anemic from nine regional states and two administrative cities of Ethiopia. More of the anemic women were found in the age group of 35 and above years that had the proportion percentages of 7.40% while women with anemia were in the age 15-19 and 25-29 with proportion of 5.20%. The first and second maximum percentages of anemic women were lived in Somalia and Oromia while the two regions that had tminimum percentage of women lived with anemia was Benishangul-Gumuz and Harari. Among anemic women, 20.7% were from rural areas, and 6.5% were from urban areas of Ethiopia.

Regarding women educational level, the highest prevalence of anemia was observed among women who have no education (15.5%) as opposed to the lowest prevalence of anemia which was recorded from women who have primary, secondary and higher education level were 7.9%, 2.8% and 1.1%, respectively. About 16.7% were used improved source of water whereas 10.5% were used unimproved source of water; 14.3% from poorest wealth index whereas about 3.4% and 9.6% from rich and middle income, respectively.

Over 11.4 % of women who had age at 1st birth were in 15-19 years and 8.4% of women who had age at 1st birth were 35 and above years. Of these women, 14.6% had menstrual cycles in the last six weeks at the time of a survey conducted whereas 12.4% were not experienced menstrual cycle in the last six

weeks. Women who caught by anemia and have no children, were 7.2% and women have no knowledge about family planning were 17.7% whereas 8.0% have information regarding family planning at health facility. In addition, the characteristics for place of delivery and births in the last, five years among woman of the reproductive age (15-49) years were presented as detail in Table 1. The average household members in this study were five with standard deviation two approximately. The average succeeding birth interval was lie between 41.73 25.328 months. Likewise, the average number of tetanus injection before birth that received by women was lie between 1.41 1.681 (Refer in Table 2).

Result of Univariate analysis of Binary Logistic regression

Binary logistic regression was used to examine the effects of each predictor on anemia status of women in the reproductive age. We employed binary logistic regression model which is an appropriate procedure that used to screen out potentially important variables before directly included in multilevel logistic regression model. Loglikelihood chi-square statistic for screen out potentially important variables was applied. The relationship between each covariate and anemia status of women is presented in Table 3.

The result showed that age of women, region, residence, educational level, source of drinking water, number of household members, wealth index, succeeding birth interval, births in last five years, age of respondent at 1st birth, duration of current pregnancy, menstruated in last six weeks, number of living children, health facility told about family planning, number of tetanus injections before birth, number of antenatal visits during pregnancy and place of delivery were significantly related to anemia of women at 10 % level of significance and candidate predictors that were included in multilevel binary logistic regression model.

Result of Multilevel Binary Logistic Regression analysis

The candidate variables that were significant in the univariate analysis of binary logistic regression can be employed into multilevel logistic regression analysis for the improvement of unobservable heterogeneity due to women nested under regions. Before employed multilevel models, chi-square was employed to test heterogeneity among anemic women between regions. As a result, the chi-square statistic was found to be 1088.22 with p-value ($p < 0.0001$) providing evidence for heterogeneity among regions and intra-class correlation (ICC) is also equal to 0.1023 which is different from zero with p-value ($p < 0.0001$). This implies that multilevel binary logistic regression was an appropriate model to handle the heterogeneity of women among regions.

Comparison of Multilevel Binary Logistic Regression Models

The candidates multilevel logistic regression models were used such as empty model with random intercept; random slope model and random slope and intercept model have been considered and identify the appropriated model in this data. The result in (Table 4) indicated that multilevel logistic regression model having fixed intercept with random slope, had the smallest Akaike Information Criteria (AIC = 385.0685) and Bayesian Information Criteria

Table1. Summary of socio-demographic covariates that associated to anemia status of women.

		Anemia status of Women					
		Anemic		Normal		Total	
		Count	%	Count	%	Count	%
Age group of mother	15-19	755	5.2	2417	16.7	3172	21.9
	20-24	715	4.9	1952	13.5	2667	18.4
	25-29	761	5.2	1891	13.1	2652	18.3
	30-34	625	4.3	1466	10.1	2091	14.4
	>=35	1073	7.4	2834	19.6	3907	27.0
Region	Tigray	331	2.3	1268	8.8	1599	11.0
	Afar	477	3.2	562	3.9	1039	7.2
	Amhara	297	2.0	1391	9.6	1688	11.7
	Oromia	482	3.3	1320	9.1	1802	12.4
	Somali	737	5.0	525	3.6	1262	8.7
	Benishangul-G.	202	1.4	836	5.8	1038	7.2
	SNNPR	379	2.6	1381	9.5	1760	12.1
	Gambela	276	1.9	709	4.9	985	6.8
	Harari	204	1.5	546	3.8	750	5.2
	Addis Ababa	256	1.8	1357	9.4	1613	11.1
	Dire Dawa	288	2.0	665	4.6	953	6.6
Residence	Urban	931	6.5	3778	26.1	4709	32.5
	Rural	2998	20.7	6782	46.8	9780	67.5
Educational level	No education	2244	15.5	4352	30.0	6596	45.5
	Primary	1141	7.9	3721	25.7	4862	33.6
	Secondary	388	2.8	1615	11.1	2003	13.8
	Higher	156	1.1	872	6.0	1028	7.1
Source of water	Unimproved	1512	10.5	3113	21.5	4625	31.9
	Improved	2417	16.7	7447	51.4	9864	68.1
Wealth index	Poor	2066	14.3	3540	24.4	5606	38.7
	Middle	484	3.4	1419	9.8	1903	13.1
	Rich	1379	9.6	5601	38.7	6980	48.2
Age at 1st birth	15-19	1668	11.4	3727	25.7	5395	37.2
	20-24	828	5.7	1914	13.2	2742	18.9
	25-29	185	1.4	461	3.2	646	4.5
	30-34	35	0.3	120	0.8	155	1.1
	>=35	1213	(8.4)	4338	29.9	5551	38.3
Menstruated in last six weeks	No	1798	12.4	4227	29.2	6025	41.6
	Yes	2131	14.7	6333	43.7	8464	58.4
Number of living children	No child	1039	7.2	3903	26.91	4942	34.1
	1-2 children	991	6.9	2714	8.7	3705	25.6
	3-4 children	845	5.9	1929	13.3	2774	19.1
	>=5 children	1054	7.2	2014	13.9	3068	21.2
Told of family planning at health facility	No	1117	17.7	3059	48.4	4176	66.1
	Yes	507	8.0	1631	25.8	2138	33.9
Place of delivery	Home	1550	10.6	2629	18.1	4179	28.8
	Government HC	613	4.2	1705	11.8	2318	16.0
	Private HC	1766	12.2	6226	43.0	7992	55.2
Births in the last five years	No child	1682	11.6	5992	41.4	7674	53.0
	1-2 children	2031	14.0	4324	29.8	6355	43.9
	>=3 children	216	1.5	244	1.7	460	3.2

Table 2. Descriptive Statistics for continues covariates that included in this Study

Variables	Minimum	Maximum	Mean	Std.
Number of household members	1	20	5.44	2.428
Succeeding birth interval (months)	8	208	41.73	25.328
Duration of current pregnancy	1	10	5.57	2.230
Number of tetanus injections before birth	0	8	1.41	1.681
Number of antenatal visits during pregnancy	0	98	2.88	5.510

Table 3. Binary Logistic Regression Model result to screen out potential factors

Variables	Log likelihood(χ^2)	DF	P-value
Age group	-8452.7834	4	0.0001***
Region	-7961.9739	10	0.0001***
Residence	-8368.8323	1	0.0001***
Education level	-8300.5552	3	0.0001***
Source of water	-8415.275	1	0.0001***
Number of household members	-8436.2883	1	0.0001***
Wealth index	-8237.9093	2	0.0001***
Succeeding birth interval	-4730.4915	1	0.0001***
Births in last five years	-8335.3165	2	0.0001***
Age of respondent at 1st birth	-8400.1147	4	0.0001***
Duration of current pregnancy	-690.22665	1	0.0003***
Menstruated in last six weeks	-8448.3855	1	0.0001***
Number of living children	-8372.2212	3	0.0001***
Told about family planning at health facility	-3596.2645	1	0.0087***
number of tetanus injections before birth	-4310.8095	1	0.0001***
number of antenatal visits during pregnancy	-4304.6734	1	0.0001***
place of delivery	-8315.6444	2	0.0001***

Table 4. Summary for comparison of multilevel logistic regression model

Methods	Random intercept	Random slope model	Random slope and intercept model
Log Likelihood	-7993.6479	-163.53426	-2749.775
AIC	15991.3	385.0685	5503.551
BIC	16006.46	491.2944	5516.561

(BIC= 491.2944) as compared other candidate models. Finally, random slope with fixed intercept model was applied which is better fit to made investigation of anemia status for women in Ethiopia.

Results of Random slope with Fixed Intercept Model

In Table 5, the result showed that inclusion of level one covariates decreased regional variations from 0.573 (level-two variance without covariates) to 0.375 that implies there is a significant variation of anemia status of women between regions in Ethiopia. The reduction of the random effects of the slope variance is due to the inclusion of fixed explanatory variables that taking into account the fixed independent variables can provide extra predictive value on anemia status of

women in each region.

Based on the multilevel logistic regression, source of drinking water, wealth index of women, age of women at first birth, number of living children and place of delivery for women had significant effect on anemia status when regional heterogeneity was included at 5% level of significance whereas age group of mother, residence, education level, number of household members, succeeding birth intervals, births in the last five years, duration of current pregnancy, menstruated in the last six weeks, told of family planning at health facility, number of tetanus injections before birth and number of antenatal visits during pregnancy were non-significant. As a result in (Table 5) showed that women who use improved water source were 1.98 times more likely to be anemic as compared to those who use unimproved water source controlling for other variables in the model. Odds of Women who live in middle and rich households were about 0.25 and 0.42 times less likely to be anemic than women who live in poor

Table 5. Socio-demographic and health related factors result of random slope with fixed intercept multilevel model analysis

Variables (Ref)		Odds ratio (OR)	SE	Statistic	p-value	95% CI for OR
Age of women (15-19)	20-24	1.22	1.89	0.13	0.898	0.059, 25.332
	25-29	2.12	3.35	0.48	0.632	0.10,46.6
	30-34	2.77	4.54	0.6	0.535	0.111 ,68.8
	>=35	6.18	10.60	1.06	0.287	0.2 ,177.5
Residence (Urban)	Rural	0.68	0.38	-0.7	0.489	0.22,2 .1
Educational level (no)	Primary	0.83	0.30	-0.5	0.599	0.412, 1.7
	Seconder	1.12	0.88	0.14	0.888	0.238, 5.2
	Higher	0.26	0.26	-1.3	0.184	0.035,1.91
Source of water(unimproved) improved		1.98	0.64	2.10	0.035	1.048 ,3.722
Number of household members		1.01	0.09	0.01	0.996	0.836, 1.2
Wealth index (poor)	Middle	0.25	0.12	-2.9	0.003	0.098 ,0.6
	Rich	0.42	0.17	-2.1	0.035	0.187, 0.9
Succeeding birth interval (months)		0.98	0.01	-1.6	0.102	0.965,1.00
Births in last five years (no birth)	1-2	3.15	2.16	-1.7	0.094	0.822,12.1
	>=3	1.10	0.98	-1.8	0.198	0.981,1.987
Age of women at 1st birth (15-19)	20-24	0.24	0.097	-3.5	0.000	0.107,0.528
	25-29	0.92	0.70	-0.1	0.922	0.211,4.09
	30-34	0.001	0.0004	-0.2	0.99	0
	>=35	1.25	0.72	0.4	0.699	0.402, 3.9
Duration of current pregnancy		1.14	0.08	1.88	0.061	0.99,1.31
Menstruated in last six weeks (no)	yes	0.36	0.51	-0.7	0.470	0.22, 5.81
Number of living children (no child)	1-2	3.68	0.012	2.13	0.033	3.48,4.98
	3-4	3.03	0.06	2.42	0.015	2.48 ,4.05
	>=5	2.98	0.21	1.97	0.19	2.01,3.12
Told of family planning at health facility (no)	yes	0.63	0.21	-1.4	0.170	0.33,1.22
Number of tetanus injections before birth		0.92	0.08	-0.9	0.368	0.78,1.096
Number of antenatal visits during pregnancy		0.99	0.03	-0.5	0.636	0.928 ,1.05
Place of delivery(home) Government HC		2.62	0.99	2.6	0.011	1.25,5.5
Private HC		1.27	1.29	0.24	0.812	0.17 ,9.3
Parameter estimates		Coefficient	SE	Z	P-vale	Odds ratio
Fixed effect intercept(β_o)		-0.4533	1.968	-0.2	0.018	0.6355
Random effect var (U_j)		0.3750	0.291			
Intercept only model var(region)		0 .573	0.831			

households respectively.

Age of women at 1st birth is highly associated with anemic status at alpha equal to 5% level of significant. Women whose age at 1st birth was 20-24 years old had odds 0.24 times less likely to be anemic as compared to women whose age at 1st birth 15-19 years old.

The number of living children is another determinant of anemia status of women in Ethiopia at 5% level of significance. Besides, risk ratio of women who had 1-2 and 3-4 living children were 3.68 and 3.03 times more likely to expose for anemic as compared to their counterparts respectively. Place of delivery is important predictor to determine anemia level of women in Ethiopia and the associated odds for women who use government health center service for delivery was 0.382 time less likely to be anemic as compared to women who use home place of delivery.

Discussion

The current study assessed demographic, socio economic and health service factors affecting anemia status and determines the variation of anemia status between regions in Ethiopia. The women with anemic have differences across geographical regions in Ethiopia as a result of healthcare facility, clean water, age at first birth and terms of economic in the regions. This result is consistent with the study done in Ethiopia that suggested food grain consumption and calorie intake patterns variation with regions.[1-5] The prevalence rate of anemia status for women under reproductive age was 27.1% which implies there is regional variation of woman at individual and regional levels in Ethiopia. This study examined the regional variation of anemic women using multilevel logistic regression with adjusting for all covariates in the model. Therefore, the risk of anemia was associated with women belongs to middle and rich wealth index, having number of children 1-2 and 3-4, using government health center for place of delivery, women whose age at 1st birth was 20-24 years old and women who use improved water.

The overall prevalence of anemia status was 27.1%. This result is slightly more than the community based cross-sectional study conducted in northeast Ethiopia which is 24.2%[6] and in Jimma 16%.[7] The difference may occur due to the scope of the study area, cultural practice and dietary factors in which our study considered whole Ethiopia whereas cross-sectional study is limited to small area. Another study confirmed with our results had prevalence 28% in East Africa,[8] 49.5%-69% in India,[6, 9, 10] 37.6% in Nepal,[11] 41.3% in Bangladesh,[12] 36-40% in some parts of Ethiopia[13, 14] and 40% in Korea.[15]

Based on the result of this finding, age of woman at 1st birth was found to be a determinant factor of anemia status of women. The likelihood of woman in the age at 1st birth 20 - 24 years old were 0.24 time less likely to be anemic as compared to women who had age at 1st birth in younger (15-19) years old. The results are consistent with study in Nepal and it suggested anemia focused on the adolescents and high fertility age of women under childbearing.[16-20]

Another important factor associated with anemic women was source of drinking water which has significant effect on women to develop anemia. Women who use improved water source were 1.98 times more likely to develop anemic as compared to those who use unimproved water source. This finding is consistent with the study in Nepal.[21]

More proportion of anemia cases were observed among women with poorest wealth index. As a

result, the women who were in the middle and rich were about 25% and 42% times less likely to develop anemia than women who were in the poorest wealth quintile respectively. This implies women in the poorest wealth index were 75% and 58% more likely to experienced anemia as compared to women categorized under middle and richest wealth index respectively. This result is linked with the previous study in Ethiopia[22] and another study in India confirmed with this finding.[23-26]

Number of living children was another important determinant that associated with prevalence of anemia of women in Ethiopia. The odds of women who had 1-2 and 3-4 living children were 3.68 and 3.03 times more likely to develop anemic respectively as compared to women who had no living children. Several studies supported our results in different countries such as study conducted in India which reported that repeated child bearing of women have significant effect to develop anemia for women and being anemic was found to be increased for women with multiple pregnancies.[23] Another study in Ethiopia lined with our result and it shows women having more children increased the family size and decreased the birth interval for woman of the reproductive age which implies this family share basic resources needs such as food, house and money which in turn exposed to anemia for women under reproductive age.[27, 28-31]

Place of delivery is important predictor to determine anemia level of women among reproductive ages in Ethiopia. The odds of multilevel analysis considering regional heterogeneity for women who use government health facility to delivery was 2.62 times more likely to become anemic as compared to women who use home place of delivery. This result consistent with the study done in Ethiopia which shows, the place of delivery and anemia status were strongly associated.[27]

Limitations

The interactions between variables were not identified during data analysis. The result in present analysis is true only for adult women; that is, it may have different outcomes when women with all ages are considered. This could be a potential case for further investigation.

Conclusions

This study shows wealth index, age of women at 1st birth, number of living children, source of drinking water and place of delivery were associated with prevalence of anemia for reproductive women in Ethiopia. Anemia status of woman of the reproductive age varies between regions significantly. But, the inclusion of those associated covariate, decreased the regional variations.

Abbreviation

DHS, Demographic and health survey; SNNPR, Southern Nations Nationality and peoples Region; EDHS, Ethiopia demographic and health survey, CSA, Central Statistical Agency; EAS, Enumeration areas; OR, Odd Ratio; X2, Chis-quare; ICC, Intra-Class Correlation coefficients; CI, Confidence Interval; AIC, Akaike Information Criteria; BIC, Bayesian Information Criteria

Declarations

Ethics approval

All processes performed in this study were in

accordance with the ethical standards of the Ethics Committee of the Ethiopia Demography Health Survey. All the data that used in this study are publicly available. The raw data used in this study can be accessed from the DHS website. Reference number: http://www.dhsmeasures.

Consent to participate

Letter of consent was received from the measure of EDHS International Program ,which authorized the data sets. Informed consent was obtained from all participants included in the study. Reference number: http://www.dhsmeasures.

Consent for publication

Not applicable.

Availability of data and material

The raw data used in this study can be accessed from the DHS website
http://www.dhsmeasures.

Competing interests

The authors declare that they have no competing interests.

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None.

Authors' contributions

All Authors have read and approved the manuscript.

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