ADDIS ABABA UNIVERSITY

SCHOOL OF GRADUATE STUDIES

COLLEGE OF NATURAL SCIENCES

DEPARTMENT OF STATISTICS

STATISTICAL ANALYSIS OF FACTORS AFFECTING DELIVERY AND POSTNATAL CARE UTILIZATION IN ETHIOPIA

by

Eskedar Girma

A thesis submitted to the department of statistics presented in partial fulfilment of the requirements for the degree of masters of science in statistics

June, 2015

Addis Ababa, Ethiopia,

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This is to certify that the thesis prepared by Eskedar Girma, entitled: **Statistical analysis of factors affecting delivery and postnatal care utilization in Ethiopia** and submitted in partial fulfilment of the requirements for the Degree Master of Science in Statistics Complies with the regulations of the University and meets the accepted standards with respect to originality and quality.

Signed by the examining committee:

Advisor_____signature_____Date_____

Examiner_____signature_____Date_____

Examiner_____signature_____Date_____

_____

Chair of Department or Graduate Program coordinator

DECLARATION

I, the undersigned, declare that the thesis is my original work, has not been presented for degrees in any other University and all sources of materials used for the thesis have been duly acknowledged.

Name: Eskedar Girma

Signature: ----------

Place of submission: Department of Statistics, College of Natural Sciences, Addis Ababa University

Date of submission: June, 2015

This thesis has been submitted for examination with my approval as a University advisor.

Dr. Adem Kedir **----------**

Advisor's Name **signature**

Professor M. K. Sharma **----------**

Advisor's Name **signature**

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ABSTRACT

Statistical analysis of factors affecting delivery and postnatal care utilization in Ethiopia.

Eskedar Girma

Addis Ababa University, 2015

Every two minutes, at least one woman dies from complications related to pregnancy or childbirth in the world. Ethiopia is one of the countries where maternal mortality ratio is high. Despite the fact that maternal health care services are essential for improvement of maternal health coverage of the services is low. The objective of this study was to identify factors that affect DC and PNC utilization. The data for the study were taken from the 2011 Ethiopian Demographic and Health Survey. Women who had at least one live birth in the five years preceding the survey were the target population of this study. Descriptive and binary logistic regression ware used to analyse the data. The result of binary logistic regression revealed that region, women's education, husband education, media exposure and wealth index statistically significant predictors of DC and PNC utilization. To ensure an improved utilization of the two services in Ethiopia improving women's education and economic status would play a great role in enhancing utilization DC and PNC services.

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DEDICATION

To the memory of my lovely daughter Liyat Esubalew.

ACRONYMS

AIC	Akaike information criterion
ANC	Antenatal care
ANOVA	Analysis of Variance
BIC	Bayesian information criterion
CI	Confidence Interval
CSA	Central Statistics Agency
DC	Delivery care
DF	Degrees of Freedom
DHS	Demographic and Health Survey
EDHS	Ethiopian Demographic and Health Survey
ICPD	International Conference on Population and Development
LL	Log Likelihood
LR	Likelihood Ratio
MDG	Millennium Development Goal
ML	Maximum Likelihood
MMR	Maternal Mortality Ratio
MOH	Ministry of Health
OR	Odds Ratio
PNC	Postnatal care
SE	Standard Error
UN	United Nations
UNFPA	United Nations Population Fund
WHO	World Health Organization

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CHAPTER-ONE

INTRODUCTION

1.1. BACKGROUND OF THE STUDY

Globally, an estimated 289,000 maternal deaths occurred in 2013. Developing countries account for 99% (286, 000) of the global maternal deaths, the majority of which are in sub-Saharan Africa (179,000) and Southern Asia (69,000). These two regions accounted for 86% of global maternal death, with sub-Saharan Africa alone accounting for 62%. The maternal mortality ratio (MMR) in developing regions was 14 times higher than in developed regions (WHO, 2014). Ethiopia is one of the sub-Saharan countries where maternal mortality ratio is high (676 per 100,000 live births) compared to other low and middle income countries (CSA, 2012).

The international community declared its commitment several times to reduce maternal and neonatal mortality in low income countries like Ethiopia. The two subsequent global conferences that included strong affirmations of the basic human right for mothers to have access to quality and comprehensive maternal and reproductive health care were, the 1994 International Conference on Population and Development (ICPD) and the Fourth International Conference on Women in 1995. Both conferences identified maternal health as a priority component of global health and development, and the 1994 ICPD produced the Program of action that mandated measurement of global progress on maternal health (WHO, 2009).

The outcome of ICPD was a twenty-year Program of Action a compilation of universal ideals outlining a shared commitment to improve the lives of all people around the world through promoting human rights and dignity, supporting family planning, sexual and reproductive health and rights, advancing gender equality, insisting on equal access to education for girls, eliminating violence against women, as well as focusing on issues relating to population and protecting the environment. The ICPD was a milestone in the history of population and development, as well as in the history of women's rights. At the ICPD, a general consensus was reached to improve women's status, along with the related goals of improving women's reproductive health and securing their reproductive rights, which represents a paradigm shift that emphasizes the reproductive autonomy of individuals (UNFPA, 2004).

Similarly in 2000, the United Nations General Council also included a goal which calls for improving maternal health, as part of the strategies for reducing maternal mortality, within the adopted eight Millennium Development Goals (MDGs). This goal was placed as the fifth MDGs (MDG5). The progress of this MDG5 is assessed against the target of reducing by three-quarters, between 1990 and 2015 (WHO, 2009), the maternal mortality ratio and by achieving, by 2015, universal access to reproductive health. Ethiopia, as UN member country that signed several international agreements, has adopted the MDGs. Among others, MDG5 has got special consideration by the Ethiopian Government (FMOH, 2010).

A review of 30 years story of maternal mortality in Ethiopia conducted by Yifru and Asres (2014) concluded that, although MDG5 envisaged significant improvement in maternal health by this time, their review showed that the performances are still far from the target. They finally suggested that to achieve the MDG5 at least before 2025 multisectoral commitment and huge investment are required.

The major complications that account for 80 percent of all maternal deaths are high blood pressure during pregnancy, severe bleeding and infections after childbirth and unsafe abortion. Many of the mothers could be saved if they were provided with access to maternal health care (WHO, 2012). Maternal health care service comprises antenatal (ANC), delivery (DC) and postnatal (PNC) care, which essentially promotes mother´s and child´s well being and helps to prevent severe complications and illnesses, even death.

ANC utilization is nearly universal, more than 95 percent, in most high and middle income countries. In developing regions, 83 percent of women attend ANC at least once during their pregnancy. However, only 52 percent of these women attend the recommended number of visit, which are at least four visits. Specifically, in sub-Saharan Africa, 69 percent of pregnant women have at least one ANC visit, more than in South Asia, at 54 percent. Despite the importance of institutional delivery in preventing maternal death, about 32 percent of the births in developing countries were made outside health institution (UN, 2014). For both newborns and mothers, the highest risk of death occurs at delivery, followed by the first hours and days after child-birth. The postnatal period (the time just after delivery and through the first six weeks of life) is especially critical for newborns and mothers (Erin et al., 2007). But this period is a neglected period. In sub-Saharan Africa not more than 13 percent receive a postnatal care visit within two days of

delivery. The level of PNC coverage is extremely low in Ethiopia. The great majority of women (92 percent) with a live birth did not receive a postnatal check up (CSA, 2012).

Studies identifying causes of maternal deaths have repeatedly emphasized the need for maternal health care. Despite the fact that maternal death is high in Ethiopia utilization of maternal health care, an essential care for further improvement of maternal and child health, is low. So it is important to identify factors influencing the use of these services.

1.2. STATEMENT OF THE PROBLEM

Every two minute, at least one woman dies from complications related to pregnancy or childbirth in the world. Ethiopia is one of the countries with the highest rates of maternal deaths in the developing world. The country is expected to reduce maternal mortality by two-thirds from levels recorded in 1990 to reach the MDG target of 267 deaths per 100,000 deliveries by the end of 2015. But the country is off-track on this goal as a result of slow progress on reduction of maternal mortality since 2005 (WHO, 2012).

To achieve this target even beyond 2015, it is important to work on the two most direct causes of maternal mortality in developing countries: unsafe abortion and inaccessibility or lack of access to maternal health care services.

Utilization of maternal health care in Ethiopia is low. According to CSA (2012) report antenatal, delivery and postnatal care coverage in Ethiopia was only 34%, 10% and 7%, respectively (CSA, 2012). Therefore, this study is aimed to identify factors that impact delivery and postnatal care.

1.3. OBJECTIVE OF THE STUDY

The general objective of this study is to identify factors that affect utilization of delivery and postnatal care in Ethiopia.

1.4. SIGNIFICANCE OF THE STUDY

This study aimed to identify factors that affect the utilization of delivery and postnatal care in Ethiopia. Hence the findings of this study could be useful in many aspects.

- Since reducing levels of maternal mortality and morbidity depends on increasing use of reproductive and maternal health services, this study is expected to identify factors underutilization of DC and PNC.
- The results may serve as important input for any possible intervention aimed at improving the maternal health care utilization which will help to reduce maternal mortality.

1.5. LIMITATION OF THE STUDY

The limitation of this study was that distance to the health facilities was not collected so it was not possible to directly assess access to these facilities and its effect on use of the services. Rather a proxy measure of place of residence was taken.

1.6. DEFINITION OF IMPORTANT TERMS

Maternal death is the death of a woman while pregnant or within 42 days of termination of pregnancy, irrespective of the duration and site of the pregnancy, from any cause related to or aggravated by the pregnancy or its management but not from accidental or incidental causes.

Maternal health is the health of women during pregnancy, childbirth, and the postpartum period. It encompasses the health care dimensions of family planning, preconception, prenatal, and postnatal care.

Antenatal care, which is also care during pregnancy, is essential for diagnosing and treating complications that could endanger the lives of mother and child.

Regular antenatal visit. According to WHO at least four antenatal visits are considered as regular antenatal visit.

Delivery care is a care given at child birth by skilled assistance and well-equipped health facilities. In this study delivery care is defined in terms of place of delivery.

Postnatal care is a care beginning immediately after the birth of a child and extending for about six weeks (42 days).

CHAPTER TWO

LITERATURE REVIEW

This section is a brief review of the literature on determinants of delivery and postnatal care services utilization. Relevant studies in both developing and developed countries are reviewed giving a special emphasis on the findings and methodological issue in developing countries.

Eyerusalem (2010) examined the role of socio-demographic factors on utilization of maternal health care services in Ethiopia using multivariate logistic regression analysis. The analysis revealed place of residence, education, birth order, husband educational level and occupation as the most important factors that explained the variability in use of assistance during delivery. Kamal (2009) using logistic regression model also found a significant positive effect of husband education on maternity care service utilization. Women whose husbands had at least secondary education were 50% more likely to use the service compared to women whose husbands had no education. In contrast a study from Abakaliki, Nigeria showed, using analysis of variance (ANOVA) that the educational level of the husband does not have significant effect on maternal health services utilization in the area (Ndie and Idam, 2013).

Navaneetham and Dharmalingam (2000), using logistic regression model found that parity, residence, education and work status of women as significant predictors of place of delivery. They found that urban resident, non-working and literate mothers were more likely to deliver their babies in health institutions.

Gwamaka (2012) conducted a research to assess factors affecting delivery in Tanzania, Nkasi district using logistic regression. The result from the analysis revealed delivery in health facility increased with increase of level of education and number of antenatal care visits, but decreased as the distance between health facility and home increases. In addition, women with secondary education were six times more likely to deliver in health facilities compared to those with no education. Those who attended ANC more than four visit were two times more likely to deliver in health facility than those who attended less than four and those who lived more than 5 kilometer were four times less likely to deliver in health facility compared to those living within 5 kilometer to health facility.

Kassu and Eshetu (2013) used logistic regression and showed that region, sex of household head, mother's level of education, religion, husband's level of education, mother's age at birth, birth order, employment status of mothers and wealth index are predictors that affect utilization of delivery and postnatal care services in rural Ethiopia.

Vishnu et al. (2014) used multiple logistic regression models to identify factors that affect utilization of postnatal care. Mothers who were from urban areas, rich families, educated, whose partners were educated, who gave birth in a health facility, and who had attended four or more antenatal visits were more likely to receive postnatal care.

Shanna and Olveña (2004) used logistic regression to study maternal health care utilization in the Philippines. They showed that women with high birth order have less chance to deliver at health facilities compared to women with first birth order. Age, level of education, work status of the respondent and urbanity were also significant factors for delivery and postnatal care.

Mluleki et al. (2014) examined factors influencing the use of maternal healthcare services in Swaziland. Logistic regression analysis revealed that woman's age, parity, media exposure, maternal education, wealth quintile, and residence influence the use of maternal health care. They also observed high utilization rate of antenatal and delivery care, and minimal use of postnatal services in Swaziland. They suggested that postnatal care should not be overlooked because it is an important dimension of maternal (and child) health care.

Desalew et al. (2014) studied the demographic and socioeconomic determinants of maternal health care services in Kombolcha, eastern Ethiopia. The study found that occupation of mothers and their husbands, education of husbands, and history of difficult labor were found to be significant predictors of institutional delivery.

Singh et al. (2012) examined the effect of selected socio-economic and demographic predictors on maternal health care using logistic regression analysis in urban India. The study revealed that mother's education, four or more antenatal visits, parity, household wealth, religion and region of residence were the most important variables that explained the variability in delivery care utilization. The finding also showed wealth index, mother's education, four or more antenatal visits, safe delivery care and region as significant factors affecting postnatal care utilization. The likelihood of receiving postnatal care was higher among mothers who have received four or more

antenatal visits and safe delivery care. The odds of receiving postnatal care found increased almost ten times for mothers who have opted for safe delivery compared to those who have not.

Ebere (2013) carried out a review of the literature on barriers and socio-cultural factors influencing the access to maternal healthcare services in Nigeria using articles published from 1998 to 20013. The result of the review showed that factors that influence the access and utilization of maternal health care services were economic, socio-cultural, and health system factors. Educational level, employment, mothers age, religion, cultural beliefs, distance to health care facilities and place of residence were also identified as a major factors that determine the utilization of maternal healthcare services in the northern region of Nigeria.

Anuja et al. (2008) examined factors affecting maternal health care seeking behaviour in Rwanda using three rounds of Rwanda Demographic and Health Survey (RDHS) data (1992, 2000, and 2005). Multinomial logit model was used to identify factors determining the choice that a woman makes at the time of child birth. The study showed that women with higher wealth class, living in urban areas, who attend antenatal care and women whose husbands have educational attainment above the primary level were more likely to deliver in a health facilities rather than at home without assistance. They also showed that compared to the first child subsequent children are more likely to be born at home without assistance and women from female headed households were less likely to deliver in a health facility compared to households headed by a man.

Yared and Asnakech (2002) investigated factors affecting maternity care services in Ethiopia using logistic regression. They identified place of residence, women's education, marital status, religion, parity and number of children under five as significant predictors among the demographic and socio-cultural characteristics of women they have considered.

Ethiopian Society of Population Studies (2008) conducted an in-depth analysis of the 2005 Ethiopian Demographic and Health Survey. Using logistic regression analysis they identified birth order, residence, mothers' education and wealth index as significant predictors of the utilization of health care services. They also found that young and urban women were more likely to use maternity health care services

Hauwa (2011) investigated the patterns and determinants of maternal health care use in Nigeria. Using logistic regression she identified education, family wealth index and place of residence as strong predictors of service utilization.

Rahman et al. (2011) used multivariate analysis and showed that mother's age at delivery, residence, education, antenatal care, place of delivery, wealth, husband's occupation, husband's concern about pregnancy complications and mother's empowerment to go to a health centre alone are factors that affect utilization of postnatal care services in Bangladesh.

Patience (2011) examined socio-economic determinants of maternal health care utilization in Ghana using logistic regression. The analysis revealed that age of mother, type of birth, education of mother, ethnicity, economic status, geographic location, residence, and religious affiliation as factors influencing services utilization.

Muchabaiwa et al. (2012) used logistic regression to identify determinants of maternal health care utilization in Zimbabwe. They found that education, wealth status, type of marriage, desire for current pregnancy, place of residence, distance to a health centre, religious affiliation and antenatal care influence delivery at a healthcare facility. The odds of delivery at a healthcare facility are 17.7 and 2.9 times higher among women who attained higher education and up to secondary education, respectively, than among those who had no schooling. Their results also showed receiving antenatal care and having access to radio programmes are significant determinants of postnatal care.

Obong (2009) established factors affecting maternal health care utilization in government health units in Apac District of Northern Uganda. Major socio-demographic, cultural and economic factors that affect mothers seeking maternal health care were: reliance on traditional taboos and rituals, distance away from modern health units, low levels of household income, low levels of basic education and ignorance and negative attitudes towards health workers. The study also found age of expecting mother, marital status, household size, number of pregnancies, who determines where to go for the services, means of transport and signs of possible complication as factors influencing maternal health seeking behavior.

Nzioki et al. (2015) aimed to explore socio-demographic factors influencing maternal and child Health service utilization in Mwingi district, Kenya using binary logistic regression. Their

finding showed that women who sought WHO recommended antenatal care services, women with secondary education and above, women in households earning more than 1 US Dollar in a day and women in employment or operating a business were more likely to utilize DC and PNC services. Women who sought WHO recommended antenatal care services (at least 4 visits) were more likely to delivered assisted by Skilled Birth Attendants and sought postpartum care.

Azuh (2011) conducted a research to identify factors which influence health care intervention utilization among Nigerian women during pregnancy and child delivery using logistic regression. The results showed that mother's education, occupation and age as well as husband's occupation significantly affect DC utilization.

Rahman (2009) investigated determinants of maternal health care utilization in Bangladesh using multinomial logistic regression and found mother's age at birth, number of family member, mother's education and place of residence as the most important determinants of delivery and postnatal care. The higher the number of family members the lower the probability of receiving DC & PNC. Mothers with no education and primary education were also less likely to receive these cares than mothers having at least secondary education. Mothers residing in rural area are less likely to utilize delivery care than urban women.

Sana and Khalil (2013) examined some socio-economic factors associated with postpartum care utilization in rural Punjab, Pakistan using binary logistic regression. They showed maternal education, husband's education, husband's occupation, monthly household income, antenatal care utilization and exposure to mass media as important factors in postpartum care utilization. Also, women having awareness about pregnancy complications have higher chances of the postpartum care utilization than those who were not aware of pregnancy complications.

CHAPTER THREE

DATA AND METHODOLOGY

3.1. SOURCE OF DATA

The source of data for this study is the 2011 Ethiopia Demographic and Health Survey (EDHS) which is obtained from Central Statistical Agency (CSA).

In EHDS, data on delivery and postnatal care were collected from women who had at least one birth in the five years before the survey. This study includes total of 7,532 women, 1,468 from urban and 6,064 from rural area, of the age group 15-49 years who had at least one birth in the five years preceding the survey.

3.2. VARIABLES OF THE STUDY

3.2.1. Response variables

The dependent variables in this study are delivery care (DC) and postnatal care (PNC). Both are categorical variables i.e. DC, delivery at home, mainly without utilizing the delivery care services and delivery at health care facilities, and PNC as whether a woman had a medical check up from a health professional within 42 days after delivery or not.

In order to obtain information on the above response variables, women were asked 1) where they gave birth, and 2) whether they received a medical check up from a health professional within 42 days after delivery.

EDHS 2011 data considered three places of delivery: public facility, private facility and home. For the purpose of this study, these are categorized as delivery at health facility (if the women gave birth at public or private sectors) and delivery at home. Let Z_i and Y_i denoted the random variables for DC and PNC, respectively, as:

$$Z_i = \begin{cases} 0, & \text{if the } i^{th} \text{ woman gave birth at health facilities/institutions} \\ 1, & \text{if the } i^{th} \text{ woman gave birth at home} \end{cases} \quad \ldots\ldots\ldots\ldots\ldots\ldots (3.1)$$

and

$$Y_i = \begin{cases} 0, & \text{if the } i^{th} \text{ woman received postnatal care} \\ 1, & \text{otherwise} \end{cases} \quad \text{..... (3.2)}$$

Table 3.1: Description and categories of response variables

Code	Variable	Type of variable	Categories
DC	Delivery care (Place of delivery)	Categorical	0=Health facility/institution 1=Home
PNC	Postnatal care (check up within 42 days after delivery)	Categorical	0=Yes 1=No

3.2.2. Predictor (Explanatory) Variables

The explanatory variables that are related to delivery and postnatal care utilization are presented in Table 3.2.

Table 3.2: Description and categories of explanatory variables

No.	Variable	Category
1.	Place of residence	0=Urban 1=Rural
2.	Region	0= Tigray 1= Afar 2= Amhara 3= Oromiya 4= Somali 5= Benishangul-Gumuz 6= SNNP 7= Gambela 8 = Harari 9 = Dire Dawa 10 = Addis Ababa
3.	Age	0=15-19 (teenagers)
		1=20-34 (young/ adult) 2=35-49 (older women)

Table 3.2: Continued

4.	Woman's educational level	0=No education 1=Primary
		2=Secondary or above
5.	Husband's /partner's education	0=No education 1=Primary 2=Secondary or above
6.	Wealth index of household	0=poor 1=middle 2=rich
7.	Work status of woman	0=No 1=Yes
8.	Birth order	0= 1 child
		1=2-3 children
		2=4-5 children
		3=6-7 children
		4=8+ children
9.	ANC visit	0= Regular visit (attending at least four ANC visit)
		1= Irregular visit
10.	Media exposure	0=No 1=Yes
11.	DC (Predictor only for PNC)	0=Health facility/institution 1=Home

3.3. METHODS OF DATA ANALYSIS

This study used descriptive and logistic regression analyses. Chi-square test was used to observe a significant association between each dependent variable and the explanatory variables; then a binary logistic regression model were fitted to investigate factors predicting the likelihood of using delivery and postnatal care.

3.3.1. BINARY LOGISTIC REGRESSION ANALYSIS

Binary logistic regression analysis was employed to analyze the data. The binary logistic regression is a type of regression which is used when the response variable is dichotomous and the predictor variables are of any type. In binary logistic regression, a single outcome variable Y_i (i=1, 2,…,n) follows a Bernoulli probability distribution that takes on the value 1 with

probability π_i and 0 with probability 1- π_i. The relationship between π_i and a vector X_i of predictors for the i[th] individual is given by:

$$\pi_i = \frac{\exp(\beta_0 + \beta_1 x_{1i} + \cdots + \beta_k x_{ki})}{1 + \exp(\beta_0 + \beta_1 x_{1i} + \cdots + \beta_k x_{ki})} = \frac{\exp(X_i'\beta)}{1 + \exp(X_i'\beta)} \quad (3.3)$$

where $\beta = (\beta_0, \beta_1, \ldots, \beta_k)'$ and $x_i = (x_{0i}, x_{1i}, \ldots, x_{ki})'$ with $x_{0i} = 1$

Odds ratio

Logistic regression analysis utilizes odds and odds-ratio. The odds of success are simply the ratio of probability of success π (the probability that a woman did not utilize DC or PNC or y=1) to probability of failure 1- π (the probability that a woman utilized DC or PNC or y=0). That is,

$$\text{Odds} = \frac{\pi}{1-\pi} \quad (3.4)$$

The odds are non-negative with value greater than one when a success is more likely than a failure. The odds ratio, denoted by OR, is defined as the ratio of the odds for y=1 to the odds for y=0 and is given by:

$$OR = \frac{\pi(1)}{1-\pi(1)} \frac{1-\pi(0)}{\pi(0)} \quad (3.5)$$

Odds ratio is an estimate of the risk of an exposed group relative to a control group or unexposed (reference) group. Odds ratio less than 1 indicates negative relationship and odds ratio greater than 1 indicates positive relationship and odds ratio=1 indicates difference between exposed and control group.

Let X is, an n × (k+1) matrix denotes the collection of k-predictor variables and, β be a (k+1) ×1 vector of parameters and then the data layout of explanatory variables is given by:

$$X = \begin{bmatrix} 1 & x_{11} & x_{12} & \cdots & x_{1k} \\ 1 & x_{21} & x_{22} & \cdots & x_{2k} \\ \vdots & \vdots & \vdots & \cdots & \vdots \\ 1 & x_{n1} & x_{n2} & \cdots & x_{nk} \end{bmatrix}$$

In logistic regression analysis, it is assumed that the explanatory variables affect the response through a suitable transformation of the probability of success. This transformation is a suitable link function of π, and is called the logit-link denoted by *logit (π)* which is defined as:

$$\text{logit}(\pi) = \log\left(\frac{\pi}{1-\pi}\right) \quad = \text{X}'\beta \tag{3.6}$$

3.3.1.1. ESTIMATION OF MODEL PARAMETERS

In fitting a logistic regression model, the maximum likelihood estimation, ML, is the most common method used to estimate the parameters included in the model. The ML method seeks to maximize the log likelihood, LL, which reflects how likely it is (the odds) that the observed values of the outcome may be predicted from the observed values of the predictors. Let y_1, y_2, ..., y_n be the n independent random observations corresponding to the random variables Y_1, Y_2,..., Y_n, respectively.

Each observation (response) can be considered as an outcome of a Bernoulli trial. Thus, for the ith observation y_i, the Bernoulli distribution is:

$$f_i(y_i) = \pi_i^{y_i}(1-\pi_i)^{1-y_i} \tag{3.7}$$

where y_i= 0 or 1 and i=1, 2, …, n

Then the likelihood function is the joint probability distribution of all n observations and is given by:

$$L = f_1(y_1)\, f_2(y_2) \ldots f_n(y_n) = \prod_{i=1}^{n} \pi_i^{y_i}\ [1-\pi_i]^{1-y_i} \tag{3.8}$$

The principle of maximum likelihood estimate states that we use, as our estimate of β, the value which maximizes the expression in L. However, it is easier mathematically to work with the log of equation L. This expression, the log-likelihood, is defined as:

$$LL\ = lnL(\beta_0, \beta_1, \ldots, \beta_k\ )$$

$$= \sum_{i=1}^{n} y_i\ (\beta_0 + \beta_1 x_1 + \cdots + \beta_k x_k) - \sum_{i=1}^{n} ln\ \{1 + \exp(\beta_0 + \beta_1 x_1 + \cdots + \beta_k x_k)\} \tag{3.9}$$

Thus, by maximizing the log-likelihood function in equation (3.9) with respect to the β_j's we can estimate the parameter vector β. Since the equation of the log-likelihood function is nonlinear in the β's , the estimates do not have a closed form expression. We can obtain $\hat{\beta}$, the estimator of β, using a numerical iterative method (Agresti, 2007).

3.3.1.2. ASSESSMENT OF THE FITTED MODEL

After the model is fitted the next important step is to check the model adequacy. This usually involves formulation and testing of a statistical hypothesis to determine whether the independent variables in the model are "significantly" related to the outcome variable (Hosmer and Lemeshow, 2000).

The likelihood ratio test, Hosmer-Lemeshow test and Wald test are the most commonly used measures of goodness of fit for categorical data.

The Hosmer–Lemeshow Test

A commonly used test of the overall fit of a model to the observed data is the Hosmer-Lemeshow test. Hosmer-Lemeshow goodness of fit test divides subjects into deciles based on predicted probabilities and constructs a "goodness -of-fit" statistic by comparing the observed and predicted number of events in each group. The differences between the observed number and expected number (calculated by summing predicted probabilities based on the model) in each group are then assessed using a chi-square test.

The Hosmer-Lemeshow goodness-of-fit statistic is given as

$$\hat{C} = \sum_{j}^{g} \frac{(O_j - E_j)^2}{v_j} \qquad (3.10)$$

where $E_j = n\pi_j$, $V_j = n\pi_j(1-\pi_j)$, g is the number of group, O_j is observed number of events in the j^{th} group, E_j is expected number of events in the j^{th} group, and V_j is a variance correction factor for the j^{th} group.

If the difference between the observed number of events and what is expected by the model is large, then the statistic $\hat{C}$ becomes large and there will be evidence against the null hypothesis

that the model is adequate to fit the data. Assuming that the null hypothesis that the model fits well $\hat{C}$ has an approximate chi-square distribution with g-2 degrees of freedom (Hosmer and Lemeshow, 2000).

The Likelihood Ratio Test

The likelihood-ratio test, a general test to compare two models, a full model and a simpler (reduced) model. It tests that the parameters in the full model are equal zero. The test uses the likelihood function. The maximum likelihood estimates maximize this function.

Let L_r is the likelihood of the reduced model and L_f is the likelihood of the full (saturated) model. The formula for likelihood ratio test statistic is

$$G^2 = \left[(-2logL_r) - \left(-2logL_f\right)\right] \quad (3.11)$$

It compares the maximized values of the fitted/reduced model (-2logL_r) and of the full/ saturated model (-2logL_f). Using minus twice its log is necessary to obtain a quantity whose distribution is known (approximately a chi-square distribution with degree of freedom equals the difference between number of parameters in the saturated model and the nested (smaller) model for large samples), and can therefore be used for hypothesis testing purposes (Hosmer and Lemeshow, 2000).

Under the global null hypothesis, H_0: $\beta_1 = \beta_2 = \ldots = \beta_k = 0$, the statistic G^2 follows a chi-square distribution with k-1 degrees of freedom. If this difference is statistically significant, then the less restrictive model (the one with more variables) is said to fit the data significantly better than the more restrictive model.

Wald Test

The Wald test is used for testing the significance of individual parameters in logistic regression. That is, the Wald test is used to test:

$$H_o: \beta_i = 0 \; against \quad H_1 = \beta_i \neq 0, \qquad i = 1,2,\ldots k \quad (3.12)$$

The Wald test statistic for testing the above hypothesis is:

$$W = \frac{\hat{\beta}_i}{SE(\hat{\beta}_i)} \qquad \text{i} = 1, 2, \ldots, \text{k} \tag{3.13}$$

Under the null hypothesis $W \sim$ N (0, 1). When the computed value of $|W| \leq Z_{(1-\frac{\alpha}{2})}$ we do not reject the null hypothesis, while if $|W| > Z_{(1-\frac{\alpha}{2})}$ then the null hypothesis can be rejected at the given alpha level (Agresti, 2007).

3.3.1.3. MODEL DIAGNOSTICS

The fitted model may be inadequate because of particular observations, outliers or influential values. These observations may affect the conclusions to be drawn from the analysis. Thus, detection and treatment of such observations should be part of the model adequacy check. Detection and treatment of outliers and influence diagnostics are some of the statistical techniques that are used to examine the adequacy of a fitted model.

There are three ways that an observation can be considered as unusual namely outlier, influence and leverage. In logistic regression, observations whose values deviate from the expected range and produce extremely large residuals and may indicate a sample peculiarity are called outliers. These outliers can unduly influence the results of the analysis and lead to incorrect inferences. An observation is said to be influential if removing the observation substantially changes the estimate of coefficients. Influence can be thought of as the product of leverage and outliers. An observation with an extreme value on a predictor variable is called a point with high leverage. Leverage is a measure of how far an independent variable deviates from its mean (Cook 1998).

3.3.1.3.1. INFLUENTIAL OBSERVATIONS

The two common measures of the influence of an observation are Cook's distance and DFBETAS.

Cook's distance: Cook's distance is designed to measure the shift in $\hat{\beta}$ when a particular observation is omitted. It is a combined measure of the impact of that observation on all regression coefficients (Cook, 1998).

Cook's distance statistic, D_i is defined as:

$$D_i = \frac{(\hat{\beta}_i - \hat{\beta}_{(i)})' (X'\hat{V}X)(\hat{\beta}_i - \hat{\beta}_{(i)})}{ps^2} \quad (3.14)$$

Alternatively, D_i is obtained as

$$D_i = \frac{r_i^2}{p}\left(\frac{h_{ii}}{1-h_{ii}}\right) \quad (3.15)$$

where

$$\hat{V} = diag\{\hat{\pi}_j(1-\hat{\pi}_j), \} j = 1, \ldots, \mathrm{k}+1 \quad (3.16)$$

r_i is the studentized residual, h_{ii} is the ith diagonal element of hat matrix, $\hat{H}$, called leverage values and p is the number of unknown parameters. D_i measures the difference between the regression coefficients obtained from the full data and the regression coefficients obtained by deleting the ith observation. Cook's distance considers the influence of the ith value on all n fitted values and not on the fitted value of the ith observation. It has been suggested that points with D_i values greater than 1 as being influential (Chatterjee and Hadi, 2006).

DFBETAS: *DFBETAS* is a measure of the change in a logistic regression coefficient when an observation is omitted from the regression analysis. It is used to assess the effect of an individual observation on the estimated parameter of the fitted model. A DFBETAS diagnostic is computed for each observation for each parameter estimate. It is the standardized difference in the parameter estimate due to deleting the corresponding observation. The DFBETAS are useful in detecting observations that causes instability in the selected coefficients. The influential observations for the individual regression coefficients are identified by DFBETAS $_{j(i),}$ j = 0, 1, 2, . . . , k and calculated as

$$\text{DFBETAS j(i)} = \frac{\hat{\beta}_j - \hat{\beta}_{j(i)}}{s_i\sqrt{c_{jj}}} \quad (3.17)$$

where c_{jj} is the (j + 1)st diagonal element from $(X'\hat{V}\,X)^{-1}$ and DFBETASj(i) measures the change in $\hat{\beta}_j$ in multiples of its standard error. DFBETASj(i) larger than $2/\sqrt{n}$ in absolute value are considered highly influential.

3.3.1.3.2. OUTLIERS DETECTION

Detecting outliers is common practice and it is important because outliers can affect the regression model in two ways: outliers may almost uniquely determine regression coefficients; they may also cause the standard errors of regression coefficients to be much smaller than they would be if the observation were excluded. There are two types of outliers, so that it is important to distinguish between the two types. Outliers in the response variable represent model failure. Such observations are called outliers. Outliers with respect to the predictors are called leverage points (Vittinghoff et al., 2005).

Leverage (hat matrix) is a measure of the importance of an observation to the fit of the model. It is used to identify observations which have a large effect on the outcome of fitting regression models and measures the influence of a point on the fit of regression. Leverages are obtained from the diagonal element of the hat matrix, H, which is given as

$$\hat{\mathrm{H}} = \hat{V}^{1/2} X (X'\hat{V} X)^{-1} \mathrm{X}'\hat{V}^{1/2} \qquad (3.18)$$

where h_{jj} is the j^{th} diagonal element of the JxJ hat matrix $\hat{\mathrm{H}}$, and it is the leverage of observation j.

Observations with leverage values larger than one are considered to be potentially highly influential.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1. DESCRIPTIVE AND RESULTS OF THE BIVARIATE ANALYSIS RESULTS

The data analysis was done using SPSS version 20 and STATA version 11. The descriptive results (in absolute figures and percentage) and the chi-square results based on bivariate analysis are given in Table 4.1 and Table 4.2. The bivariate analysis results show that the association between attending regular ANC visits and, DC and PNC are insignificant at 1% level of significance. Both the response variables have 10 predictors in common while PNC has one additional predictor, DC, DC is used as a predictor of PNC.

Table 4.1: Descriptive and bivariate analysis results for DC utilization

Predictors	Categories	Delivery care				df	Chi-square
		Home		Health institution			
		Count	(%)	Count	(%)		
Region*	Tigray	725	11.5	100	8.1	10	1768.1 (.000)
	Afar	659	10.5	41	3.3		
	Amhara	862	13.7	84	6.8		
	Oromiya	985	15.6	104	8.4		
	Somali	487	7.7	48	3.9		
	Benishangul-Gumuz	545	8.7	51	4.1		
	SNNP	971	15.4	67	5.4		
	Gambela	483	7.7	111	9		
	Harari	266	4.2	161	13		
	Dire Dawa	256	4.1	187	15.1		
	Addis Ababa	57	0.9	282	22.8		
Place of Residence*	Urban	546	8.7	922	74.6	1	2861.10
	Rural	5750	91.3	314	25.4		
Mother's educational level*	No education	4660	74	347	28.1	2	1809.9 (.000)
	Primary	1537	24.4	511	41.3		
	Secondary or above	99	1.6	378	30.6		

* indicates significant at 1 level of significance

Table 4.1: Continued

Birth order*	1 child	923	13.1	513	2.7	4	667.1 (.000)
	2-3 children	1886	17.6	461	5.3		
	4-5 children	1555	24.7	164	13.3		
	6-7 children	1106	30	65	37.3		
	8+ children	826	14.7	33	41.5		
Media exposure*	No	3236	51.4	171	13.8	1	588.5 (.000)
	Yes	3060	48.6	1065	86.2		
Wealth index *	Poor	3376	53.6	135	10.9	2	1444.5 (.000)
	Middle	1154	18.3	47	3.8		
	Rich	1766	28	1054	85.3		
Husband's/Partners educational level*	No education	3588	57	198	16	2	1462.7 (.000)
	Primary	2253	35.8	477	38.6		
	Secondary or above	455	7.2	561	45.4		
Work status*	No	4466	70.9	706	57.1	1	91.6 (.000)
	Yes	1830	29.1	530	42.9		
Age *	15-19 (teenager)	346	5.5	57	4.6	2	85.9 (.000)
	20-34 (younger)	4251	67.5	994	80.4		
	35-49 (older)	1699	27	185	15		
ANC visit	Irregular visit	4845	77	954	77.2	1	0.031 (.883)
	regular visit	1451	23	282	22.8		

* indicates significant at 1 level of significance

Table 4.2: Descriptive and bivariate analysis results for PNC utilization

Predictors	Categories	Postnatal care				df	Chi-square
		No		Yes			
		Count	(%)	Count	(%)		
Region*	Tigray	695	12.50	130	10.70	10	805.4 (.000)
	Afar	644	5.40	56	9.90		
	Amhara	878	6.60	68	13.50		
	Oromiya	1013	7.30	76	15.60		
	Somali	490	4.30	45	7.50		
	Benishangul-Gumuz	533	6.10	63	8.20		
	SNNP	974	6.20	64	15.00		
	Gambela	493	9.70	101	7.60		
	Harari	285	13.70	142	4.40		
	Dire Dawa	332	10.70	111	5.10		
	Addis Ababa	158	17.50	181	2.40		
Place of Residence*	Urban	818	12.60	650	62.70	2	1429.6 (.000)
	Rural	5677	87.40	387	37.30		
Mother's educational level*	No education	4653	71.60	354	34.10	2	1156.9 (.000)
	Primary	1659	25.50	389	37.50		
	Secondary or above	183	2.80	294	28.40		
Birth order*	1 child	1055	16.20	381	36.70	4	309.04 (.000)
	2-3 children	1994	30.70	353	34.00		
	4-5 children	1556	24.00	163	15.70		
	6-7 children	1081	16.60	90	8.70		
	8+ children	809	12.50	50	4.80		
Media exposure*	No	3218	49.50	189	18.20	2	354.09 (.000)
	Yes	3277	50.50	848	81.80		
Wealth index *	Poor	3337	51.40	174	16.80	2	813.4 (.000)
	Middle	2019	31.10	801	77.20		
	Rich	1139	17.50	62	6.00		

* indicates significant at 1 level of significance

Table 4.2: Continued

Husband's/Partners educational level*	No education	3556	54.70	230	22.20	2	925.66 (.000)
	Primary	2361	36.40	369	35.60		
	Secondary or above	578	8.90	438	42.20		
Working status*	No	4551	70.10	621	59.90	2	43.1 (.000)
	Yes	1944	29.90	416	40.10		
Age *	15-19 (teenager)	351	5.40	52	5.00	1	28.6 (.000)
	20-34 (younger)	4452	68.50	793	76.50		
	35-49 (older)	1692	26.10	192	18.50		
ANC visit	Irregular visit	5017	77.20	782	75.40	1	1.69 (.204)
	regular visit	1478	22.80	255	24.60		
Delivery care*	Health institution	459	7.10	777	74.90		3002.1 (.000)
	Home	6036	92.90	260	25.10		

* indicates significant at 1 level of significance

4.2. RESULTS OF LOGISTIC REGRESSION ANALYSIS

4.2.1. Maximum likelihood estimation for parameters

In the previous section, a bivariate analysis was conducted to examine the association between each of the selected predictor variables with DC and PNC. Significant association was found between some of predictor variables and, DC and PNC. However, a bivariate association between two variables does not necessarily imply a significant causal relationship between them, because in real life more than one predictor variables operates to influence the response variable.

Therefore, it is important to carry out a statistical analysis which would incorporate more than one predictor variable at a time. A backward stepwise likelihood ratio test for binary logistic regression analysis was carried out in order to select the most important covariates among the 9 covariates associated with DC and 10 covariates associated with PNC provided from the bivariate analyses. As a result, only one of the variables namely, work status of women becomes an insignificant predictor of DC and six of the variables become significant predictors of PNC using the backward stepwise likelihood ratio test of the binary logistic regressions procedure at 5% level of significance. The results are shown in Tables 4.3 and 4.4.

Table 4.3: Binary multiple logistic regression analysis results for DC utilization

Predictors	$\hat{\beta}_j$	S.E.	Wald	df	Sig.	EXP ($\hat{\beta}_j$)	95% C.I.for EXP(β_j)	
							Lower	Upper
BORD			75.295	4	**.000**			
1 child	-1.591	.252	39.797	1	.000	.204	.124	.334
2-3 children	-.862	.241	12.739	1	.000	.422	.263	.678
4-5 children	-.580	.240	5.851	1	.016	.560	.350	.896
6-7 children	-.397	.248	2.561	1	.110	.672	.413	1.093
8+ children (ref)								
AGE			12.112	2	**.002**			
15-19 (teenager)	.841	.244	11.881	1	.001	2.318	1.437	3.738
20-34 (younger)	.239	.146	2.677	1	.102	1.270	.954	1.690
35-49 (older) (ref)								
REGION			194.852	10	**.000**			
Tigray	1.214	0.215	31.756	1	.000	3.366	2.207	5.133
Afar	1.979	0.257	59.117	1	.000	7.236	4.369	11.985
Amhara	0.903	0.221	16.709	1	.000	2.466	1.6	3.802
Oromiya	1.372	0.21	42.726	1	.000	3.944	2.614	5.952
Somali	1.469	0.244	36.078	1	.000	4.343	2.689	7.013
Benishangul-Gumuz	1.067	0.244	19.138	1	.000	2.906	1.802	4.686
SNNP	1.594	0.23	48.151	1	.000	4.921	3.138	7.719
Gambela	0.395	0.224	3.115	1	0.078	1.484	0.957	2.299
Harari	0.398	0.216	3.406	1	0.065	1.489	0.976	2.271
Dire Dawa	-0.211	0.217	0.947	1	0.33	0.81	0.529	1.239
Addis Ababa (ref)								
RESIDENCE								
Urban	-1.956	.114	292.774	1	.000	.141	.113	.177
Rural (ref)								

* indicates significant at 1 level of significance ref-- reference

Table 4.3: Continued

MOTHER'S EDU.			64.717	2	**.000**			
No education	1.403	.175	64.076	1	.000	4.069	2.886	5.737
Primary	.940	.159	34.983	1	.000	2.560	1.875	3.496
Secondary or above (ref)								
WEALTH INDEX			32.669	2	**.000**			
Poor	.646	.132	23.974	1	.000	1.907	1.473	2.470
Middle	.776	.177	19.237	1	.000	2.174	1.536	3.075
Rich (ref)								
HUSBAND EDU.			38.833	2	**.000**			
No education	.885	.143	38.476	1	.000	2.424	1.832	3.206
Primary	.522	.120	19.046	1	.000	1.685	1.333	2.129
Secondary or above (ref)								
MEDIA EXPOSURE								
No	.615	.114	29.014	1	.000	1.850	1.479	2.315
Yes (ref)								
Constant	.735	.352	4.365	1	.037	2.086		

* indicates significant at 1 level of significance ref-- reference

Table 4.4: Binary multiple logistic regression analysis results for PNC utilization

Predictors	$\hat{\beta}_j$	**S.E.**	**Wald**	**df**	**Sig.**	**EXP** $(\hat{\beta}_j)$	**95% C.I.for EXP(β_j)**	
							Lower	**Upper**
BORD			8.552	4	.073			
1 child	.148	.195	.575	1	.448	1.159	.791	1.698
2-3 children	.280	.187	2.234	1	.135	1.323	.917	1.910
4-5 children	.049	.192	.065	1	.799	1.050	.720	1.531
6-7 children	-.156	.205	.583	1	.445	.855	.572	1.278
8+ children (ref)								
REGION			79.895	10	**.000**			
Tigray	-.825	.194	18.069	1	.000	.438	.300	.641
Afar	-.420	.230	3.325	1	.068	.657	.418	1.032

* Factor level significant at <5%. ref – reference category

Table 4.4: Continued

Amhara	.076	.211	.130	1	.719	1.079	.714	1.630
Oromiya	.415	.199	4.324	1	.038	1.514	1.024	2.238
Somali	-.076	.242	.100	1	.752	.926	.577	1.489
Benishangul-Gumuz	-.563	.222	6.440	1	.011	.570	.369	.880
SNNP	.204	.211	.932	1	.334	1.226	.811	1.854
Gambela	-.549	.208	6.962	1	.008	.577	.384	.868
Harari	-.636	.195	10.634	1	.001	.530	.361	.776
Dire Dawa	.182	.190	.912	1	.340	1.199	.826	1.742
Addis Ababa (ref)								
MOTHER'S EDU.			11.484	2	**.003**			
No education	.558	.167	11.142	1	.001	1.748	1.259	2.426
Primary	.419	.146	8.244	1	.004	1.520	1.142	2.024
Secondary or above (ref)								
WEALTH INDEX			20.884	2	**.000**			
Poor	.564	.127	19.662	1	.000	1.758	1.370	2.255
Middle	.430	.166	6.710	1	.010	1.537	1.110	2.129
Rich (ref)								
ANC visit								
Regular	.196	.104	3.586	1	.058	1.217	.993	1.490
Irregular								
HUSBAND EDU.			14.187	2	**.001**			
No education	.449	.148	9.244	1	.002	1.567	1.173	2.094
Primary	.446	.122	13.303	1	.000	1.563	1.229	1.986
Secondary or above (ref)								
MEDIA EXPOSURE								
No	.312	.116	7.257	1	**.007**	1.366	1.089	1.713
Yes (ref)								
DC								
Health institution	-3.171	.113	784.453	1	**.000**	.042	.034	.052
Home								
Constant	1.748	.281	38.617	1	.000	5.744		

* Factor level significant at <5%. ref – reference category

4.2.2. Goodness of fit test

Before interpreting the parameter estimated, we should assess the model goodness of fit.

Classification Tables

Classification table is a method to evaluate the predictive accuracy of the logistic regression model. The classification Tables 4.5 and 4.6 show how well our full model correctly classifies cases. The overall percentage in the lower right corner of the tables show that the classifications which predict DC and PNC are 91.3% and 90.7%, respectively.

Table 4.5: Classification table for model predicting DC utilization.

Observed		Predicted		
		Place of delivery		Percentage Correct
		Health institution	HOME	
Place of delivery	Health institution	800	436	64.7
	HOME	221	6075	96.5
Overall Percentage				**91.3**

Table 4.6: Classification table for model predicting PNC utilization.

Observed		Predicted		
		Postnatal care Utilization		Percentage Correct
		Yes	No	
Postnatal care Utilization	Yes	677	360	65.3
	No	337	6158	94.8
Overall Percentage				**90.7**

Likelihood ratio rest (LRT), AIC and BIC

Table 4.7: Results of Model Fit Statistics for the empty and full models

	DC		**PNC**	
Goodness of fit measure	Empty model	Full model	Empty model	Full model
DF	1	26	1	27
Log Likelihood	-3362.332	-1758.391	-3018.284	-1800.936
AIC	6726.664	3568.782	6038.569	3655.871
BIC	6733.591	3748.881	6045.496	3842.898

The values of the likelihood ratio test statistic LR= 3206.88 with P-value 0.0000 for DC and LR= 2434.70 with P-value 0.0000 for PNC. LR is approximately Chi-square distributed with degrees of freedom equal to the difference between numbers of predictors between the nested models (degrees of freedom for DC=26-1=25 and degrees of freedom for PNC=27-1=26). Since the P-value is very small, we can reject the null hypothesis of no significant difference between the two models. Table 4.7 also shows that the AIC and BIC values for the full model are smaller than the empty model. Therefore, we conclude that the less restrictive model (full model) fit the data significantly better than the more restrictive model (empty model). So adding the predictor variables to the model has significantly increased our ability to predict utilization of DC and PNC.

Hosmer - Lemeshow goodness of fit test

Table 4.8: Test of significance of Hosmer-Lemeshow goodness of fit statistic

Hosmer and Lemeshow goodness of fit test					
DC			**PNC**		
Chi-square	DF	Prob>chi2	Chi-square	DF	Prob>chi2
8.706	8	0.368	11.118	8	0.195

Hosmer-Lemeshow goodness of fit test is a check if the null hypothesis that the model adequately fits the data. With this test, the P-values for the model predicting DC and PNC are 0.368 and 0.195, respectively, which are larger than 0.05. Therefore, we do not reject the null hypothesis, implying that the model fits the data at an acceptable level; this proves that the predicted data are not significantly different from the observed data.

4.2.3. Logistic regression diagnostics results

The adequacy of the fitted model was checked for possible presence of outliers and influential values. The diagnostic test results for detection of outliers and influential values are presented in the Appendix (Table 4.9 and Table 4.10).

One method of detecting outliers is to use leverage values. The larger the value of leverage h_j (i.e. $h_j>1$), the more likely the potential that observation has for influencing the model fit. Table

4.9 and Table 4.10 show that the maximum leverage values 0.02477 and 0.02639 (for DC and PNC) are both less than one indicating the absence of outlying observation. Cook's distance measures the effect of excluding any specific observation on the remaining set of parameter estimates. A Cook's distance less than unity shows that an observation has no overall impact on the estimated vector of regression coefficients. Since the computed Cook's distances (D_i<1) for DC and PNC are all less than one we conclude that there are no influential cases.

Table 4.9 and Table 4.10 also show that there are no high values of DFBETAs. The maximum DFBETAs are all less than unity implying no specific impact of an observation on the coefficient of a particular predictor variable. Thus, based on the above goodness of fit tests and diagnostic checking, we conclude that both models for (DC and PNC) are adequate.

4.2.4. Interpretation of results for DC

Table 4.3 presents the results of binary multiple logistic regression analysis for delivery care service utilization. The results show birth order, age, region, mother's educational level, wealth index, husband's educational level and media exposure are predictors that affect utilization of both DC at 5% level of significance.

Birth order has significant effect on DC utilization. Women with first birth order was 80% less likely (aOR=.204, 95% CI: .124-.334) to give birth at home compared to women having children with birth order of eighth or more. Similarly, women with 2-3 children and 4-5 children were 58% (aOR=.422, 95% CI: .263-.678), and 44% less likely (aOR =.560, 95% CI: .350-.896), to give birth at home as compared to women having children with birth order of eighth or more.

Women aged 15- 19 years (teenagers) were 2.3 (aOR =2.318, 95% CI: 1.437- 3.738) times more likely to give birth at home compared to women aged 35- 49 years (older).

The estimated odds ratio for women in Tigray, Afar, Amhara, Oromiya, Somali, Benishangul-Gumuz, and SNNP compared to mothers who live in Addis Ababa are (aOR =3.366, 95% CI: 2.207- 5.133) (aOR =7.236, 95% CI: 4.369-11.985), (aOR =2.466, 95% CI:1.6- 3.802), (aOR =3.944, 95% CI: 2.614- 5.952), (aOR = 4.343, 95% CI:2.689- 7.013), (aOR = 2.906, 95% CI: 1.802- 4.686) and (aOR = 4.921, 95% CI: 3.138- 7.719), respectively. This implies that women who live in Tigray, Afar, Amhara, Oromiya, Somali, Benishangul-Gumuz, and SNNP are 3.4,

7.2, 2.5, 3.9, 4.3, 2.9 and 4.9, respectively, times more likely to give birth at home compared to women who live in Addis Ababa.

The results also show the significant effect of mother's education on DC utilization. Women who have no education are 4 times more likely (aOR = 4.069, 95% CI: 2.886- 5.737) to give birth at home compared to women who have secondary or above education. And women who have primary education 2.56 times more likely (aOR = 2.560, 95% CI: 1.875- 3.496) to give birth at home as compared to women who have secondary or above education.

Another important predictor of DC is wealth index. The adjusted odds ratio of DC utilization by women from poor and middle household wealth index compared to those women from rich wealth index are 1.907 (aOR = 1.907 95% CI: 1.473- 2.470) and 2.174 (aOR = 2.174 95% CI: 1.536- 3.075) This means women from poor and middle household wealth index are 1.9 and 2.2 times more likely to give birth at home compared to women from rich household.

Husband educational level has a significant effect on women's utilization of delivery care. Women whose husbands had no education are 2.4 times more likely (aOR = 2.424, 95% CI: 1.832- 3.206) to give birth at home than women whose husbands had secondary or higher education and those who whose husbands had primary education were 68.5% more likely (aOR = 1.685, 95% CI: 1.333- 2.129) to give birth at home than women married to a man with secondary or higher education.

Having media exposure has a significant effect on utilization of DC. Women who have no media exposure are 85% more likely (aOR = 1.850, 95% CI: 1.479- 2.315) to give birth at home as compared to women who has media exposure.

4.2.5. Interpretation of results for PNC

Table 4.4 present binary multiple logistic analysis results. The analysis revealed region, mother's educational level, wealth index, husband's educational level, media exposure and DC as significant predictors of PNC utilization.

For women in Tigray, Oromiya, Benishangul-Gumuz, Gambela and Harari compared to mothers who live in Addis Ababa the adjusted odds ratios are (aOR =.438, 95% CI: .30- .641), (aOR =1.514, 95% CI: 1.024- 2.238), (aOR =.570, 95% CI: .369- .880), (aOR =.577, 95% CI: .384-

868), (aOR = .530, 95% CI: .361-.776), respectively. This implies that women who live in Tigray, Benishangul-Gumuz, Gambela and Harari are 56%, 43%, 42% and 57%, respectively, less likely to miss PNC compared to women who live in Addis Ababa. Women in Oromiya are 1.5 times more likely not to attend PNC as compared to women who live in Addis Ababa.

The results also show the positive effect of mother's educational level on PNC utilization. Women who has no education and primary education are 1.75 (aOR = 1.748, 95% CI: 1.259-2.426) and 1.5 ($\widehat{OR}$= 1.520, 95% CI: 1.142- 2.024), respectively, times more likely not to attend PNC ompared to women who have secondary or above education.

The estimated aOR for women whose husbands had no education is 1.56. This means that women whose husbands have no education is 57% more likely (aOR = 1.567, 95% CI: 1.173-2.094) to miss PNC compared to women whose husbands have secondary or above education. Those whose husbands had primary education are 56% more likely (aOR = 1.563, 95% CI: 1.229- 1.986) not to attend PNC than women whose husbands have secondary or above education.

The estimated aOR for women whose households wealth index is poor and middle compared to those women whose wealth index is rich are 1.758 (aOR = 1.758, 95% CI: 1.370- 2.255) and 1.537 (aOR = 1.537, 95% CI: 1.110- 2.129), respectively. This implies that poor and middle level women are about 76% and 54%, respectively, more likely to miss PNC utilization compared to rich women.

Women without media exposure are about 37% more likely to miss PNC compared to women who had media exposure (aOR = 1.366, 95% CI: 1.089- 1.713).

Utilization of DC has a significant effect on PNC utilization. The likelihood of using PNC service was 96% lower for women who give birth at home compared to women who give birth at health institution (aOR = .042, 95% CI: .034-.052).

4.3. DISCUSSION OF THE RESULTS

It is expected that disparities on DC and PNC utilization exist among regions. The level of utilization of delivery care services was found to be highest in Addis Ababa where as PNC utilization was low . The highest utilization of delivery care could be due to the increased

availability of infrastructure such as shorter distance to health facilities, better roads and transportation and also it could be because women with secondary or above education live in Addis Ababa than in other regions. It could also be because the city is more advantaged in terms of accessing health professionals and facilities than other regions of the country. In this thesis unexpected results observed in utilization of PNC due to missing observation in the data. Similar finding was obtained from a study conducted by Ethiopian Society of Population Studies (2008).

Place of residence is found to have significant effect on the utilization of DC, but not on PNC. Utilization of DC was higher among urban women than among their rural counterparts. Similar results were found by Eyerusalem (2010), Yared and Asnakech (2002), and Rahman (2009). Eyerusalem (2010) revealed that women living in rural areas are 69% less likely to get assistance from health professionals compared to urban women (aOR 0.31 95% CI: 0.2-0.4). One possible explanation for this could be that health and education infrastructures are highly concentrated in urban areas and also may be that most of the rural women are not exposed to education. It may also be because women in rural areas often have to cover longer distance to get to health facilities.

This study showed that women's education is an important factor which affects utilization of DC and PNC services. Women with secondary or above education are more likely to have these services. similar studies by Nzioki et al. (2015), Azuh (2011) and Gwamaka (2012) also showed education as the most important factor which had influence on maternal care utilization. The possible explanation could be that education is likely to enhance female autonomy and help women to develop greater confidence and capability to make decisions about their own health. It is also likely that literate women seek higher quality services and have greater ability to use health care inputs that offer better care.

This study identified husbands education as a significant factor of delivery and postnatal care utilization. Use of these maternal health care services was shown higher for women whose husbands were secondary or higher educated. But there is no significant difference in PNC utilization between women married to uneducated and primary educated man. Kamal (2009) and Eyerusalem (2010) also came up with a similar result that having partners who had secondary or higher education increased the likelihood of delivering with professional assistance compared to those with partner who had no education (aOR = 2.2 95% CI: 1.5-3.2). In contrast Ndie and Idam

(2013) showed that educational level of the husband does not have significant effect on maternal health services Abakaliki, Nigeria.

The current study showed household wealth to be a significant predictor of DC and PNC utilization. Women from wealthy households are more likely to utilize maternal health services than those from poor and middle level households. This result is consistent with other studies (Vishnu et al., (2014); Singh et al., (2012); Kassu and Eshetu (2013)). Low coverage of maternal healthcare utilization among poor households could be due to the low priority assigned to health seeking to other basic daily living needs.

Our study identified women's exposure to mass media (TV, newspapers, radio) affects utilization of maternal health care (DC and PNC). Women who had no exposure to all three media are more likely to give birth at home and not to attend PNC. Mluleki et al. (2014) showed that utilization of PNC among women who watch TV is over four fold more likely (aOR =4.36, 95% C.I: 1.5-12.7] than women who do not watch TV. A study in Zimbabwe showed that having access to radio programmes has a significant effect on postnatal care (Muchabaiwa et al., 2012). The possible reason is that media provide increased awareness and knowledge, as well as bring about changes in attitudes, social norms and behaviors that may lead to positive public health outcomes and information related to healthy behavior and health care services.

CHAPTER FIVE

CONCLUSION AND RECOMMENDATIONS

5.1. CONCLUSION

Despite the fact that MDG5 is given special consideration by the Ethiopian government, utilization of maternal health care, an essential care for further improvement of maternal and child health, is low. More than 80% of women attend home delivery and also do not received PNC.

The findings of this study identified region, wealth index, women's educational level, husband's educational level and media exposure as the major factors that affect utilization of delivery and postnatal care. Women who had no education, married to an uneducated man, who are poor and had no media exposure are more likely to give birth at home and not to attend PNC.

Moreover, women's age, place of residence and birth order has a significant effect on DC utilization. Women who give birth at teenage were more likely to deliver at home than older women. Also rural women were less likely to use DC services. Birth order is also found to contribute to DC utilization. Women use DC services more at their first birth order. Women who gave birth at health institution were more likely to attend PNC.

5.2. RECOMMENDATIONS

From the findings and conclusions, the following recommendations are made to ensure improved utilization of maternal health services in Ethiopia.

- Efforts must be made to improve women's economic status and to eradicate illiteracy among women as a means to empower them to take better care of their health.
- There is a huge gap of maternal health care services utilization between women who reside in urban and rural areas. So Health Extension Workers have to be placed close to the rural population in order to create awareness about the importance of these services and provide the services.
- More programs should be aired in different mass media to promote maternal health care services.

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APPENDIX

Table 4.9: Model diagnostic test results for detection of outliers and influential values for model predicting DC utilization.

Descriptive Statistics

	N	Minimum	Maximum
Analog of Cook's influence statistic	7532	.00000	.10567
Leverage value	7532	.00034	.02477
DFBETA for constant	7532	-.04750	.04233
DFBETA for Birth_order(1)	7532	-.03173	.05338
DFBETA for Birth_order (2)	7532	-.03047	.05227
DFBETA for Birth_order (3)	7532	-.02750	.04982
DFBETA for Birth_order (4)	7532	-.02509	.04462
DFBETA for AGE(1)	7532	-.03824	.02998
DFBETA for AGE(2)	7532	-.01821	.01978
DFBETA for REGION(1)	7532	-.02433	.01911
DFBETA for REGION(2)	7532	-.03933	.03348
DFBETA for REGION(3)	7532	-.02342	.02270
DFBETA for REGION(4)	7532	-.02325	.01794
DFBETA for REGION(5)	7532	-.03217	.03181
DFBETA for REGION(6)	7532	-.02938	.02930
DFBETA for REGION(7)	7532	-.02394	.02433
DFBETA for REGION(8)	7532	-.02456	.02633
DFBETA for REGION(9)	7532	-.02292	.02065
DFBETA for REGION(10)	7532	-.02220	.02455
DFBETA for RESIDENCE(1)	7532	-.01197	.01137
DFBETA for Edu_level(1)	7532	-.02219	.02103
DFBETA for Edu_level(2)	7532	-.02085	.01883
DFBETA for WI(1)	7532	-.01335	.01596
DFBETA for WI(2)	7532	-.02493	.01709
DFBETA for HEdu_level(1)	7532	-.01238	.01613
DFBETA for HEdu_level(2)	7532	-.00926	.01232
DFBETA for WORK(1)	7532	-.00512	.00677
DFBETA for MEDIA(1)	7532	-.01172	.00870
Valid N (list wise)	7532		

Table 4.10: Model diagnostic test results for detection of outliers and influential values for model predicting PNC utilization.

Descriptive Statistics

	N	Minimum	Maximum
Analog of Cook's influence statistic	7532	.00001	.09090
Leverage value	7532	.00051	.02639
DFBETA for constant	7532	-.04627	.02640
DFBETA for Birth_order (1)	7532	-.03237	.03880
DFBETA for Birth_order (2)	7532	-.02653	.03732
DFBETA for Birth_order (3)	7532	-.02396	.03472
DFBETA for Birth_order (4)	7532	-.02023	.03052
DFBETA for AGE(1)	7532	-.03830	.03370
DFBETA for AGE(2)	7532	-.01610	.01888
DFBETA for REGION(1)	7532	-.01835	.02212
DFBETA for REGION(2)	7532	-.03261	.03254
DFBETA for REGION(3)	7532	-.02790	.02291
DFBETA for REGION(4)	7532	-.02521	.01958
DFBETA for REGION(5)	7532	-.03683	.03267
DFBETA for REGION(6)	7532	-.03139	.03145
DFBETA for REGION(7)	7532	-.02447	.02431
DFBETA for REGION(8)	7532	-.02698	.02728
DFBETA for REGION(9)	7532	-.02134	.02224
DFBETA for REGION(10)	7532	-.02320	.01661
DFBETA for RESIDENCE(1)	7532	-.02030	.01112
DFBETA for Edu_level(1)	7532	-.01504	.02392
DFBETA for Edu_level(2)	7532	-.01472	.01708
DFBETA for WI(1)	7532	-.01692	.01545
DFBETA for WI(2)	7532	-.02243	.01650
DFBETA for HEdu_level(1)	7532	-.01721	.01770
DFBETA for HEdu_level(2)	7532	-.01160	.01273
DFBETA for WORK(1)	7532	-.00522	.00787
DFBETA for MEDIA(1)	7532	-.01130	.01064
DFBETA for DC(1)	7532	-.00893	.01495
Valid N (list wise)	7532		