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Multilevel Modeling of Utilization of Maternal Health Care Services in Ethiopia

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Abstract

This paper has aimed to find out the determinants of utilization of maternal health care services in Ethiopia. The study used data from 2011 Ethiopian Demographic and Health Survey (EDHS) which has a two-level hierarchical structure, with over 16,515 women nested within eleven geographical regions. The bivariate analysis result showed that maternal education, husband education, maternal age, visited by community health workers, marital status, women's exposure to media, place of residence, birth order, maternal work status, wealth index, and religion have shown significant variations in the usage of antenatal and delivery care services.. The study shows that the coverage of antenatal care service uptake is only 35.1 percent while that of delivery care is 9.6 percent. Multilevel logistic regression models have been used to analysis the data. The significant deviance based chi-square test shows that random coefficients model better fit to the data. Generally, the usage of maternal care services in Ethiopia is far from the expectation. So, attention must be given to educating women, providing relevant information, shaping the traditional believes of mothers and improving service quality. It is also recommended that multilevel models better than traditional single level models when the data structure is hierarchical, like EDHS data.

Key words: Ethiopia, Ethiopian Demographic and Health Survey, Maternal Care, Multilevel Analysis, Random effect

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1. Introduction

Complications of pregnancy and childbirth are a leading cause of maternal morbidities and mortalities in developing countries. The WHO estimates that over 500,000 women and girls die each year from the complications. Worldwide, approximately 99% of these deaths occur in developing world. These high morbidity and mortality rates make maternal health a huge public health problem in the developing countries of the world, including Ethiopia.

The health services in Ethiopia are organized primarily as decentralized within the regions of the country. The service centers are consisted of 143 hospitals, 690 health centers and 1,662 health stations owned by Ministry of Health. The government of Ethiopia has implemented a health sector development program (HSDP). It consists of five year programs which focus on further improving health service delivery, capacity building and development of preventive health care (Wakabi, 2008).

To facilitate the delivery of this services, the HSDP I introduced a four-tier system for health service delivery, characterized by a primary health care unit (PHCU), comprising one health centre with five satellite health posts, district hospital, zonal hospital and specialized 7 hospitals. A PHC-unit has been planned to serve 25,000 people, while a district and a zonal hospital are each expected to serve 250,000 and 1,000,000 people respectively (FMOH, 2005)

2. Statement of the Problem

Studies in the 1990s have shown that about 25% of Ethiopian women received antenatal care **(**ANC) and less than 10% received delivery care (DC) (Becker et al, 1993; CSA, 2005; Mekonnen, and Mekonnen, 2002; Mengistu, and James. 1996; Mesganaw, 1990). This low utilization of health care services gives some indication of weak service coverage in the country. This study aims to assess the current status of the key determining factors of utilization of maternal health care services in the country.

3. Objective of the Study

The general objective of this study is to model the determinants of utilization of maternal health care services, specifically; antenatal and delivery care services and, assess the variation in the use of these services among the different regions of Ethiopia. In line with the general objective, the specific objectives are:

- To identify different demographic and socio- economic determinants of use of maternal health care services in Ethiopia.
- To analyze the factors that contribute to variations in the use of the services in the regional states as in the country.
- To determine the extent of variation in the utilization of these services within and between regions.
- To compare results obtained from traditional (single level) and multilevel approach in identifying determinants of the utilization of maternal health care services in Ethiopia.
- To provide information to researchers and policymakers.
- To suggest strategies for improving health care services of women using the results obtained from the study.

4. Methods of Data analysis

4.1 Description of the Study Area

The study is conducted in Ethiopia. Ethiopia is situated in the Horn of Africa between 3 and 15

degrees north latitude and 33 and 48 degrees east longitude (CSA, 2001). The altitude in the country ranges from 4620 meters above sea level to 120 meters below sea level at the Danakil Depression. The country has 9 Regional States and two city administrations with 611 Woredas and 15,000 Kebeles. According to the third census of 2008, Ethiopian population was 74 million (CSA, 2005).

A total of 17,817 households were selected for the sample, of which 17,018 were found to be occupied during data collection. In the interviewed households 17,385 eligible women were identified for individual interview; complete interviews were conducted for 16,515, yielding a response rate of 95%.

The variables included in this study are based on consideration in previous studies. The dependent variables of the study are specified to only ANC and DC service utilizations.

A woman is considered to have used ANC if she was checked by a health professional (doctor, nurse or midwife) at least once during her pregnancy period. The WHO recommends four or more visits as optimal number of visits for those with uncomplicated pregnancy.

Delivery Care Service is coded as 1, if a mother delivered at Health Institution and 0, if a mother delivered at Home.

The independent or predictor variables used in the study include: mothers' education, work status, place of residence, region, age of respondent, religion, birth order, community health workers (CHW), marital status, women exposure to media, wealth index and husband's education

4.2 Multilevel Logistic Regression Model

This study employs data which have been collected by using two stage cluster sampling; in such samples, the individual observations are in general not completely independent (EDHS, 2011).

The problem of dependencies between individual observations occurs in survey research, if the sample is not taken at random but cluster sampling from geographical areas is used instead. For similar reasons as in EDHS, 2011, respondents from the same geographical area will be more similar to each other than are respondents from different geographical areas. This leads again to estimates for standard errors that are too small and produce spurious 'significant' results.

A multilevel logistic regression model can account for lack of independence across levels of nested data (i.e., individuals nested within regions). Conventional logistic regression assumes that all experimental units are independent in the sense that any variable which affects the utilization of maternal health care services (UMHCS) has the same effect in all regions, but multilevel models are used to assess whether the effect of predictors vary from region to region (Goldstein, H.,2003).

The binary multilevel logistic regression model has a binary outcome (use and not use of ANC). In this study the basic data structure of the two-level logistic regression is a collection of N groups (regions) and within-group j (j= 1,2, ..., N), a random sample n_j of level-one units (mothers). The response variables, i.e., we let $Y_{ij}=1$ if the i^{th} mother in j^{th} region use ANC, and $Y_{ij}=0$ otherwise; with probabilities, ($P_{ij}=P(y_{ij}=1|X_{ij},u_j)$, is the probability of using ANC for mother i in region j; where u_j is a random cluster effect and often assumed to be $N(0,\sigma_u^2)$. Analogous representations are given

for DC service usage. Let P_{ij} be modeled using a logit link function. The two-level model is given by:

$$logit(P_{ij}) = log(P_{ij}/1-P_{ij})$$

$$= \beta oj + \sum_{i=1}^{k} \beta 1j\, X1ij \qquad (1)$$

where i=*1, 2, 3, .,.,., k* & $\beta_{oj} = \beta_o + U_{oj,}$ $\beta_{1j}=\beta_1+U_{1j}$, ..., $\beta_{kj}=\beta_k+U_{kj}$

4.3 The Empty Multilevel Logistic Regression Model

The empty two-level model for a dichotomous outcome variable refers to a population of groups (level-two units) and specifies the probability distribution for group-dependent probabilities p_j in $Y_{ij} = p_j + \varepsilon_{ij}$ without taking further explanatory variables into account. We focus on the model that specifies the transformed probabilities $f(p_j)$ to have a normal distribution. This is expressed, for a general link function f (p), by the formula:

$$g(p_j) = \beta_o + U_{oj}$$

where β_o is the population average of the transformed probabilities and U_{oj} is the random deviation from this average for group j.

4.4 The Random Intercept Model

In the random intercept model the intercept is the only random effect meaning that the groups differ with respect to the average value of the response variable, but the relation between explanatory and response variables cannot differ between groups. We assume that there are variables which potentially explain the observed success and failure. These variables are denoted by X_h, (h = 1, 2,…, k) with their values indicated by X_{hij} since some or all of those variables could be level one variables, the success probability is not necessarily the same for all individual in a given group (Snijders and Bosker, 1999). Therefore, the success probability depends on the individual as well as the group, and is denoted by P_{ij}. The outcome variable is split into an expected value and residual as:

$$\boldsymbol{Y_{ij} = P_{ij} + R_{ij}}$$

Random Coefficient Model

Now consider a model with group-specific regressions of logit of the success probability, $logit(P_{ij})$, on a single level one explanatory variable X,

$$logit(P_{ij}) = log(P_{ij}/1-P_{ij}) = \beta_{oj} + \beta_{1j}X_{1ij} \qquad (2)$$

The intercepts β_{oj} as well as the regression coefficients or slopes, β_{1j} are group dependent. These group dependent coefficients can be split into an average coefficient and the group dependent deviation:

$$\beta_{oj} = \beta_o + U_{oj} \; and \; \beta_{1j} = \beta_{1} + U_{1j}$$

Substitution into (2) leads to the model

$$\boldsymbol{logit(P_{ij}) = log(P_{ij}/1-P_{ij}) = (\beta_o + U_{oj}) + (\beta 1 + U_{1j})\, X_{1ij}}$$

$$\boldsymbol{= \beta_o + \beta_1 X_{1ij} + U_{oj} + U_{1j}X_{1ij}} \qquad \textbf{(3)}$$

There are two random group effects, the random intercept U_{oj} and the random slope U_{1j}.

5. Results and discussion

5.1 Descriptive Statistics

Results of utilization pattern for antenatal care and assistance during delivery are presented in Table 1 below. The results show that the

utilization of ANC service is 35.1%. The delivery care usage is 9.6 percent. This low usage of maternal services could be the cause of the death of both mothers and children in the last five years in the country.

Table 1: Summary of Usage of ANC & DC Services in Ethiopia (EDHS, 2011)

Variable		Frequency	%
ANC	Yes	5789	35.1%
	No	10717	64.9%
DC	No (Home)	2958	90.4%
	Yes (HI)	313	9.6%

5.2 Bivariate analysis

There were enormous variations on the use of ANC among mothers in the past five years. Maternal education, husband education, maternal age, visited by community he, marital status, women's exposure to media, place of residence, birth order, maternal work status, wealth index, and religion were selected as predictor variables of ANC in the bivariate analysis in the table shown below (Table 2).

The bivariate analysis reveals that use of antenatal care service was higher (40.7%) in the age group 20-34 in which more than half of women of reproductive age were found. Working mothers had a relatively higher percentage of use of antenatal care services (40.7%) when compared to those who were not working (32.1%). High percent of women (46.6%) used antenatal care service for the first child than the later ones.

Education was an important determinate of use of ANC. About 48.6% of women with secondary education and above received ANC while it was only 31.2% among those who were illiterate. The result also showed that mothers education was associated with ANC use (x2 = 251.2, DF=2 & P=0.000). Similarly all the other variables in the bivariate analysis can be interpreted in the same way.

Results displayed in Table 3 reveal that the majority of women (69.2%) with secondary education and higher used DC service as compared to those with no education (6.2%). It is also important to note that mother's current age (x^2=4.2, DF=2, P=0.001) was significant. Similarly, all other predictors of DC service were significant in the bivariate analysis.

Table 2: Summary of Background Characteristics of Women According to Use of ANC Service in Ethiopia (EDHS, 2011)

Characteristics	Category	N	N (%)	ANC		x^2 (P-value)
				Used (%)	Not used (%)	
Mother's age	15-19	3835	23.2	20.8	79.2	466.8 (0.000)
	20-34	8307	50.3	40.7	59.3	
	35-49	4373	26.5	36.8	63.2	
Religion	Orthodox	6995	42.4	40.8	59.2	185.524 (0.000)
	Protestant	2936	17.8	33.3	64.7	
	Muslim	6170	37.4	30.1	69.1	
	Others	406	2.5	25.9	74.1	
Place of residence	Urban	464	33.9	43.3	56.7	21.1 (0.000)
	Rural	906	66.1	30.8	69.2	
Visited by CHW	No	13814	83.7	31.1	68.9	582.8 (0.000)
	Yes	2692	16.3	55.4	4.6	
Marital status	Never in union	4413	26.7	22.7	17.3	420.6 (0.000)
	Married	10204	61.8	40.3	59.7	
	Others	1898	11.5	35.7	64.3	
Partner's education	No educ.	5905	48.9	31.0	69	413.1 (0.000)
	Primary	4088	33.8	44.5	55.5	
	Sec.+	927	16.2	54.9	45.1	
Mother's Work status	Not working	10849	65.7	32.1	67.9	119.9 (0.000)
	Working	5659	34.3	40.7	59.3	
Mother's education	No educ.	8278	50.1	31.2	68.8	251.2 (0.000)
	Primary	5858	35.5	35.3	64.7	
	Sec+	1395	8.4	48.6	51.4	
Birth order	1	2015	12.2	46.6	53.4	107.1 (0.000)
	2-3	3242	19.6	43.8	56.2	
	4-5	2409	14.6	39.4	60.6	
	6-7	1766	10.7	5.5	94.5	
	8+	1464	8.9	5.9	94.1	
Wealth index	Poor	6113	37.0	26.6	73.4	498.867 (0.000)
	Medium	2268	13.7	31.6	68.4	
	Rich	8134	49.3	42.4	57.6	
Exposure to Media	No	3040	18.4	38.5	61.5	19.450 (0.000)
	Yes	13475	81.6	34.3	65.3	

Table 3: Summary of Background Characteristics of Women According to Use of DC Service in Ethiopia (EDHS, 2011)

Characteristics		N	N (%)	DC		x^2 (P-value)
				Used (%)	Not used (%)	
Mother's current age	15-19	3835	23.2	13.3	86.7	4.2 (0.001)
	20-34	8307	50.3	10.5	89.5	
	35-49	4373	26.5	6.0	94	
Place of residence	Urban	464	33.9	68.4	31.6	79.3 (0.000*)
	Rural	906	66.1	5.8	94.2	
Visited by CHW	No	13814	83.7	9.4	90.6	0.548 (0.459)
	Yes	2692	16.3	10.4	89.6	
Husband's education	No educ.	5905	48.9	4.5	95.5	319 (0.000)
	Primary	4088	33.8	10.2	89.8	
	Sec.+	1927	16.2	34.5	65.5	
Mother's Work status	Not W.	10849	65.7	8.8	91.2	5.7 (0.017)
	Working	5659	34.3	11.7	88.3	
Mother's education	No educ.	8278	50.1	6.2	93.8	452 (0.000)
	Primary	5858	35.5	13.2	86.8	
	Sec.+	1395	14.4	69.2	30.8	
Birth order	1	2015	122			66.8 (0.000)
	2-3	3242	19.6	14.9	85.1	
	4-5	2409	14.6	7.0	93	
	6-7	1766	10.7	5.5	94.5	
	8+	1464	8.9	5.9	94.1	
Wealth index	Poor	6113	37.0	4.50	95.5	245.7 (0.000)
	Middle	2268	13.7	3.70	96.3	
	Rich	8134	49.3	21.9	78.1	
Religion	Orthodox	6995	42.4	14.1	85.9	27.85 (0.000)
	Protestant	2936	17.8	7.1	92.9	
	Muslim	6170	37.4	8.2	91.8	
	Others	406	2.5	10.2	89.8	
Exposure to Media	No	3040	18.4	11.9	88.1	4.065 (0.044)
	Yes	13475	81.6	9.1	90.9	

Table 4 shows that the conditional probability of mothers' utilization of MHCs. The probability that a pregnant mother may attend DC given that she has already attended ANC is about 0.15. The following table displays result for the two MHCs.

Table 4: Independent Test and Conditional Probability of UMHCS

		DC usage	
		Yes, Freq (%)	No, Freq (%)
ANC usage	Yes	189(15.0)	1067
	No	124(6.2)	1887

- Conditional probability = P(DC=using/ANC=using) = 0.15
- P(ANC=using, DC=using)=0.0817

5.3 Multivariate Results of Multilevel Logistic Regression

In order to use statistical packages for multilevel analysis, it is convenient to organize the data to reflect the hierarchical structure in the analysis. The EDHS data were therefore first sorted in such a way that all records for the same higher level (level-2: Region) unit are grouped together and within this group, all records for a particular lower level (level-1: Women) unit are contiguous. All the selected covariates found significant in the bivariate analysis were included in multilevel analysis. The multilevel process was stepwise. The first step examined the null model of overall probability of use of MHCS without adjustment for predictors. Second step included first the univariate analysis (both single and multilevel), and then random intercept multilevel univariate analysis for each of the selected explanatory variables. Then a model building for two-level logistic regression analysis was constructed.

A chi-square test statistic was applied to assess heterogeneity in the proportion of women who use MHCS among regions. See table 4.11 shows that the test yields (ANC, $\chi 2 = 539.541$, df =10, P=0.000; DC, $\chi 2 = 445.597$, df=10, P=0.000). Thus, there is an evidence of heterogeneity of UMHCS among regions.

Table 5: Chi-Square Tests of Heterogeneity

		Region
ANC	Chi-square	539.541
	Df	10
	Sig.	0.000
DC	Chi-square	445.597
	Df	10
	Sig.	0.000

The deviance-based chi-square values for the empty models of both ANC & DC services shown below (Table 6) are the difference in log likelihoods of an empty models of single level logistic regression and their corresponding empty models of multilevel logistic regression. The chi-square values are compared with the critical values from the chi-squared distribution with additional parameters as degree of freedom. The result shows that the empty models with random effect for both services are better than those without random effect which shows that testing the random parts is necessary.

The chi-square test for the random intercept model of ANC is significant showing that the random intercept model fits better than the empty model. The significant deviance based chi-square value of random coefficient model for ANC service indicates that the random coefficient model fits significantly better than the empty model and the random intercept and fixed slope model. Taking the hierarchical nature of the three models in to consideration, the random coefficient model was found to be the best model of fitting the utilization of antenatal health care services from all other multilevel regression models.

However, the insignificant deviance-based chi-square test values of DC service use shows that both random intercept and random coefficient models fit poorly as compared to the empty model. As a result of this, only empty multilevel logistic regression model was used to describe the regional variation in the use of delivery care service from trained health professionals.

Table 6: Deviance Based Chi-square Test Statistics of Multilevel Models

	Empty model	Random intercept model	Random coefficient model
ANC -2*log likelihood	20917.126	1049.752	1045.7258
Deviance based chi-square test	489.93	6.21	15.49
P- value	0.000	0.012704	0.000
DC -2*log likelihood	1887.4865	94.5747 1	96.11
Deviance based chi-square test	176.56	0.57853	2.45
P- value	0.000	0.44689	0.118

5.4 Single-level and multilevel models Comparison

The deviance-based chi-square test is used to select a model that fits the data best. Models were fitted with and without second level error variance (σ2u (region)). The hypothesis to be tested is:

Ho: Multiple logistic regression (one-level) model is best fit the data or better analysis method than the other (σ2u (region) = 0)

versus

H1: Multi Level model is best fit the data or better analysis method than one-level regression method where (σ2u (region) =0).

The difference chi-squared value between deviance of ordinary regression and multilevel model is calculated as 1055.91298 - 1049.7524= 6.16058, with 1 df has P-value = 0.013063. The df is 1 because there is only one more parameter in the multilevel model. By comparing the test statistic to the x2 distribution at 1 df we reject the null hypothesis based on deviance (-2log (likelihood)) statistic. Since the test statistic is greater than the tabulated value or a very small P-value implied that the multilevel model is best fit over the ordinary multiple regression models.

We first fit a simple model with no predictors i.e. an intercept-only model that predicts the probability of usage of MHCS and it can be considered as a parametric version of assessing heterogeneity of UMHCS among regions of the country. The variance of the random factor and the intra-region correlations in intercept only model are given below.

The variance of the random factor indicates that there is a regional difference in the utilization of maternal health care services in Ethiopia. The intra-region correlations of the intercept only models of ANC and DC service

use are 0.0483 and 0.2611 respective1ly. This means that about 4.83% and 26.1% of the variation in the utilization of ANC and DC services was due to region effect respectively. From the empty model estimates of ANC, we can say that the log odds of receiving antenatal care from a medically-trained provider with uoj = 0 is o= -0.6126233. The intercept for region j is -0.6126233+uoj where the variance of uoj is estimated as 2oj = 0.4086517. Similarly, we can also say that the log odds of receiving delivery care from a health professional with uoj = 0 is o= -2.084531.

The intercept for region j of the service is also -2.084531+uoj

As can be seen from Table 8 below, the analysis of the random intercept multilevel logistic regression model shows that usage of antenatal care service varied among regions. The value of σ2u is the estimated variance of the intercept in random intercept and fixed slope model. The result displayed that the region-wise difference in the use of ANC service was statistically significant. In addition, marital status, mothers' education, visited by CHW, women's exposure to media and religion were found to be significant determinants of variation in use of ANC among the regions.

Table 7: Results for Empty Multilevel Models of Use of ANC and DC Service

ANC	Coef	Std. Err.	Z	P>|z|	[95% Conf. Interval]
Fixed part					
B_o-intercept	-0.612623	0.1215671	-5.04	0.000	-0.8508904, 0.3743561
Random part					
σ^2_u=var(u_{oj})	0.408652	0.0900185			0.2653684, 0.6292997
Rho (ρ)	0.048309	0.0202549			0.0209566, 0.1074418
DC					
Fixed part	Coef	Std. Err.	Z	P>|z|	[95% Conf. Interval]
B_{o-}intercept	-2.08453	0.3318231	-6.28	0.000*	-2.734892, -1.434169
Random part					
σ^2_u=var(u_{oj})	1.07832	0.2440637			0.6919742, 1.680376
Rho (ρ)	0.261143	0.0873421			0.127054, 0.4618709

Table 8: Result of Random Intercept Multilevel Model

Covariate		Coeff	SE	z	P>|z|	95% CI
Religion	Orthodox(R)					
	Protestant	-.6931	.2927	-2.37	0.018	(-1.26685, -.119407)
	Muslim	-.5604	.2134	-2.63	0.009	(-.978818, -.14202)
	Others	-1.3628	.6682	-2.04	0.041	(-2.67248, -.05317)
Place of residence	Rural(R)					
	Urban	.1953	.3042	0.64	0.521	(-.400989, .791756)
Wealth	Poor(R)					
	Middle	-.2437	.2453	-0.99	0.321	(-.724663, .237229)
	Rich	.2187	.2336	0.94	0.349	(-.239143, .676656)
Media	No	-.4564	.2121	-2.15	0.031	(-.872257, -.040585)
	Yes(R)					
Marital status	Married (R)	-.5334	.2319	-2.30	0.021	(-.987995, -.078876)
	Never in union					
Mothers' education	No educ. (R)					
	Primary	.8154	.2092	3.90	0.000	(.40537, 1.22543)
	Sec.+	1.5217	.3729	4.08	0.000	(.79084, 2.25259)
Husband education	No educ(R)					
	Primary	.2842	.1923	1.48	0.139	(-.092741, 1.2254)
	Sec.+	.1205	.2930	0.41	0.681	(-.453918, .69499)
CHW	No (R)					
	Yes	.7634	.2037	3.75	0.000	(.364191, 1.16281)
Work status	No (R)					
	Yes	.07965	.1696	0.47	0.639	(-.252942, .412243)
Age	15-19(R)					
	20-34	-.0440	.4269	-0.10	0.918	(-.880962, .792791)
	35-49	-.5061	.4641	-1.09	0.276	(-1.4159, .403637)
BirthO	1(R)					
	2-3	-.0873	.2414	-0.36	0.718	(-.560599, .385993)
	4-5	.2297	.2744	0.84	0.402	(-.308169, .767744)
	6-7	.2636	.3109	0.85	0.396	(-.345693, .873021)
	8+	.4407	.3646	1.21	0.227	(-.273862, 1.1554)

Random part

Random intercept	Estimate	S.E.	95% CI
σ^2u=var (U_{oj})	0.3242	0.0726	(0.208913, .503139)
Rho (ρ)	0.0309	0.0134	(0.0130926, .07145)

The models fitted in previous analyses have allowed the probability of receiving antenatal care from a medically-trained provider to depend on the region (as well as individual characteristics). This was achieved by allowing the model intercept to vary randomly across regions in a random intercept model. We have assumed, however, that the effects of individual characteristics such as age and education are the same in each region, i.e. the coefficients of all explanatory variables are fixed across regions. We will now extend the random intercept model to allow both the intercept and the slope of at least one of the explanatory variables to vary randomly across regions.

Allowing an explanatory variable to vary across regions maternal age was included as an explanatory variable in the model. Although we know from our single-level analysis that there is a linear relationship between the log-odds of antenatal care and age, we will start by fitting age effect.

Table 9 below reveals that there is a significant change in the estimate of the between-region variance, suggesting that the distribution of maternal age is different across regions (Leckie, 2004). All other significant predictor variables namely, marital status, mothers' education, visited by CHW, women's exposure to media and religion were added alone to the model in the same manner. The estimates of maternal age and visited by CHW were found to vary significantly across the regions. Hence, they were selected as variables that vary significantly at the higher level (region).

Table 10 shows analysis of random intercept and random slope model. It shows the effect of husband education and community health workers on the use of ANC service at second level. The result also shows that the effect of husband education on the log-odds of receiving antenatal care in region j is estimated as 0.0526078 + σ2uj where σ2uj is the slope variance. The between-region variances in the use of the care service due to the effect of maternal age and CHW separately are estimated to be 0.1544566 and 0.1269131 respectively. Similarly, the between-region variation in the use of ANC due to the mutual effect of both factors is estimated to be 0.1203351. The intercept variance (2.047197) is interpreted as the between-region variance in the log-odds of antenatal care at the mean values of the two variables.

In the random coefficient model the relationship between explanatory and response variables differ between groups. As a result, the relationship between the explanatory variables and ANC service uptake is different between regions. The table also reveals that the regions differ with respect to the average value of the ANC service uptake.

Table 9: Allowing maternal age to vary across regions

ANC	**Coeff**	**Std. Err.**	**Z**	**P>|z|**	**[95% CI]**
Fixed part					
Age	.3723	.0434	8.56	.000	.2871496, .4575931
Cons	-1.9469	.5667	-3.44	.001	-3.057786,-.8361836
Random Part					
Random-effects	Estimate	Std. Err.	[95% CI]		
Region: Identity					
Var(cons)	.2742	1.5752	1.6321, 8.5355		

Table 10: Result of Random Intercept and Random Slope Multilevel Model

	Coeff	Std. Err.	Z	P>|z|	[95% Confidence Interval]
Fixed Part					
Age	-.3316	.2150	-1.54	0.123	-.7531, .0898
Work	.1080	.1696	0.64	0.524	-.2245,.44059
CHW	.8130	.2561	3.17	0.002	.3110, 1.3150
H.educ	.1631	.1330	.133	0.220	-.0977, .424
M.educ	.7481	.1620	4.62	0.000	.4306, 1.0657
Marital status	-.5622	.2321	-2.42	0.015	-1.017,-.1072
Media	-.5028	.2113	-2.38	0.017	-.9171, -.0886
Wealth	.0757	.1141	0.66	0.507	-.1480, .299510
Residence	.1315	.2963	0.44	0.657	-.4492,0 .7124
Religion	-.4354	.1403	-3.10	0.002	-.7104, 0.1605
Birth	.1357	. 0824	1.65	0.100	-.0259, 0.2974
Random part Random-effects Parameters					
Region: Unstructured		Estimate	Std. Err.	[95% Conf. Interval]	
Var(CHW)		0.1269	0.1681	0.0095, 1.7029	
Var(Age)		0.1544	0.1437	0.0249, 0.9573	
Var(cons)		2.0471	1.6223	0.4331, 9.67644	
Cov(CHW, Age)		0.1203	0.1246	-0.1239, 0.3646	
Cov(CHW, cons)		-0.4108	0.4779	-1.3476, 0.5260	
Cov(Age, Cons)		-0.5596	.4666	-1.4743, .3549	

6. Discussions of Results

The current study is aimed to model the usage of maternal health care services, specifically ANC and DC utilization. The study showed that the coverage of mothers who received antenatal care for their recent births was 35.1 percent and institutional delivery service utilization was 9.6 percent in the country.

These results show that the level of utilization of maternal health care services in Ethiopia is still lower than that of in many sub-Saharan African countries. For example, ANC usage is 60.3% for Nigerian, 88.0 % for Benin, 72.8% for Burkina Faso, 83.4% for Cameroon, and 91.9% for Ghana (Addai, 2000; Adekunle, C et al, 1990; and Reynolds, H.W et al, 2006).

Similarly, the indicator of skilled assistance during delivery care is considerably lower in Ethiopia than in most African countries. Very small figure in the utilization of institutional delivery in this study is consistent with the result from a recent UNICEF report (UNICEF, 2007). The report shows that regarding skilled assisted delivery, Ethiopia performed the smallest next to Niger and Somalia in sub-Saharan Africa.

Use of maternal health care services had shown almost no change in the country in the five years from 2000-2005. For example, it has been observed that the uptake of ANC service didn't exceed 28% in these years while maternal mortality rate remains one of the highest in the world (CSA, 2001). However, the current study showed that it reached to 35.1 percent this shows that there is a remarkable change but not adequate enough in utilization of ANC service during the last five years. This was partly due to the role of community health workers. Community health workers had a strong significant effect on the utilization of ANC. This is because of the fact that at least two trained health extension worker were placed at each kebeles of the country. As a result, the percentage of use of both ANC and DC, especially, in the rural areas has been increased.

The finding that utilization of antenatal services is higher than use of institutional delivery is consistent with the results of previous studies conducted in Ethiopia (Dagne E., 2010) and elsewhere (Osubor, K.M et al, 2006). One of the reasons that have often been advanced for this is the unpredictable nature of the onset of labor in the face of difficulty in accessing health facilities in resource-poor environments. Many rural areas of the country are of such environments, with the characteristic poor road networks, limited transportation services and underserved population in terms of health facilities.

Different predictor variables are found to be strongly related with the utilization of ANC. The covariates: mothers' educational status, visited by CHW, marital status of women, region and mothers' exposure to media are the significant predictor variables of ANC use in the study.

Our finding regarding the significant positive association between education and the indicators of antenatal care service use agrees with previous results (Becker S. et al, 1993). Education serves as a proxy for information, cognitive skills, and values; education exerts effect on health-seeking behavior through a number of pathways (Raghupathy, S. 1996). These pathways include higher level of health awareness and greater knowledge of available health services among educated women, improved ability of educated women to their enhanced level of autonomy that results in improved ability and freedom to make health-related decisions, including choice of maternal services to use (Schultz, T.P., 1984). Educated mothers are more likely to take advantage of public health-care services than other women (Caldwell, J.C., 1981). Education may also

impart feelings of self-worth and confidence as well as reduce the power differential between service providers and clients, thereby reducing the reluctance to seek care. The current result is also consistence with previous study in Nepal which documented that women education to be a major factor influencing maternal health service utilization (Gubhaju, B., 2001).

The relationship between mother's age and utilization of MHCS is often contradictory (Burgard, S., 2004). Some studies have reported a significant association between age and MHCS utilization (Ikeako, L.C., et al, 2006) others have shown no such association (Nwakoby, B.N., 1994). This study found that age of the mother is not significantly related to both use of antenatal care services and use of assistance during delivery. This finding is also consistent with results reported in 2000 EDHS. Women who were visited by community health workers are more likely to use ANC than those who didn't. Moreover, mothers' exposure to media has been a significant predictor variable in the study. It is found that those mothers who are exposed to information about maternal health care services are more likely to utilize the services better than the others. These findings are supported by a study done in Ethiopia, which showed that UMHCS is significantly associated with availability of community health worker and media (Meseret A., 2010).

Marital status was a significant determinant for use of antenatal care service. Married women were more likely to receive ANC than single mothers. This was similar to other studies conducted in the country (Mekonnen, Y. and Mekonnen, A. 2002). This could be due to fear of stigma because a pregnancy without marriage is not accepted by the community in the study area. Therefore it appears rational to see that most of single and widowed mothers might be faced unwanted pregnancies. Moreover, these mothers want to hide their pregnancy from their parents and the community instead of receiving ANC service. In most cases single mothers are never married and might be too young and aggravating the stigma. Religion is found be significantly related with use of antenatal care services. This finding is also consistent with the previous studies (Kamal, S.M.M., 2009).

Another important statistical technique used in the study is multilevel logistic regression analysis. In this analysis women are nested within regions. Three multilevel models were fitted: an empty model, a random intercept with fixed slope and a random intercept with a random slope model were applied.

7. Conclusions

The current study is intended to assess the determinants of utilization of maternal health care services in Ethiopia. The study showed that the coverage of ANC service is 35.1% which indicates that the use of maternal health care services is inadequate and distributed unequally in the country.

Factors influencing maternal health services utilization operate at various levels - individual and region levels. The single level logistic regression model showed that mothers' educational status, the role of CHW, marital status of women, region and mothers' exposure to media were the determinant factors of ANC usage. The results of the current study are in line with other findings in the country like, in (Meseret A., 2010) and (Mekonnen, Y. and Mekonnen, A. 2002). Moreover, these findings are also similar to many literatures documented abroad on maternal health influencing factors, such as in Nepal and Turkey. The effect of community health worker on utilization of antenatal care service was one of the significant predictor variables in this study. It was also found to vary more than the other explanatory variables in the study.

Multilevel empty model fit better than the single level empty model for both antenatal and delivery care services. Moreover, the random intercept with a random slope model fits significantly better than the other multilevel models in the analysis of antenatal care service use. However, only multilevel empty model was significant while both random intercept and random coefficient models were insignificant under the deviance based chi-square test in the analysis of delivery care service.

In general, the fixed parts of the effects of explanatory variables included in the multilevel models have somewhat similar interpretation as that of single level analysis as discussed above. Whereas the random parts of the intercept and the coefficients provide additional information about the variation in the utilization of the services at the higher level.

Result from empty model shows that the usage of maternal care services is different in different regions. The reason for this could be the difference in socio-demographic characteristics of women in the regions.

The random intercept model shows that the intercept term varies across the regions assuming all explanatory variables of women are the same in all regions. However the results of random coefficient model show that the effect of these variables is different across region.

8. Recommendations

The findings from all bivariate, single level and multilevel analysis confirmed that maternal education was significant predictor variable for both the services, it is implicated that an enormous variation on use of maternal health care among the educated and illiterate mothers. Therefore it needs special effort and attention to improve formal and informal education for mothers and girls, especially on health education.

Since women's exposure to media has influence on the use of the services, information about maternal health care services should be delivered through radio, television, newspapers in local languages.

It is crucial that training for service providers focusing on changing attitudes towards women and girls by improving confidentiality, and offering relevant information and resources be conducted. This not only addresses the problem of un-friendly service providers but also improves accessibility of ANC by stimulating demand of the improved quality services.

To be optimally effective, interventions to promote maternal health service utilization need to take these findings into consideration: they should target the underlying factors that are relevant to each type of maternal health service. It is particularly important for interventions to explore effective ways of increasing service utilization among lowly educated women in rural areas who are the least likely to use maternal health services.

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