ADDIS ABABA UNIVERSITY

GRADUATE STUDIES PROGRAMME

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DEPARTMENT OF STATISTICS

DETERMINANT FACTORS AFFECTING UTILIZATION OF MATERNAL HEALTH CARE SERVICES IN RURAL ETHIOPIA

Kassu Mehari

A Thesis submitted to

The Department of Statistics

Presented in Partial Fulfillment of the Requirements for the Degree of Masters of Science (Biostatistics)

Addis Ababa University

Addis Ababa, Ethiopia

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Advisor: Professor Eshetu Wencheko

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School of Graduate Studies

This is to certify that the thesis prepared by Kassu Mehari, entitled: *Determinant Factors Affecting Utilization of Maternal Healthcare Services in Rural Ethiopia* and summited in partial fulfillment of the requirements for the Degree of Master of Science (Biostatistics) complies with the regulations of the University and meets the accepted standards with respect to originality and quality.

Signed by the Examining Committee:

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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.

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Date of submission: May, 2012

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

Prof. Eshetu Wencheko ----------

Advisor‟s Name signature

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ABSTRACT

Determinant factors affecting utilization of maternal healthcare services in rural Ethiopia

Kassu Mehari
Addis Ababa University, 2012

Maternal mortality in Ethiopia is one of the highest in the world. In 2006 the maternal mortality rate was 673 per 100,000 live births (CSA and ORC Macro, 2006). Maternal mortality ratio is one of the indicators in the MDG that is raising concern in achieving the set target of reducing the rate by two-third by 2015. Many mothers also suffer from complications of pregnancy and delivery. In addition to that maternal healthcare service utilization is far below the acceptable level. The main objective of this study is to identify the determinant factors affecting utilization of maternal health care services in rural Ethiopia.The data for the study were taken from the 2011 Ethiopian Demographic and Health Survey which is a nationally representative survey of women in the age group15-49 years. Mothers who had atleast one child in the five years before the survey were included in the analysis. To estimate the effect of the socio-economic and demographic variables on maternal health service utilization three outcome variables were considered, these were: use of antenatal care (ANC), delivery care and postnatal care (PNC) services. The logistic regression was used to develop models based on the outcome variables. Utilization of maternal healthcare services was found to be very low among non-educated mothers as compared to those who have atleast primary education. In the logistic regression model mother‟s age at birth, educational status of the mother, sex of head of household, household wealth, work status of the mother, region, religion, birth order of the child and educational status of the husband were found to be indicators of utilization of delivery care and PNC services in the total sample of mothers. Religion and sex of household head were not significantly related with ANC use. To increase mother‟s utilization of health care services and improve maternal health in rural Ethiopia some crucial steps regarding educating mothers and creating job opportunity for mothers should be taken. Great attention should be given to those mothers who are living in rural areas of Ethiopia with no education and in the low economic status group.

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It gives me a great pleasure to come to this final point to express my deepest gratitude to all individuals and institutions who contributed in one way or another to my study and the realizing of this thesis.

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Finally, I would like also to thank the Ethiopian Central Statistics Agency for providing me with all the relevant secondary data used in this study.

DEDICATION

To my friends, Daniel Tewolde, Meraf Hailu, Shimelis Bekele, and Yishaq Feye and their families who were beside me in those **dark days**, without whose caring support it would not have been possible for me to achieve success, and to the memory of my mother, Tekolash Meressa, who couldn‟t see her fruit.

ACRONYMS

ANC	Antenatal care
CEEPA	Centre for Environmental Economics and Policy in Africa
CSA	Central Statistical Agency
DHS	Demographic and Health Survey
EDHS	Ethiopian Demographic and Health Survey
GDP	Gross domestic product
MDG	Millennium development goal
MMR	Maternal mortality rate
PNC	Postnatal care
ROC	Receiver Operating Characteristic
UN	United Nations
UNFPA	United Nations Population Fund
UNICEF	United Nations Children‟s Fund
USAID	United States Agency for International Development
WHO	World Health Organization

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CHAPTER ONE

INTRODUCTION

1.1 Background of the study

Economic slowdown and food security crisis are the main challenging problems that almost all countries of the world faced and they have become the burning issues at both national and international levels. The economic slowdown will diminish the incomes of the poor; the food crisis will raise the number of hungry people in the world and push millions people into poverty. The poor are not only those with the lowest incomes but also those who are the most deprived of health, education and other aspects of human well-being. The poor health and nutrition of women and the lack of care that contributes to their death in pregnancy and child birth also negatively affect the health and survival of infants and children they leave behind. Most maternal deaths do occur in poor countries and it is well known that poor countries are also the ones with highest maternal mortality rates (De Brouwere and Lerberghe, 2001).

Maternal health has emerged as global priority because of a great gap in the status of mother‟s wellbeing between rich and the poor countries. According to WHO (2008), maternal health refers to the health of women during pregnancy, childbirth and the postpartum period. In rich countries, where women have access to basic health care, giving birth is a positive and fulfilling experience. On the other hand, for many women in poor countries it is associated with suffering, ill health and even death.

The World Health Organization (WHO, 2005) estimates that 536,000 maternal deaths occur worldwide each year from complications arising from pregnancy, and a high

proportion of these deaths occur in sub-Saharan Africa. Developing countries accounted for 99% (533,000) of the deaths. Slightly more than half of the maternal deaths (270,000) occurred in the sub-Saharan Africa region alone, followed by South Asia (188,000). Thus, sub-Saharan Africa and South Asia accounted for 86% of global maternal deaths. Maternal Mortality Ratio (MMR) in 2005 was highest in developing regions with 450 maternal deaths per 100,000 live births, in stark contrast to developed regions with 9 maternal deaths per 100,000 live births and in countries of the commonwealth of independent states 51 maternal death per 100,000 live births. Among the developing regions, sub-Saharan Africa had the highest MMR with 900 maternal deaths per 100,000 live births in 2005, followed by South Asia (490), Oceania (430), South-Eastern Asia (300), Western Asia (160), Northern Africa (160), Latin America and the Caribbean (130), and Eastern Asia (50).

The fifth Millennium Development Goal (MDG) aims at improving maternal health and targets reducing MMR by 75% between 1990 and 2015 – that is, it seeks to achieve an expected 5.5% annual decline in MMR from 1990. However, MMR has decreased at the global level at an average of less than 1% annually between 1990 and 2005. To make the achievement of the fifth MDG a reality, MMR will have to decrease at a much faster rate – especially in sub-Saharan Africa, where the annual decline has so far been about 0.1% (WHO, 2005). Mothers play a principal role in the rearing of children and the management of family affairs, and their loss from maternity-related causes is a significant social and personal tragedy.

An estimated 358,000 maternal deaths occurred worldwide in 2008, a 34% decline from the levels of 1990. Despite this decline, developing countries continued to account for

99% (355,000) of the deaths. Sub-Saharan Africa and South Asia accounted for 87% (313,000) of global maternal deaths. Eleven countries including Afghanistan, Bangladesh, the Democratic Republic of Congo, Ethiopia, India, Indonesia, Kenya, Nigeria, Pakistan, Sudan, and the United Republic of Tanzania, comprised 65% of all maternal deaths in 2008 (WHO 2010).

The MMR in 2008 was also highest in developing regions with 290 maternal deaths per 100,000 live births versus 14 maternal deaths per 100,000 live births in developed regions and countries of the Commonwealth of Independent States (40). Among developing regions, sub-Saharan Africa had the highest MMR at 640 maternal deaths per 100 000 live births in 2008, followed by South Asia (280), Oceania (230), South-Eastern Asia (160), North Africa (92), Latin America and the Caribbean (85), Western Asia (68), and Eastern Asia (41) (WHO2010).

The progress of reducing MMR is notable, but the annual rate of decline is less than half of what is needed to achieve the fifth Millennium Development Goal (MDG5) target of reducing the maternal mortality ratio between 1990 and 2015. This will require an annual decline of 5.5%. The 34% decline since 1990-2008 translates into an average annual decline of just 2.3%. This is still far from the annual decline of 5.5% required to achieve MDG5 (WHO 2010).

All pregnant women face some level of maternal risk. According to WHO (2000), about 40% of pregnant women experienced delivery complications, while about 15% needed obstetric care to manage complications which are potentially life threatening to the mother or infant. Despite the importance of antenatal care to predict and prevent some

complications, many are sudden in onset and unpredictable. Studies demonstrating the high levels of maternal mortality and morbidity in developing countries and research identifying causes of maternal deaths have repeatedly emphasized the need for antenatal care and availability of trained personnel to attend women during labor and delivery (Fortney et al., 1988). The importance of tetanus toxoied injections given prior to birth to reduce neonatal mortality has been documented as well (Bhatia, 1989). Since a large proportion of maternal and neonatal deaths occur within the first few days after delivery, safe motherhood programs have recently increased their emphasis on the importance of postnatal care.

Pregnant women still die from four major causes: severe bleeding after childbirth, infections, hypertensive disorders, and unsafe abortion. Every day, about 1,000 women died due to these complications in 2008. Out of the 1,000, 570 lived in sub-Saharan Africa, 300 in South Asia and five in high-income countries. The risk of a woman in a developing country dying from a pregnancy-related cause during her lifetime is about 36 times higher compared to a woman living in a developed country (WHO 2010).

The utilization of maternal health care is one of the important factors to reduce the incidence of maternal mortality. United Nations data about maternal health care from developing countries are as follows: the number of pregnant women who receive at least one antenatal care is approximately 74 percent in 2005 (UN, 2008); 40 percent of deliveries take place in health facilities (UNFPA, 2004); and skilled health personnel assist nearly 61 percent of births in 2006 (UN, 2008). Obviously, the data indicate that commitment of governments to maternal health care have not reached the levels required

to make strong impact on mortality rates. Many existing interventions have been found to be ineffective in preventing maternal deaths. Laws and regulations in many countries sometimes impede health care policies (mostly in specific areas such as sexuality education and access of adolescents to reproductive health information and services).

According to the third census which was made in 2007, Ethiopia had total population of 74 million people which makes it the second most populous nation in Africa next to Nigeria. Of these, 50.5% were males and 49.5% were females and a large proportion of women (24%) are in the reproductive age (15-49 years). About 85% of the population resides in rural areas while the rest live in urban areas (CSA, 2007).

Agriculture remains by far the most important sector in the Ethiopian economy for the following reasons: (i) it directly supports about 85% of the population in terms of employment and livelihood; (ii) it contributes about 50% of the country's gross domestic product (GDP); (iii) it generates about 88% of the export earnings; and (iv) it supplies around 73% of the raw material requirement of agro-based domestic industries. Agriculture is also the major source of food for the population and hence the prime contributing sector to food security. In addition, agriculture is expected to play a key role in generating surplus capital to speed up the country's overall socio-economic development (CEEPA, 2006).

In Ethiopia, the levels of maternal and infant mortality and morbidity are among the highest in the world. The maternal mortality rate in 2006 was 673 per 100,000 live births, and the infant mortality rate was 113 per 1,000 (CSA and ORC Macro, 2006). One explanation for poor health outcomes among women and children is the nonuse of

modern health care services by a sizable proportion of women in Ethiopia. According to the Ministry of Health of Ethiopia report in 2007, about 52% Ethiopian women received antenatal care (ANC), less than 17% received professionally assisted delivery care and 19% received postnatal care (PNC). Previous studies have also clearly demonstrated that the utilization of available maternal health services is very low in the country. Several studies in the 1990s have shown that about 25 percent of Ethiopian women received antenatal care and less than 10 percent received professionally assisted delivery care (Mengistu and James, 1996; Mesganaw et al., 1990).

According to the Central Statistical Agency (CSA) report of the 2011 Ethiopian demographic and health survey (EDHS), urban women are twice more likely to have received ANC from a health professional than rural women (76 % vs. 26 %) and also 51% of births to urban mothers were attended by a health professional and 50 % delivered in a health facility, compared with 5 % and 4 %, respectively, of births to rural women (CSA, 2011). This shows the existence of a huge gap in maternal health care services utilization between rural and urban Ethiopia.

1.2 Statement of the problem

The study of maternal healthcare service utilization becomes one of the most important research areas in developing countries because of the serious damage to the societal wellbeing. Despite the fact that maternal health care utilization is essential for further improvement of maternal and child health,little is known about the current magnitude of use and factors influencing the use of these services in rural Ethiopia. This study therefore aims to fill this gap.

The current study presents an analysis of the effect of demographic and socioeconomic variables on maternal healthcare utilization. The data used in this study are obtained from the Ethiopian Demographic and Health Survey conducted in2011. It is hoped that the result of the study will help to identify the main demographic and socioeconomic factors affecting maternal health care utilization in Ethiopia.

1.3 Objectives of the study

The general objective of the study is to identify the determinant factors affecting utilization of maternal healthcare services in rural Ethiopia.

This general aim can be translated into the following specific objectives:

- To identify socioeconomic and demographic factors which are associated with maternal healthcare service utilization.
- To estimate the model that shows the relationship between use of maternal healthcare service and demographic and socioeconomic variables.
- To compare the maternal healthcare service utilization among the different categories of maternity.

1.4 Significance of the study

- ✓ Studies that have been done to explore the determinants of maternal health service utilization in Ethiopia have shown that a variety of factors affect maternal health care service utilization. Very few of the studies have attempted to look at rural Ethiopia. So this study will identify factors which affect utilization of maternal health services, which help to solve the problem of low maternal health care utilization in rural Ethiopia.

- ✓ It is expected that this study would appraise the current understanding of the maternal health care services utilization in rural Ethiopia.
- ✓ The results of the study could appraise understanding of policymakers by elucidating the main determinant factors affecting the maternal health care utilization in rural Ethiopia. The results can serve as an important input for any possible intervention aimed at improving the maternal health care utilization which will help to reduce maternal mortality rate.

1.5 Scope and limitation of the study

This study uses secondary data collected by Central Statistical Authority (CSA), i.e., the Ethiopia Demographic and Health Survey of the year 2011(EDHS 2011). The study uses information on women of age 15-49 who had at least one child in the five years before the survey for rural Ethiopia. Like any other source of data, the EDHS 2011 has its own limitations. A major limitation of the data is that some important potential predictors about the utilization of maternal health services, for example, accesses to mass media information about maternal healthcare, distance to health facilities, transportation services, the price and quality of care and respondent‟s belief concerning healthcare practices have not been covered.

1.6 Outline of the study

This research is presented in five chapters, including this introduction chapter and a concluding chapter. Chapter one highlights major issues relating to maternal health at a global level and Ethiopia in particular. The significance and objectives of the study are also described. Chapter two contains both theoretical and empirical literature reviews relating to factors associated with the utilization of maternal health care services. Chapter three briefly describes the methodological issues of the study and Chapter four gives the results and discussions. Finally, conclusions and recommendations of the study are presented in Chapter five.

CHAPTER TWO

LITRATURE REVIEW

In this chapter we will present a critical review of the literature on determinants of maternal health care utilization. Relevant studies in both developing and developed countries are reviewed giving a special emphasis on the findings and methodological issue in developing countries.

2.1 Theoretical literature review

Before discussing the conceptual framework which is helpful for identifying the determinant factors of maternal health services utilization, we discuss the components of maternal health care services, which have been found to greatly reduce maternal morbidities and mortality. A discussion of the different maternal health care services and its use is presented in this subsection.

Maternal health refers to the health of women during pregnancy, childbirth and the postpartum period. The importance of maternal health care services in reducing maternal and infant morbidity and mortality has received increasing recognition since the International Conference on Population and Development (ICPD) in Cairo. According to the ICPD program of action, maternal health services should include education on safe motherhood; effective and focused prenatal care; maternal nutrition programs; adequate delivery assistance that avoids excessive recourse to caesarian sections and provides for obstetric emergency; referral services for pregnancy, childbirth and abortion complications; post-natal care and family planning (UNFPA, 2004).

Antenatal care (ANC) is the health care of women throughout the course of pregnancy. Good prenatal care helps ensure the health of both the mother and the baby. Regular checkups and prenatal testing are important parts of prenatal care. It is part of the primary health care services for pregnant women and management of the fetus. Complications during pregnancy and childbirth are unpredictable and often occur suddenly without warning. Thus, it is argued that the traditional use of ANC to identify risk factors (e.g. age, parity, etc.) associated with poor maternal outcomes has limited benefit since the risk factors do not directly cause the poor outcome (Yuster, 1995). However, focused ANC has been found to offer the opportunity for early detection and timely treatment of diseases which improves maternal outcomes. For example, detection and treatment of high blood pressure, to prevent eclampsia, has been found to greatly reduce mortality (McCaw-Binns *et al,* 2004). Similarly, improved maternal outcomes have been recorded through the detection and treatment of anemia (Reynolds*et al,* 2006).

Many women living in developing countries including Ethiopia are at risk of pregnancy-related complications including hemorrhage, obstructed labor, pre-eclampsia/eclampsia, and infection. Problems that may complicate pregnancy and delivery, such as anemia, hypertensive disorders, and multiple pregnancies, also need to be detected and managed. In many developing countries, the presence of malaria, HIV, or syphilis can also harm a pregnancy, as can experience of intimate partner violence. If detected and managed early and correctly through accessing high-quality antenatal care services, pregnancies can be made safe and result in healthy babies.

The strength of ANC, therefore, lies in its role for early identification of complications and also for providing information on danger signs and how to handle them (Yuster,

1995). Furthermore, other potential benefits of antenatal care are counseling on nutrition and healthy pregnancy/delivery behavior; provide tetanus immunization, malaria prophylaxis, iron and folic acid tablets and helping women to select a trained birth attendant or institution to deliver their babies in. Antenatal care also makes it possible to screen for sexually transmitted diseases such as HIV infection, which is known to have taken its fee in much of the developing world.

Counseling and education of pregnant women about their own health and that of their children is also an opportunity that can be incorporated into ANC. WHO recommends a minimum of four ANC visits for every pregnant woman. However, the capability of ANC in improving maternal health outcomes is greatly reduced in the absence of a sensible health and referral system where women can receive emergency obstetric care when needed.

Skilled Birth Attendant (or Delivery care) is an accredited health professional-such as a midwife, doctor or nurse, who has been educated and trained to proficiency in the skills needed to manage normal (uncomplicated) pregnancies, childbirth and the immediate postnatal period, and in the identification, management and referral of complications in women and newborns. Traditional birth attendants trained or not, are excluded from the category of skilled attendant at delivery (WHO, 2004). There are two aspects of the delivery services that are considered in this analysis-whether the delivery was at home or at a health care facility and whether a trained person was present to assist in the delivery. Social norms in rural areas are such that home delivery is preferred to institutional deliveries. This in itself is not a problem if hygienic and appropriate delivery practices

are used either by traditional helpers or by a professionally trained person who makes home visits for helping with the delivery.

In developed countries and in many urban areas in developing countries, skilled care at delivery is usually provided in a health facility. However, births can take place in a range of appropriate places, from home to tertiary referral center, depending on availability and need, and WHO does not recommend any particular setting for giving birth. Home delivery may be appropriate for a normal delivery, provided that the person attending the delivery is suitably trained and equipped and that referral to a higher level of care is an option (Population Council, 2010). Skilled birth attendants are trained to recognize the signs of complications early enough to intervene and manage the situation or make quick referrals to higher levels of care. This is illustrated by historical evidence from industrialized countries where maternal mortality was reduced by half following the introduction of professional midwifery care at birth, in the early 20th century. Improved access to hospitals after the Second World War further reduced maternal death rates, subsequently resulting in the impressive low levels currently recorded (De Brouwere et al, 1998; WHO, 2005).

Contemporary empirical research also supports the presence of skilled birth attendances as a tool to improving maternal health. For example, in the 1950s and 1960s, studies show that maternal mortality ratios were reduced by half in Sri Lanka, Malaysia and Thailand within a 10-year period by increasing the number of midwives attending to births. Similarly, by doubling the proportion of births assisted by skilled professionals, Egypt reduced its maternal mortality ratio by 50% between 1983 and 2000 (WHO, 2008). Skilled attendance during delivery can only be provided in the presence of functioning

health systems (Bell *et al*, 2003) which include adequately trained and motivated workers, well equipped facilities, transportation and rapid referral systems. These are nonexistent in the health systems of developing countries, which are grossly under-funded. It is, therefore, no surprise that women in these countries have limited access to skilled birth attendances and even less access to emergency obstetric care (WHO, 2005). The presence of skilled birth attendances at all births is regarded as, probably, the single most critical intervention for reducing pregnancy-related deaths and disabilities (Bell*et al*, 2003). For this reason, the proportion of births attended by a skilled health professional is currently being used as one of the indicators for monitoring progress in the achievement of the fifth millennium development goal (MDG 5). Hence, in this study we will focus on determining the factors which affect attending birth by a skilled heath professional.

Postnatal Care (PNC) is healthcare provided following childbirth to both mother and infant. The postnatal period is the time from immediately after birth up to 42 days. It is important for mothers to receive care at this time as it has been recorded that more than 60% of maternal deaths take place during the postnatal period (Population Council, 2010; Gill et al, 2007). The death of a mother further exposes her newborn child to high risks of morbidity and mortality. Thus, receiving PNC can make the difference between life and death for both mother and child. In developing countries, the most common causes of maternal deaths during the postpartum period are hemorrhage, infections and hypertensive disorders (Gill et al, 2007). Technically, all of these conditions are treatable. Through examination of the mother after childbirth, PNC can identify these conditions

and any other life-threatening or devastating conditions that may require urgent medical attention.

Several other important services and information can be provided during PNC. These include family planning services where information about child spacing and techniques to avoid unwanted pregnancies can be given. Other services and information, such as maternal and child nutrition, immunization, hygiene and sanitation, prevention of infections including HIV and other Sexually Transmitted Infections (USAID, 2009) can all be provided during PNC. However, though the importance of these services are well known and are sometimes available in clinics, it is reported that less than 30% of women in developing countries access or receive care or medical follow-up in the period immediately following childbirth. The postpartum needs of women living with HIV are particularly acute and underserved (Population Council, 2010).

Conceptual framework of maternal health care

There has been considerable research, particularly in developing countries, exploring the economic and socio-cultural barriers that discourage women from using maternal health care services.

Andersen (1995) has developed a behavioral model that describes the multiple influences on utilization of health care services and, subsequently, on health status. This model suggests that personal health practices and people‟s use of health services are functions of the following three categories:

- **Predisposing characteristics** refers to factors that present preceding the ill health and need for care, such as demographic factors, social structures and health beliefs. Demographic factors such as age and gender represent biological urges the likelihood that people will need health services. Social structure is measured by a broad array of factors that determine the status of a person in the community, his or her ability to cope with and command the resources to deal with these problems, and how healthy and unhealthy the physical environment is likely to be (education, occupation, ethnicity, etc.). Health beliefs are attitudes, values and knowledge that people have about health and health care services that might influence their subsequent perceptions of need and use of these services (Andersen, 1995).
- **Enabling resources** provide patients with the means to make use of the services (Andersen, 1995). Community and personal enabling resources must be available to use in anytime needed. For example, health personnel and facilities must be available and people must have the means and know how to get to those services and make use of them. Income, health insurance, a regular source of care, and travel and waiting times are some of the measures that can be important in this respect (Andersen, 1995).
- **Need** refers to health status, perceived by the individual or evaluated by the health providers (Andersen, 1995). It is how people view their own general health and functional state, as well as how they experience the symptoms of illness, pain and worries about their health and whether or not they judge their

problems to be of sufficient importance and magnitude to seek professional health care.

This model also consists of health status outcomes in order to extend the measures of access to include dimensions which are particularly important for health policy and health reform. It also depicts feedback loops showing that outcome, in turn, affects subsequent predisposing factors and perceived need for services as well as health behavior (Andersen, 1995).

Another similar conceptual framework has been developed by Kroeger (1983) which helps to determine the determinants of maternal health care utilization. Kroeger (1983) proposed that determinants of utilization in developing countries could be grouped under three broad headings: (1) predisposing factors including age, sex, household composition and size, ethnic group affiliation and education; (2) characteristics of illness, expected benefits from treatment and beliefs about disease causation; and (3) characteristics of the health-care system, including acceptability, accessibility, cost and quality of care. This framework is for answering the question about how people enter the sick role and make choices regarding the use or non-use of different kinds of health services.

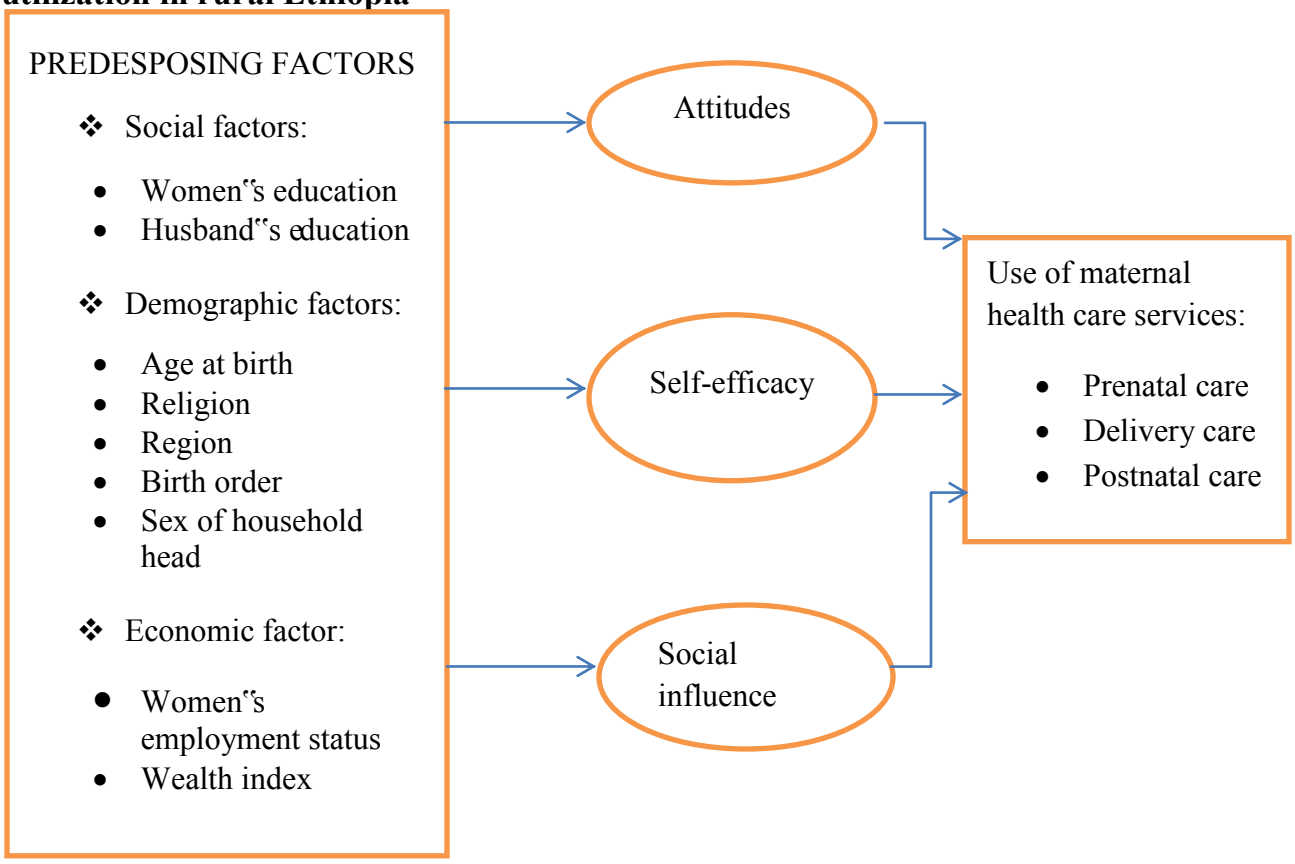
In addition, there is another model in the literature, which has been used in studies on determinants of utilization of health care services in general, and maternal health care services in particular. “The Attitudes - Social influence - Self-efficacy (ASE)” model predicts various health related behaviors. There are three main psycho-social factors which have been identified that predict behavior intention: attitudes, social influences and self-efficacy. A person‟s attitude towards a specific behavior is a result from performing

the behavior, for example a person‟s attitude in deciding whether to use family planning or traditional practices. Social influence is as a result of social norms: influence from other peoples whether to perform or refrain from the specific behavior, and whether other people in society perform or refrain from doing specific behavior. Self-efficacy expectations can be seen as a person‟s belief whether she/he can perform the desired behavior and manage the barriers that may prevent him/her from doing specific behavior (Amooti-Kaguna and Nuwaha, 2000).

The implication of this model is that a person‟s health behavior can be changed by changing a person‟s attitudes, person‟s perception of social norms and social support and her/his self-efficacy expectations (Amooti-Kaguna and Nuwaha, 2000). Moreover, external variables which are left out of this model but need to included, such as social, demographic and economic factors, are expected to influence behavior through behavioral determinants and intention.

In this study, the model of maternal health care service use appeals on the three conceptual frameworks of health seeking behavior adapted from Andersen, Kroeger, and Amooti-Kaguna and Nuwaha. However, we cannot use the entire spectrum of determinants in all frameworks, because sufficient data are not available. Thus, a modified framework is created, corresponding with the availability of data from the 2011 Ethiopia Demographic and Health Survey. Descriptions of the variables those are included in the model to help in the analyses relating to rural Ethiopia are presented below.

Figure-1: A framework to study the determinant of maternal healthcare utilization in rural Ethiopia



2.2 Empirical literature review

Previous empirical studies have found that the use of maternal health services is related to demographic, cultural, and socio-economic factors, such as age of women, birth order, size of household, women and husband education, wealth index, place of residence, religious background, employment, women‟s decision making power, and income level. These factors are discussed in turn.

It is well recognized that women‟s current age plays an important role in the utilization of medical services (Elo, 1992). Mother‟s age may sometimes serve as a proxy for the women‟s accumulated knowledge of health care services, which may have a positive

influence on the use of health services. Possible explanations for higher use of maternal healthcare services by older women could include the fact that women in this cohort are generally more experienced and knowledgeable about healthcare services and their use which may improve utilization. Older women may also be more confident and have higher household decision-making power than younger women, particularly adolescents (Reynolds*et al*, 2006), which will improve their likelihood of health service use. A number of studies support the view that older women are more likely to seek maternal health care services than younger women (Addai, 2000; Chakraborty et al., 2003). In contrast, the Ethiopian Society of Population Studies (2008) using logistic regression modelshowed the non-significant effect of mother‟s age at birth on maternal healthcare utilization. On the other hand, because of development of modern medicine and improvement in educational opportunities for women in recent years, younger women may have an enhanced knowledge of modern health care services and place more value upon modern medicine.

Several studies have found a strong association between birth order and use of health care services (Wong *et al*., 1987; Elo, 1992; Kamal, 2009). Because of perceived risk associated with first pregnancy, a woman is more likely to seek maternal health care services for first birth than higher-order births. Having more children may also cause resource constraints, which have a negative effect on health care utilization (Wong *et al*., 1987).

It is well recognized that mother‟s education has a positive impact on health care utilization. In a study in Peru using DHS data, Elo (1992) using logistic regression model found quantitatively important and statistically significant effect of mother‟s education on

the use of prenatal care and delivery assistance. In another study, Becker and colleagues (Becker *et al*., 1993) using logistic regression model found mother‟s education to be the most consistent and important determinant of the use of child and maternal health services. It is argued that better educated women are more aware of health problems, know more about the availability of health care services, and use this information more effectively to maintain or achieve good health status. Similar study conducted using EDHS data of 2005, by the Ethiopian Society of Population Studies (2008), indicated female education retains a net effect on maternal health service use, independent of other women‟s background characteristics, households‟ socioeconomic status and access to health care services.

The strong influence of mothers‟ education on the utilization of health care services is consistent with findings from other studies. Mother‟s education may also act as a proxy variable of a number of background variables representing women‟s higher socioeconomic status, thus enabling her to seek proper medical care whenever she perceives it necessary. Research in developing countries has consistently shown maternal schooling to be strongly and positively associated with utilization of maternal healthcare services (Elo, 1992; Nigussie*et al*, 2004; Kamal, 2009; Munsur*et al*, 2010). The higher a women's level of education the more likely she is to utilize maternal healthcare services.

In addition, Kamal (2009) using regression model showed that husband‟s education is another factor which affects utilization of maternal health care services. Husband‟s education is found to have a significant positive association with maternity care service utilization. The pattern of service utilization by husband‟s education was found to be almost on par with what was observed for women‟s education. Although husband‟s

education appeared to be a significant factor where the seeking of assistance from skilled birth attendances is concerned, it was not as strong a factor as women‟s education. This is because the husband‟s education is strongly associated with the wife‟s education. Nevertheless, women whose husbands had at least secondary education were 50 % more likely to use the service compared to women whose husbands had no education. Husband‟s education level, like the seeking of assistance from skilled birth attendances, also appeared less pronounced as a factor influencing the use of medically-equipped places.

Women‟s decision making power plays a paramount role in determining health care needs of women. Since men are decision makers and in control of all the resources, they decide when and where women should seek health care. Thus, the low status of women prevents them from recognizing and voicing their concerns about health needs (WHO, 2000). In contrast, the study conducted by the Ethiopian Society of Population Studies (2008), household decision-making autonomy was found to be an unimportant predictor of women‟s health seeking behavior. Thus, though women‟s decision making might be expected to promote the use of antenatal care, empirical evidence from surveys is mixed.

Economic stability of households is also one of the well-recognized factors that can affect the utilization behavior of a woman. The poorest women in the poorest regions of the world have the lowest service coverage. A study in over 50 countries showed that on average more than 80% of births were attended for the richest women compared with only 34% of the poorest women (Gill *et al*, 2007). Most studies use approximations for the household living standard, because survey data do not include full information on household income and/or expenses. These approximate indicators differ by study and can

include the occupation of the pregnant women, her husband‟s education level and his occupation, the ownership of durable goods, and household amenities such as water source and toilet facility. Addai (2000) includes only the occupation of the pregnant woman in his analysis and finds no significant effect. Another study from Nepal using regression model showed that household economic status in particular was found to be an important factor associated with utilization of maternal health care services. This can be explained by the ability to pay for services by economically well off groups but the fact that there was a significant relationship after controlling for other factors like place of residence suggests that the richest groups differ from their poor counterparts by more than just dispensable income (Matsumura and Gubhaju**,** 2001). Becker *et al.* (1993) use several indicators to estimate logistic regression model but only find a significant association with the husband‟s education level and the ownership of a radio or television. They argue that both variables might not only indicate household living standard, but also the access to information and the capacity to use it beneficially. In contrast, Elo (1992)using logistic regression model finds positive and significant associations between antenatal care use and several living standard indicators including the husband‟s education level and his occupation, the use of piped water and ownership of several household durables.

McCaw-Binns *et al.* (1995) also using logistic regression model report positive associations between antenatal care use and the occupation of the woman and of the main wage earner in the household, and the level of weekly food expenses. Wong *et al.* (1987) is the only study with full information on household income and wealth, but reports only some small positive effects of household wealth and the income of other household

members on modern antenatal care use. The Ethiopian Society of Population Studies (2008) also showed that women in households with the lowest wealth index are less likely to seek maternal health care services than women in households with middle wealth quintile. The probability of seeking health care services is higher among women at the household with the highest wealth index.

Studies indicate that religion is negatively associated with the use of some maternal healthcare services but shows no significant difference for others. A study in Bangladesh (Kamal, 2009) found that utilization of skilled birth attendance was relatively higher among non-Muslim women than among Muslims, but failed to find a significant association for the use of antenatal care and institutional delivery. Similarly, a lower propensity for the use of skilled birth attendance and postnatal care was found among women in northern Nigeria, who are predominantly Muslim, compared to those in the southern part of the country who are mostly of the Christian faith. Muslim women are nearly one and a half times more likely to utilize antenatal care services. In contrast, women who followed a traditional belief system are less likely to use the service than any other religious group (Yaredand Asnaketch,2002). But, no significant difference was found in the use of antenatal care among different religious groups (Babalola and Fatusi, 2009). Study conducted by the Ethiopian Society of Population Studies (2008) also revealed similar results.

The place of residence is an important factor affecting maternal healthcare services utilization. A study done based on the 2000 Ethiopian DHS demonstrated that 27% of mothers who gave birth in the five years before the survey received ANC from health professional and further analysis showed that urban women showed higher use of ANC

than the rural counterparts, 83% of women in Addis to 22% women in the rural regions (Yaredand Asnaketch,2002). Proximity to a health facility has been found to affect the use of maternal healthcare services especially in rural areas (Rahaman et al, 1982 cited in Chakraborty et al, 2003) as these facilities are usually located at long distances. *A* systematic review which assessed the inequalities in maternal health service utilization using 30 papers from 23 countries including Ethiopia showed that pattern of use of the maternal health services was different among countries and even within countries. Urban and wealthy women were more likely to receive assistance of health professional than rural and poor women. The study also showed that wealthier women were likely to seek early ANC than poor women (Say and Raine, 2007). For many, lack of transportation and/or considerations of the cost of transportation serve as mitigating factors to healthcare seeking. For others, the low quality of services and anticipation of poor behavior from health staff may be the mitigating factor/s. In general rural women are less likely to give birth in health facility than their urban counterparts (Babalola and Fatusi, 2009).

Many factors interact in different ways to predict utilization of healthcare services. For example, utilization of ANC for women in the rural parts of both northern India and Kwazulu Natal, South Africa is inadequate. But while the reason for rural women in India is a lack of willingness to invite health workers into their homes, in Kwazulu Natal it is because women have little or no time left after completing their essential household responsibilities (Say and Raine, 2007). Similarly, study in Philippines reported urban and rural women differed significantly in the types of prenatal care most frequently used. For the urban women the most frequently used type of care tended to be modern public

(40.2%), while rural women frequently used traditional practitioners (45%). Overall, about 38% of the rural and 59% of the urban women had modern prenatal medical care (Wong et al., 1987). In another study conducted in Gondar, Northwest part of Ethiopia, to asses safe delivery service utilization among women of childbearing age 46% of the women attended ANC at least once in their pregnancy, the percentage of women living in urban area and receiving ANC was about three times higher than those mothers living in rural parts of the region. Only 14% of the mothers gave birth in health facilities out of this 2% of women living in the rural regions gave birth in health facilities (Mesfin and Getnet, 2004).

The importance of place of residence in determining women‟s use of maternal health care can be explained through the availability of health facilities. It is undeniable that generally, medical facilities are more ready accessible in urban than in rural areas. In addition, urban women tend to be more educated and therefore, have greater knowledge about the benefits of maternal health care.

Dependence on men for economic survival has been a principal barrier to women‟s control over their reproductive behavior in developing countries. Empowering women with more economic participation and control in their households and communities might be the key to their achieving control over their own reproductive health. It is generally assumed that women who are working and earning money will have better autonomy and the financial ability to pay for services. However, Miles-Doan and Brewster (1998) argue that this will also depend on the intrinsic characteristics of the job and not simply on its income-generating power.

As a result of the contextual differences in women's employment, studies have presented mixed results in the association between employment and maternal healthcare services utilization. Several studies have found a positive association between maternal healthcare services use and women's formal employment suggesting that the capacity to earn could contribute to maternal healthcare services utilization through empowerment. On the other hand, in some regions of the world, it has also been found that non-employed women are more likely to use some maternal healthcare services than earning women (Miles-Doan and Brewster, 1998; Kamal, 2009). Few studies also indicate that women engaged in low company occupations e.g. farming, are less likely to utilize maternal healthcare services (Addai, 2000). Similarly, Gill *et al.* (2007) showed that women‟s economic opportunity in providing for the family measured by their involvement in gainful or paid employment, type of occupation and status of work also affects their health and health seeking behavior. This might empower women and they will have increased control over income and on decision making concerning their health. As a result they will have increased health seeking behavior leading to improved maternal health.

Another important factor for maternal health care utilization is family size. It is argued that women from large families tend to underutilize various maternal health care services because of too many demands on their time. Larger families also cause resource constraints, which have a negative effect on health care utilization (Wong et al., 1987). Chakraborty et al. (2003) found a U-shaped relation between family size and the use of health services for treating any complications during pregnancy. Clearly family size (number of children) could be endogenous in a model for determinants of utilization of

maternal health services. In such a case, birth type (single birth or first of multiple birth) could be used as an instrument.

To summarize, this brief literature review has shown the importance of a range of characteristics in determining maternal health care behavior. In this study, maternal health care services are observed under three categories: antenatal care, assistance during delivery and postnatal care. Women education, educational status of husband, women‟s working status, women‟s age at birth, birth order, wealth index, region, sex of household head and religion are the independent variables, which are assumed to have positive or negative associations with the utilization of maternal health care services. The construction of analytical framework is adapted from Andersen (1995), Kroeger (1983) and Amooti-Kaguna and Nuwaha (2000). The literature review of the outcome and predictor variables are based on previous research particularly in developing countries.

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). It is the third survey conducted in Ethiopia as part of the worldwide Demographic and Health Surveys project. The 2011Ethiopia Demographic and Health Survey was designed to provide estimates for the health and demographic variables of interest for the following domains: Ethiopia as a whole; urban and rural areas (each as a separate domain); and 11 geographic administrative regions (9 regions and 2 city administrations), namely: Tigray, Affar, Amhara, Oromiya, Somali, Benishangul-Gumuz, Southern Nations, Nationalities and Peoples (SNNP), Gambela and Harari regional states and two city administrations, that is, Addis Ababa and Dire Dawa.

The principal objective of the 2011 EDHS is to provide current and reliable data on fertility and family planning behavior, child mortality, adult and maternal mortality, children‟s nutritional status, use of maternal and child health services, knowledge of HIV/AIDS, and prevalence of HIV/AIDS and anaemia.

The 2007 Population and Housing Census, conducted by the CSA, provided the sampling frame from which the 2011 EDHS sample was drawn. The 2011 EDHS sample was selected using a stratified, two-stage cluster design; enumeration areas (EAs) were the sampling units for the first stage. The sample included 624 EAs, 187 in urban areas and 437 in rural areas. Households comprised the second stage of sampling. A complete

listing of households was carried out in each of the 624 selected EAs from September 2010 through January 2011. A representative sample of 17,817 households was selected for the 2011 EDHS, of which 17,018 were covered during data collection. Of these, 16,702 were successfully interviewed, yielding a household response rate of 98 percent.

All women aged 15-49 and all men aged 15-59 were eligible for interview. The 2011 EDHS used three questionnaires: the Household Questionnaire, the Woman‟s Questionnaire, and the Man‟s Questionnaire. These questionnaires were adapted from model survey instruments developed for the MEASURE DHS project to reflect the population and health issues relevant to Ethiopia. In addition to English, the questionnaires were translated into three major local languages-Amharigna, Oromiffa, and Tigrigna.

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 percent. Similarly, a total of 15,908 eligible men were identified for interview; completed interviews were conducted for 14,110, yielding a response rate of 89 percent. In general, response rates were higher in rural areas than urban areas, for both women and men.

In EHDS, information and data on ANC use, delivery care, and postnatal care were collected from women who had at least one birth in the five years before the survey. This study is limited to rural women of the age group 15-49 years who had at least one birth in the five years preceding the survey the total number of women who had at least one birth in the five years was 6251.

3.2 Variables to be considered in the study

The variables which will serve for the estimation are defined in this section.

Response variables

In this study three response variables were created from questions included in the maternal health component of the EDHS questionnaire. The main focus is a number of specific questions asked of women about their most recent pregnancy and live birth in the five years preceding the survey. Women were asked 1) whether they were checked by a trained health professional, that is, doctor, nurse, or midwife, at least once during pregnancy, i.e., antenatal care (ANC); 2) whether they were attended by a trained health professional during their delivery, i.e., professionally assisted delivery (PAD); and 3) whether they received a medical checkup from a health professional within 42 days after delivery, i.e., postnatal care (PNC). In all these cases, the response variable is coded "1" if the woman obtained services either from health professionals or health institutions and "0" otherwise.

Predictor (explanatory) variables

The explanatory variables are classified into two groups: socioeconomic and demographic. The choice of these variables will be guided by the determinants of maternal health service utilization literature. Description for explanatory variables is given below.

NB: These categories of the independent variables given below were coded starting from zero to make it appropriate for identification and bivariate analysis only. For analysis using logistic regression methods we coded it as given in Appendix 1.

Table3.1 Description and categories of explanatory variables

No.	Variable	Explanation	Categories
1	Mother"s age at birth (X_1)	The age of the mother at the time of the most recent birth. Coding is done in three cohorts: 15-19 years, 20-34 years and 35-49 years; representing adolescents/teenagers, young adults and older women respectively.	0=15-19 1=20-34 2=35-49
2	Women"s educational level (X_2)	Educational status refers to the highest educational level the woman attained and it was categorized into two groups as no education, primary plus higher. In the survey the category primary, secondary and higher education were separate categories but for this study the three were merged because the numbers of rural women in the secondary and higher education group were very few.	0=no 1=primary and above education
3	Educational level of husband (X_3)	Similar to women educational status this was categorized into two groups as no education and primary and above.	0=no 1=primary and above education
4	Employment status (X_4)	In the survey this was defined as if the woman has been currently working in any field other than household work. This was classified as employed or non-employed	0= employed 1=non-employed
5	Religion (X_5)	Classification of this variable was developed according to previous literature as: Coptic orthodox, protestant, and Muslim and others like traditional religion.	0=Coptic Orthodox 1=Muslim 2=Protestant 3=others
6	Region (X_6)	This variable classified as: Tigray, Affar, Amhara, Oromiya, Somali, SNNP, Benishangul-Gumuz, Gambela, Harari, and Dire Dawa. In this study the region Addis Ababa is omitted since there is no recorded rural subject.	0=Tigray 1=Affar 2=Amhara 3=Oromiya 4=Somali 5=Benishangul-Gumuz 6=SNNP 7=Gambela 8=Harari 9=Dire Dawa
7	Birth order (X_7)	This refers to the rank of the child at birth. It has three categories as; 1, 2-4, and 5+.	0=1 1=2-4 2=5+
8	Wealth index (X_8)	This is a measure of the standard of living of the family the woman belongs to. It is based on characteristics related to the socio-economic status of a household e.g. ownership of	0=poor 1=middle 2=rich

		consumer goods, toilet facilities, type of drinking water source, etc. For this study, the wealth index is divided into three categories: 'poor', 'middle', and 'rich'.	
9	Sex of household head (X_9)	This is classified as male or female. Based on the answer from the usual residents of the households on who the head of the household is.	0=female 1=male

3.3 Method of Data Analysis

In this study both bivariate and multivariate analyses will be carried out for the three maternal health care variables. Bivariate statistics analysis will be used to observe a significant association between each of the three dependent variables and the social, economic, demographic factors. For the multivariate analysis, the response category was collapsed to create a dichotomous variable on the basis of whether or not the woman had received maternal health care. Since the interest is in identifying women at risk because they did not receive care, the outcome variables were coded as 1 if the women received antenatal care and as 0 if she did not receive antenatal care. The same coding procedure was applied for delivery and postnatal care. This study considers only those women who had at least one live birth in the five years preceding the survey. If women had more than one live birth in the past five years, only care received for the most recent live birth is considered.

3.4 The Logistic Regression Method

There are several multivariate analytical methods that can be used to examine the relationship between several predictor/explanatory variables and a response variable. Regression analysis is one of the most common multivariate statistical methodologies which is used to investigate relationships and predict outcomes. One type of regression analysis is known as logistic regression. Logistic regression is mainly appropriate when

the predicted outcome is binary. When the response variable has two categories, binary logistic regression is used. When the response variable has more than two categories, multinomial logistic regression is appropriate. When the response variable category is to be ranked, ordinal logistic regression is used. Logistic regression techniques resolve inconsistencies associated with dichotomous dependent data and the assumptions of ordinary sum of squares regression methods. The predictor variables that are used for outcome prediction may be dichotomous, categorical, continuous or mixed. Logistic regression is based on the logit transformation of the response variable. The logit transformation generates a continuous logarithmic curve from non-continuous data so that a regression model can be developed. The outcome probabilities for each response variable value are the basis for the model. The logit transformation is necessary since dichotomous response data violates ordinary least squares assumptions. Another issue with dichotomous data is that the error terms are not normally distributed, thus ordinary sum of squares regression and all normality tests are invalid.

Logistic regression is less restrictive than ordinary sum of squares regression. It does not require normally distributed dependent data or homogeneity of variance. Predictions made by ordinary sum of squares regression are based on the observed changes in the independent data itself. Logistic regression is based on the log of the odds of a particular event occurring with a given set of observations. The only assumptions of logistic regression are that the resulting logit transformation is linear, the response variable is dichotomous and that the resultant logarithmic curve doesn‟t include outliers. Discriminant analysis and logistic regression will produce similar results with dichotomous dependent data except discriminant analysis is more restrictive and

complex. Unlike discriminant analysis, logistic regression does not restrict the nature of the predictor variable. In contrast with discriminant analysis, logistic regression doesn‟t restrict categorical predictor variables. Discriminant analysis relies on strict adherence to normality assumption while logistic regression does not have this requirement. Thus, in instances where the predictor variables are a categorical, or a mix of continuous and categorical, logistic regression is preferred.

Logistic regression has two main uses. The first is the prediction of group membership. Since logistic regression calculates the probability or success over the probability of failure, the results of the analysis are in the form of an odds ratio. Logistic regression also provides knowledge of the relationships and strengths among the variables.

Because of the above and other reasons this study will employ the logistic regression analysis.

3.5 The Odds ratio

Logistic regressions work with odds so it is necessary to define both odds and odds ratio. The odds are simply the ratio of the probabilities for the two possible outcomes. If πis the probability that the event will occur, then 1 − πis the probability that the event will not occur:

$$\text{Odds} = \frac{\pi}{1-\pi}$$

In 2 × 2 tables, within row 1 the *odds* of success are odds1 = $\pi_1/(1-\pi_1)$, and within row 2 the odds of success equal odds$_2$= $\pi_2/(1-\pi_2)$. The ratio of the odds from the two rows,

$$\theta = \frac{odds_1}{odds_2} = \frac{\pi_1 (1-\pi_2)}{\pi_2 (1-\pi_1)}$$

is the *odds ratio*. Whereas the relative risk is a ratio of two probabilities, the odds ratio θ is a ratio of two odds.

3.6 The Logistic Regression Model

Logistic regression model is a generalized linear model with dichotomous response variable that is, the response variable can take the value 1 with a probability of success π, or the value 0 with probability of failure 1- π. This type of variable is called a Bernoulli variable. The explanatory or predictor variables can take any form. The relationship between the explanatory variables and the response variable is not a linear function in logistic regression, but rather a linear relationship exists between the logit of the explanatory variables and response variable. Given p explanatory variables denoted by the vector $X' = (X_1, X_2, \ldots, X_p)$ the conditional probability that the outcome is present be denoted by $P(Y = 1|X) = \pi$.

The model is:

$$P(Y = 1|X) = \pi(x) = \frac{e^{(\beta_0 + \beta_1 x_2 + \beta_2 x_2 + \cdots + \beta_p x_p)}}{1 + e^{(\beta_0 + \beta_1 x_2 + \beta_2 x_2 + \cdots + \beta_p x_p)}}$$

where β_0= the constant of the equation and, β_i= the coefficient of the i^{th} predictor variable.

An alternative form of the logistic regression equation is

$$\text{logit}[\pi(x)] = \ln\left[\frac{\pi(x)}{1-\pi(x)}\right] = \beta_0 + \beta_1 x_2 + \beta_2 x_2 + \cdots + \beta_p x_p$$

3.7 Method of estimating parameters

Maximum likelihood estimation, ML, is the most common method used to calculate the logit coefficients. This contrasts to the use of ordinary least squares (OLS) estimation of coefficients in regression. OLS seeks to minimize the sum of squared distances of the data points to the regression line. ML methods seek 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. Suppose (y_1, y_2,…,y_n) be the *n* independent random observations corresponding to the random variables (Y_1, Y_2,…,Y_n). Since the Y_i is a Bernoulli random variable, the probability function of Y_i is

$f_i(y_i) = \pi_i^{yi} (1-\pi_i)^{1-yi}$; $y_i = 0$ or 1; i = 1, 2, ..., *n*, since Y‟s are assumed to be independent, the joint probability function or likelihood function is given by:

$$L = L(\beta_o, \beta_1, ...\beta_p) = g(y_1, y_2, ..., y_n) = \prod_{i=1}^{n} \pi_i^{y_i} (1-\pi_i)^{1-y_i}$$

L is the likelihood function - for observed data it is a function of the parameters. The principle of maximum likelihood 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

$$LL = ln\, L(\beta_o, \beta_1, ...\beta_p) = \sum_{i=1}^{n} y_i (\beta_o + \beta_1 x_1 + ... + \beta_p x_p) - \sum_{i=1}^{n} \ln\{1 + \exp(\beta_o + \beta_1 x_1 + ... + \beta_p x_p)\}$$

To find the value of **β** that maximizes L(**β**) we differentiate L(**β**)with respect β_j, and set the resulting expressions equal to zero. The solution for the maximum likelihood estimates is obtained by a method called Newton Raphson iteration which is known as

Iteratively Reweighted Least Square (IRLS) algorithm. In brief, this iterative procedure for maximizing L (**β**) works with a linear approximation of the derivative of L (**β**) with respect to β_0, β_1, ..., β_p and an initial estimate of β_0, β_1, ..., β_p is obtained . From there an updated estimate of β_0, β_1, ..., β_p is obtained. Iteration continues until a convergence criterion is reached.

3.8 Deviance

In multiple linear regressions, the residual sum of squares provides the basis for tests for comparing mean functions. In logistic regression, the residual sum of squares is replaced by the *deviance (-2LL)*. The deviance is defined for logistic regression to be

$$Deviance = -2\ln(likelihood) = -2\text{LL} = 2\sum_{i=1}^{n}\left[y_i ln\left(\frac{y_i}{\hat{y}_i}\right) + (m_i - y_i) ln\left(\frac{m_i - y_i}{m_i - \hat{y}_i}\right)\right]$$

where, $\hat{y}_i = m_i\hat{\pi}(x_i)$is the fitted number of successes in $m_i$trials.

Deviance is useful to see whether additional explanatory variables improve the fit significantly or not. To do this we should for each model have the resulting deviance. The deviance difference from one fitted model to an extended model is approximately χ^2-distributed with df which equals the number of additional free regression parameters.

3.9 Assessment of the fitted model

After the model is fitted the next important step is checking the model adequacy. Assuming that we are preliminarily satisfied with the final model (model contains variables in their correct functional form) the objective will be to look at how closely model fitted responses approximate observed responses. There are several steps involved

in assessing the appropriateness, adequacy and usefulness of the model. First, the overall goodness of fit of the model is tested. Second, the importance of each of the explanatory variables is assessed by carrying out statistical tests of the significance of the coefficients. Then, the ability of the model to discriminate between the two groups defined by the response variable is evaluated. Additionally, detecting influential observations will follow, i.e. residual analysis and influential statistics.

3.9.1 Goodness of fit of the model

The goodness of fit or calibration of a model measures how well the model describes the response variable. Assessing goodness of fit involves investigating how close values predicted by the model are to the observed values.

The Hosmer–Lemeshow test

The Hosmer–Lemeshow test is a commonly used test for assessing the goodness of fit of a model and allows for any number of explanatory variables, which may be continuous or categorical. The test is similar to a χ^2goodness of fit test and has the advantage of partitioning the observations into groups of approximately equal size, and therefore there are less likely to be groups with very low observed and expected frequencies. The observations are grouped into g (mostly, g=10) based on the predicted probabilities. For either grouping strategy, the Hosmer-Lemeshow goodness-of-fit statistic, $\hat{C}$, is obtained by calculating the Pearson chi-square statistic from the $g \times 2$ table of observed and estimated expected frequencies.

A formula defining the calculation of $\hat{C}$ is as follows:

$$\hat{C}=\sum_{k=1}^{g}\frac{(o_k-n'_k\bar{\pi}_k)^2}{n'_k\bar{\pi}_k(1-\bar{\pi}_k)}$$

where, g denotes the number of groups, n'_k (=n/10) is the number of observations in the k^{th} group,c_k denotes the number of covariate patterns in the k^{th} decile, o_k is the number of responses among the c_k covariate patterns, and $\bar{\pi}_k$is the average estimated probability. The distribution of the statistic $\hat{C}$is well approximated by the chi-square distribution with *g - 2* degrees of freedom, χ^2 *(g-2)* (Hosmer and Lemeshow, 2000).

If p-value for the Hosmer-Lemeshow goodness of fit test is greater than 0.05, we will not reject the null hypothesis that there is no difference between observed and model predicted values, implying that the model estimates are adequate to fit the data at an acceptable level.

The likelihood ratio test

The likelihood ratio test, also called the log-likelihood test, is based on -2LL (deviance). The likelihood ratio test is a test of the significance of the difference between the likelihood ratio (-2LL) for the fitted model and the likelihood ratio for a reduced model. This difference is called "model chi-square". There are two main forms of the likelihood ratio test, one for the overall test and the other test of individual model parameters.

Test of the overall goodness of fit is used to assess the overall goodness fit of the model. The likelihood ratio test looks at the model chi-square (chi square difference) by subtracting deviance (-2LL) for the final (full) model from deviance for the intercept-only model. The degrees of freedom in this test equal the number of terms in the model minus 1 (for the constant). This is the same as the difference in the number of terms between the

two models, since the null model has only one term. Model chi-square measures the improvement in fit that the explanatory variables make compared to the null model. The likelihood ratio test is thus a test of the overall model. The overall test statistic for likelihood ratio test is given as:

$$Likelihood\ ratio\ test = G^2 = -2ln(L_{null}/L_k) = -2(LL_{null} - LL_k)$$

where, L_{null} is the likelihood of the null model and $L_k$is the likelihood of the model comprising k predictors.

Under the global null hypothesis, H_0: $\beta_1 = \beta_2 = ... = \beta p = 0$ the likelihood ratio test statistic, G^2, follows a chi-square distribution with p degrees of freedom (Hosmer and Lemeshow, 2000).

Test of individual model parameters: The likelihood ratio test assesses the overall logistic model but does not tell us if particular predictor variables are more important than others. This can be done, however, by comparing the difference in -2LL for the overall model with a nested model which drops one of the predictor variables. We can use the likelihood ratio test to drop one variable from the model to build a nested reduced model. In this situation, the likelihood ratio test tests if the logistic regression coefficient for the variable dropped can be treated as 0 or not, thereby justifying dropping the variable from the model. A non-significant likelihood ratio test indicates no difference between the full and the reduced models, hence justifying dropping the given variable so as to have a more parsimonious model that works just as well. Note that the likelihood ratio test of individual parameters is a better criterion than the alternative Wald test when considering which variables to drop from the logistic regression model (Agresti, 2007).

3.9.2 Test for individual predictors

To determine the significance of the predictor variables we can use either the Wald statistic or the likelihood ratio test (discussed above).

The Wald test

The Wald statistic is an alternative test which is commonly used to test the significance of individual logistic regression coefficients for each predictor variable (that is, to test the null hypothesis in logistic regression that a particular logit (effect) coefficient is zero).The Wald test approximates the likelihood ratio test, but with the advantage that it only requires estimating one model.

The Wald test statistic is:

$$W=\left(\hat{\beta}_j \Big/ s.e.(\hat{\beta}_j)\right)^2$$

The Wald statistic, W, under the null hypothesis is approximately chi-square distributed. Each Wald statistic is compared with a χ^2 distribution with 1 degree of freedom. Wald statistics are easy to calculate but their reliability is questionable, particularly for small samples. For data that produce large estimates of the coefficient, the standard error is often inflated, resulting in a lower value of the Wald statistic, and therefore the explanatory variable may be incorrectly assumed to be unimportant in the model. Likelihood ratio tests are generally considered to be superior (Agresti, 2007).

3.10 Logistic Regression Diagnostics

The next important step in logistic regression model building is to perform an analysis of residuals and diagnostics to study the influence of observations. To do this we need both leverage statistic and the residuals.

The hat matrix, H, is defined as a matrix which project the observed y to obtain the predicted and given as

$$H = V^{1/2}X(X'V\,X)^{-1}X'V^{1/2}$$

where V is the J×J diagonal matrix with elements $v_j = m_j\hat{\pi}_j(1-\hat{\pi}_j)$, X is the Jx(p+1) design matrix, and m_j is the total number of subjects with the same covariate pattern.

In linear regression the diagonal elements of the hat matrix are called the *leverage values* and are proportional to the distance from $x_j$to the mean of the data. This concept of distance to the mean is important in linear regression, as points that are far from the mean may have considerable influence on the values of the estimated parameters. The extension of the concept of leverage to logistic regression requires additional discussion and clarification.

Let the quantity $h_j$denote the j^{th} diagonal element of the matrix H defined before. It may be shown that

$$h_j = m_j\hat{\pi}(x_j)\left(1-\hat{\pi}(x_j)\right)\boldsymbol{x}_j'(\boldsymbol{X}'\boldsymbol{V}\boldsymbol{X})^{-1}\boldsymbol{x}_j = v_j \times b_j$$

where

$$b_j = \boldsymbol{x}_j'(\boldsymbol{X}'\boldsymbol{V}\boldsymbol{X})^{-1}\boldsymbol{x}_j$$

and $\boldsymbol{x}'_j = (1, x_{1j}, x_{2j}, \ldots, x_{pj})$ is the vector of covariate values defining the j^{th} covariate pattern. The sum of the diagonal elements of H is, $\sum h_j = (p + 1)$, the number of parameters in the model.

3.10.1 Residual Analysis

Residual analysis for logistic regression is complicated by the fact that the errors are not normally distributed. The deviance residuals do provide information about the fit of individual cases, or more to the point, the contribution of a case to the (overall) deviance. Residuals in OLS are defined as the difference between the observed value for Y_i and the predicted value for Y_i based on the model (i.e. $\hat{Y}_i$). Residuals in a logit model can be defined as the difference between Y_i (0 or 1) and the predicted probability for Y_i. To emphasize the fact that the fitted values in logistic regression are calculated for each covariate pattern and depend on the estimated probability for that covariate pattern, we denote the fitted value for the jth covariate pattern as $\hat{y}_j$ where

$$\hat{y}_j = m_j \hat{\pi}_j$$

where $\hat{\pi}_j$ is the estimated probability for j^{th} covariate.

We begin by considering two measures of the difference between the observed and the fitted values: the Pearson residual and the deviance residual. For a particular covariate pattern the Pearson residual is defined as

$$\text{Pearson residual} = r_j = \frac{y_j - m_j \hat{\pi}_j}{\sqrt{m_j \hat{\pi}_j (1 - \hat{\pi}_j)}}$$

The summary statistic based on these residuals is the Pearson chi-square statistic. Therefore Pearson chi-square statistics is defined as (Hosmer and Lemeshow, 2000)

$$\chi^2 = \sum_{j=1}^{J} r_j^2$$

The standardized residual divides ($y_{j\,-\,m_j\hat{\pi}_j}$) by its standard error, and given as

$$\text{Standardized residual} = rs_i = \frac{y_{j\,-\,m_j\hat{\pi}_j}}{\sqrt{m_j\hat{\pi}_j(1-\hat{\pi}_j)(1-h_j)}} = \frac{r_j}{\sqrt{(1-h_j)}}$$

The standardized residual equals $\frac{r_j}{\sqrt{(1-h_j)}}$, so it is larger in absolute value than the Pearson residual r_j. It isapproximately standard normal when the model holds. An absolute value of rs_i larger than roughly 2 or 3 provides evidence of lack of fit.

The deviance residual for the j^{th} covariate is defined as

$$Devaince\ residual = d_j = \pm\left\{2\left\{y_j\, ln\left(\frac{y_j}{m_j\hat{\pi}_j}\right) + (m_j - y_j) ln\left(\frac{m_j - y_j}{m_j(1-\hat{\pi}_j)}\right)\right\}\right\}^{1/2}$$

The summary statistic based on the deviance residuals is the deviance, and given as (Hosmer and Lemeshow, 2000)

$$D = \sum_{j=1}^{J} d_j^2$$

The distribution of the statistics $\chi^2$and *D* under the assumption that the fitted model have large sample is chi-square with degrees-of-freedom equal to J - (p +1).

3.10.2 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 Valueis a term used in connection with regression analysis and, in particular, in analyses aimed at identifying those observations which have a large effect on the outcome of fitting regression models. Leverage points are those observations, if any, made at outlying values of the predictor variables such that the lack of neighboring observations means that the fitted regression model will pass close to that particular observation. Leverages are obtained from the diagonal element of the hat matrix, H, which is given as

$$H = V^{1/2}X(X'V X)^{-1}X'V^{1/2}$$

Where h_j is the j^{th} diagonal element of the JxJ hat matrix H, and it is the leverage of observation *i.* Here, V is the JxJ diagonal matrix with elements $m_j\hat{\pi}_j(1-\hat{\pi}_j)$ and X is the Jx(p+1) design matrix.

The greater the value of h_j(i.e. $h_j>1$), the more potential that observation has for influencing the model fit. But, some caution must be used in interpreting these

values. Because of the weights employed, $\hat{\pi}_j(1-\hat{\pi}_j)$, cases with estimated probabilities near 0.5 can have larger leverage values, and those at the extremes, smaller leverage values. In other words influential cases on the other hand may have small leverage values when predicted probabilities are $\hat{\pi}_j<.1$ or $\hat{\pi}_j>.9$.

3.10.3 Influential statistics

Influential values are points that have exerted excessive influence on the regression coefficient estimates. Influential measures can be used to identify cases that are highly influential on the logistic regression estimates. An influential point affects the statistical significance as well as the strength and direction of the association between a response variable and predictor variables. The two common measures of the influence of an observation are Cook"s distance and DFBETAS.

Cook's Distance is a measure of the influence of an observation (available in both OLS and logistic regression). Cook"s distance D is proposed to measure the effect of excluding any specific observation on the set of parameter estimates. D is greater than 0, and may be arbitrarily large. Cook (1977) gives the value of D, d>1 identifies cases that might be influential.

Cook"s D_i statistic is defined as:

$$D_i = \frac{\left(\hat{\beta}_i - \hat{\beta}_{(i)}\right)' (X'VX) \left(\hat{\beta}_i - \hat{\beta}_{(i)}\right)}{ps^2}$$

Alternatively, D_i is obtained as

$$D_i = \frac{r_i^2}{p}\left(\frac{hi}{1-hi}\right)$$

Where r_i is the standardized residual and h_i is the i^{th} diagonal element of H computed from the full regression and p is the number of unknown parameters

DFBETAS: For each parameter estimate, a DFBETAS diagnostic is calculated for each observation. This is the standardized difference in the parameter estimate due to deleting the observation, and it can be used to assess the effect of an individual observation on each estimated parameter of the fitted model. These measures are useful for detecting observations that are causing instability in the selected coefficients. The influential observations for the individual regression coefficients are identified by DFBETASj(i), j = 0, 1, 2, . . . , p and calculated as

$$DFBETAS_{j(i)} = \frac{\hat{\beta}_j - \hat{\beta}_{j(i)}}{s_i\sqrt{c_{jj}}}$$

wherec_{jj} is the (j + 1)st diagonal element from $(X'VX)^{-1}$. DFBETASj(i) measures the change in $\hat{\beta}_j$ in multiples of its standard error. Values of DFBETASj(i) greater than 2 would certainly indicate a major, but very unlikely, impact from a single point. The cutoff point of $\frac{2}{\sqrt{n}}$ is suggested by Belsley *et al* (1980) as the point that will tend to highlight the same proportion of influential points across datasets.

3.11 Measure of classification accuracy

One measure of the adequacy of a binary logistic regression model is its ability to accurately predict a binary response, given the values of the terms (predictors) in the

model. This ability can be summarized in a classification table which tabulates the number of times the fitted model classifies the response correctly for each of the two response values and ROC curve which is obtained by plotting sensitivity against 1 – specificity. Since ROC curve is more informative than a classification table, in this study we will employ the ROC curve to summarize the predictive power of our model.

The ROC curve

Another measure of goodness-of-fit often used to evaluate the fit of a logistic regression model is based on the simultaneous measure of sensitivity (True positive) and specificity (True negative) for all possible cutoff points π_0. First, we calculate sensitivity and specificity pairs for each possible cutoff point and plot sensitivity on the y axis by (1-specificity) on the x axis. This curve is called the receiver operating characteristic (ROC) curve. An ROC curve is more informative than a classification table, because it summarizes predictive power for all possible π_0. When π_0 gets near 0, almost all predictions are $\hat{y}$= 1; then, sensitivity is near 1, specificity is near 0, and the point for (1 – specificity, sensitivity) has coordinates near (1, 1). When π_0 gets near 1, almost all predictions are $\hat{y}$= 0; then, sensitivity is near 0, specificity is near 1, and the point for (1 – specificity, sensitivity) has coordinates near (0, 0). The ROC curve usually has a concave shape connecting the points (0, 0) and (1, 1).The area under the ROC curve, which ranges from zero to one, provides a measure of the model's ability to discriminatebetween those subjects who experience the outcome of interest versus those who do not.

Hosmer and Lemeshow provide general rules for interpreting area under ROC curve values. Paraphrasing their rules gives the general guidelines below:

ROC=0.5	No discrimination
0.7≤ROC<0.8	Acceptable discrimination
0.8≤ROC<0.9	Excellent discrimination
ROC≥0.9	Outstanding discrimination (but extremely rare)

CHAPTER FOUR

STATISTICAL DATA ANALYSIS AND DISCUSSION

4.1 Introduction and descriptive statistics

4.1.1 Introduction

The purpose of this chapter is to analyze the effect of different socio-economic and demographic determinants of maternal healthcare utilization of mothers in rural Ethiopia using the data from the 2011 Ethiopian Demographic and Health Survey (EDHS).

The response variables considered in this study are binary assuming two outcomes (0 = not using, 1 = using healthcare), which are indicators of maternal healthcare utilization status of mothers in rural Ethiopia. Descriptive, bivariate and binary logistic regression analyses are used to measure the effects of the determinants of maternity care utilization. The descriptive part provides percentages of maternal healthcare utilization status of mothers. The bivariate analysis is used to see the association between the outcome variables (utilization of ANC, delivery care, and PNC) and other predictor variables. The binary logistic analysis is employed to assess the determinants of maternal healthcare utilization and to predict the odds of maternal healthcare utilization in rural Ethiopia. The data are analyzed using the Statistical Package for Social Sciences (SPSS) version 20.

4.1.2 Summary of descriptive statistics

4.1.2.1 Summary of descriptive statistics of antenatal and delivery care

Table 4.1 shows the percentage distribution of mothers who had a live birth in the five years preceding the survey by utilization of antenatal and delivery care for the most

recent birth. Examination of differentials and determinants of antenatal and delivery care in Table 4.3 shows that most of the background variables are related with antenatal and delivery care. However, there are significant variations within the variable. Utilization of ANC services is found to be lower for older mothers (25.1%) than young mothers (28.4 %) and adolescent mothers (32 %). It was also observed that utilization of delivery care services is 3.5% for older mothers, 6.1% for young mothers and 9% for adolescent mothers. The proportion of mothers using ANC and delivery care for the first birth is relatively higher (36.8%) and (14.2%) than subsequent birth orders 28.9% and 5.3% for birth order two to four, and 24.3% and 3.4 % for five and higher birth order, respectively.

There are marked regional variations in ANC and delivery care coverage, the proportion of mothers receiving ANC services from a health professional is higher for Tigray, Gambela, Harari and Benishangul-Gumuz regions (42.8%, 36.7%, 37.5%, and 29.5%, respectively). In the remaining regions, Dire Dawa (28.2%), Amhara (27.3%), and Oromiya (25.8%), SNNP (23.4%), Affar (19.9%) and Somali (15.8%) mothers use ANC services from health professionals. The proportion of mothers receiving delivery care from health professionals for Gambela, Harari, Dire Dawa and Tigray are 12.5%, 9.2%, 8.3%, and 6.5%, respectively. In the remaining regions, namely Benishangul-Gumuz (5.8%), Amhara and Oromiya (5.7%), SNNP and Somali (4.5%), and Affar (1.1%) mothers get delivery care services from health professionals.

As compared to followers of the Coptic Orthodox religion who use the services (ANC 34.5 % and delivery care 7.9 %), Protestant mothers are less to use ANC (27.5 %) and delivery care (6.5 %) services. On the other hand, Muslim mothers tend to occupy an

intermediate position in using ANC (24.7 %) and delivery care (4.5 %) services and other religion follower mother take the least position in utilization of ANC (19.9%) and delivery care (3.3%) services.

Antenatal and delivery care services coverage is also associated with sex of household head and wealth. Mother‟s with male household head use ANC (27.7%) and delivery care (5.5%) services less than mother‟s with female household head 30.4% and 8.1%, respectively. Mother‟s with the lowest wealth index are less to see medical professionals for their most recent birth than mothers in higher wealth index. Mothers whose household wealth index is poor use ANC (21.4%) and delivery care (3.8%) services. Middle wealth index mothers use ANC (30.5%) and delivery care (4.7%) services and 42.6% and 12%, respectively, for mothers with rich wealth index.

The data show that 42.6% and 12.5% of mothers with primary or higher educational category use ANC and delivery care services, respectively. The comparable percentages for mothers with no formal education are 23.3% and 3.7%, respectively. In addition mothers whose husband‟s had primary or higher educational status use ANC (35.5%) and delivery care (9%) services. Mother‟s whose husband had no formal education use ANC (22.9%) and delivery care (3.7%). With regard to employment status, employed mothers were more likely to use ANC and delivery care (34.1% and 8.5%, respectively) services than mothers who are not employed use ANC (25.8%) and delivery care (4.9%).

4.1.2.2 Summary of descriptive statistics of postnatal Care

Adequate utilization of postnatal care can help to reduce mortality and morbidity among mothers and their babies. Postnatal care is important for mothers for treatment of

complications arising from delivery, especially for births that occurred at home. For non-institutional births particularly, postnatal care enables detection of complications that may threaten the survival of the mother. In rural Ethiopia, where the largest proportions of births take place at home, postnatal care by health professionals is extremely low and uncommon. In Table 4.4 the bivariate analysis for postnatal care and predictor variables presented and shows that all of the predictor variables have association with utilization of PNC services. In Table 4.2 the percentage distribution of mothers who had a live birth in the five years preceding the survey by utilization of PNC for the most recent birth given and the description is presented below.

As is the case in antenatal and delivery care services, there existed marked variation in utilization of postnatal care services as a function of women‟s background characteristics. The data show that 12.1% of the younger mothers, 9.5% of the adult mothers and 6.7% of the older mothers used postnatal care services; most of the time they use the services for the first birth than other higher birth orders (see Table 4.2).

Other characteristics which associated with utilization of postnatal care are work status of mothers and husband‟s educational level. About 11% and 8.6% of employed mothers and unemployed mothers, respectively, used postnatal care services. In addition, mothers whose husband had primary or above education (12.3%) utilize postnatal health care than mothers whose husband had no formal education (7%).

Postnatal care coverage is also associated with mother‟s education, wealth, sex of household head and religion. Mothers with primary or above education are more than

those with no education (15% and 7.4%, respectively), to receive postnatal care from health professionals. The proportion of mothers who get no postnatal care declines steadily as their educational level increases. Mothers with the lowest (6.8%) wealth index are less to see medical professionals to take postnatal checkups for their most recent birth than mothers in middle (8.4 %) and higher (16.1%) wealth index. Religion is also found to be a significant indicator of postnatal care services in rural Ethiopia. Coptic-orthodox (12.3%) religion follower mothers see health professionals for postnatal care than Protestant (8.8%), Muslim (7.8%) and others (3.4%) religion follower mothers. In addition, mothers with female household head (12.1%) use postnatal care than mothers with male household head (8.6%).

Postnatal care service utilization is substantially higher among mothers who live in Harari (19.3 %), Gambela (13.8 %), Tigray (13.7%), Dire Dawa (10.1 %) and Benishangul-Gumuz (9.69%). On the other hand, mothers who live in Amhara (8.4%), Oromiya (7.6%), Afar (6.9%), SNNP (6.4%), and Somali (4.5%) regions use postnatal care very low.

4.2 Bivariate Statistical Analysis

The bivariate statistical analysis addresses the marginal effect of a predictor variable on the response without taking into account other predictors. And it shows the association between the outcome variable and other predictor variables, obtained by cross tabulation of the response variables, maternal healthcare (i.e. ANC, delivery care and PNC) usage to the other predictor variables independently. Bivariate

chi-square analysis is done for 9 variables and all of them are statistically significant at 10% (since, $p<0.1$)significance level for all the three maternal health care‟s.

The chi-square test shows utilization of maternal healthcare have a relationship with different predictor variables, according to the result presented in Table 4.3 and 4.4 the three maternal health care‟s (i.e. ANC, delivery care and PNC) utilization have association with region, sex of household head, mother‟s education, religion, husband education, mothers age at birth, birth order, employment status of mothers and wealth index.

4.3 Binary logistic regression analysis

In the previous section, a bivariate analysis was conducted to examine the relationship of each of the selected predictor variables with variables representing maternal health care utilization in rural Ethiopia. It was found that there is a significant association between some of predictor variables and maternal health care use in rural Ethiopia. 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. The regression analysis method adopted in the present study is binary logistic regression, which would allow the identification of the effect of each of the selected predictor variables on maternal healthcare utilization controlling for the effects of other predictor variables.

This chapter aims to investigate on how the differentials in the utilization of maternal healthcare when its relationships with the predictor variable adjusted for the simultaneous effects of the different characteristics of the women, their husbands and their household related variables. Given the interest in the dichotomous use of modern maternal healthcare utilization, namely whether a woman utilized maternal health care or not, a dichotomous logistic regression was employed to determine which factors best explain and predict the outcome of the use of a maternal healthcare utilization during pregnancy, delivery and after delivery.

4.3.1 Binary logistic regression analysis of ANC

Table 4.7 Case Processing Summary of ANC and delivery care

Unweighted Cases(a)		N	Percent
Selected Cases	Included in Analysis	6154	100.0
	Missing Cases	0	.0
	Total	6154	100.0
Unselected Cases		0	.0
Total		6154	100.0

a. If weight is in effect, see classification table for the total number of cases.

Table 4.8 Dependent Variables Encoding

Response variables	Original Value	Internal Value
Antenatal care	Non using Using	0 1
Delivery care		
Postnatal care		

Block 0: Beginning Block

Variables in the Equation

		$\hat{\beta}$	S.E.($\hat{\beta}$)	Wald	df	Sig.	Exp($\hat{\beta}$)
Step 0	Constant	-.935	.028	1088.935	1	.000	.393

In the model equation we see that the intercept-only model or null model is ln(odds) = -0.935. If we exponentiate both sides of this equation we find that our predicted odds [Exp($\hat{\beta}$)] = 0.392. That is, the predicted odd of using ANC is 0.392.

Block 1: Method = Enter

Table 4.9 Omnibus Tests of Model Coefficients for ANC

		Chi-square	df	Sig.
	Step	564.654	22	.000
Step 1	Block	564.654	22	.000
	Model	564.654	22	.000

Consider the model which includes all predictors. Omnibus Tests of Model Coefficients gives us a Chi-Square of 564.654which is significant at 0.05. This is a test of the null hypothesis that adding the predictors to the model has not significantly increased our ability to predict mother‟s utilization of ANC. Since our omnibus test is significant we can conclude that adding the predictors to the model has significantly increased our ability to predict mother‟s utilization of ANC.

Table 4.10 Hosmer and Lemeshow testfor ANC

Hosmer and Lemeshow Test

Step	Chi-square	df	Sig.
1	11.487	8	.176

Contingency Table for Hosmer and Lemeshow Test

		ANC= 0		ANC = 1		Total
		Observed	Expected	Observed	Expected	
Step 1	1	554	545.479	61	69.521	615
	2	535	524.039	83	93.961	618
	3	520	512.548	99	106.452	619
	4	467	490.468	148	124.532	615
	5	452	457.495	144	138.505	596
	6	440	449.592	174	164.408	614
	7	437	425.785	179	190.215	616
	8	385	392.525	230	222.475	615
	9	353	350.205	262	264.795	615
	10	276	270.865	355	360.135	631

Hosmer-Lemeshow test is used to assess the overall goodness of fit of the fitted model. The Hosmer-Lemeshow test is performed by dividing the predicted probabilities into deciles (10 groups based on percentile ranks) and then computing a Pearson chi-square that compares the predicted to the observed frequencies (in a 10×2 table). An insignificant chi-square indicates a good fit to the data and, therefore, good overall model fit. Since the p-value is 0.176 (>0.05) which is insignificant therefore our fitted logistic regression model is good fit.

Table 4.11 Measure of classification accuracy for ANC

Area Under the Curve

Test Result Variable(s): Predicted probability

Area	Std. Error[a]	Asymptotic Sig.[b]	Asymptotic 95% Confidence Interval	
			Lower Bound	Upper Bound
.772	.013	.000	.747	.798

a. Under the nonparametric assumption

b. Null hypothesis: true area = 0.5

The area under the ROC curve, which ranges from zero to one, provides a measure of the model's ability to discriminate between those subjects who experience the outcome of interest versus those who do not. The area under the ROC, 0.772, lies between 0.7 and 0.8, and statistically significant, the classification is acceptable. Therefore the fitted model is adequate.

4.12 Variables in the Equation for ANC usage

		$\hat{\beta}$	S.E. ($\hat{\beta}$)	Wald	df	Sig.	Exp($\hat{\beta}$)	95% C.I.for EXP($\hat{\beta}$)	
								Lower	Upper
Step 1[a]	sexhhh(1)	.151	.080	3.610	1	.057	1.163	.995	1.360
	husedu.(1)	-.305	.067	20.497	1	.000	.737	.646	.841
	birthorder			12.198	2	.002			
	birthorder(1)	.383	.110	12.142	1	.000	1.466	1.182	1.818
	birthorder(2)	.117	.075	2.392	1	.122	1.124	.969	1.302
	wealth			120.440	2	.000			
	wealth(1)	-.818	.075	118.411	1	.000	.441	.381	.512
	wealth(2)	-.389	.087	20.117	1	.000	.678	.572	.803
	religion			4.623	3	.202			
	religion(1)	.383	.204	3.528	1	.060	1.466	.983	2.187
	religion(2)	.184	.191	.926	1	.336	1.202	.827	1.747
	religion(3)	.312	.201	2.413	1	.120	1.366	.922	2.026
	mothedu.(1)	-.596	.073	67.505	1	.000	.551	.478	.635
	mothage			6.934	2	.035			
	mothage(1)	-.285	.141	4.079	1	.043	.752	.571	.992
	mothage(2)	-.028	.090	.099	1	.753	.972	.815	1.159
	moth.work (1)	-.327	.066	24.300	1	.000	.721	.633	.821
	region			93.525	9	.000			
	region (1)	.525	.196	7.157	1	.007	1.691	1.151	2.484
	region (2)	-.088	.184	.230	1	.632	.915	.638	1.314
	region (3)	-.076	.190	.163	1	.687	.926	.639	1.344
	region (4)	-.409	.172	5.621	1	.018	.664	.474	.932
	region (5)	-.582	.205	8.026	1	.005	.559	.374	.836
	region (6)	-.075	.179	.178	1	.673	.927	.653	1.317
	region (7)	-.465	.190	5.969	1	.015	.628	.433	.912
	region (8)	.200	.204	.962	1	.327	1.221	.819	1.820
	region(9)	-.045	.201	.049	1	.825	.956	.644	1.419
	Constant	.117	.274	.182	1	.670	1.124		

a. Variable(s) entered on step 1: sexhhh, husedu.,birthorder, wealth, religion, mothedu., mothage, moth.work, region.

4.3.2 Binary logistic regression analysis of delivery care

Block 0: Beginning Block

Variables in the Equation

		$\hat{\beta}$	S.E.($\hat{\beta}$)	Wald	df	Sig.	Exp($\hat{\beta}$)
Step 0	Constant	-2.767	.054	2621.544	1	.000	.063

In the model equation we see that the intercept-only model or null model is ln(odds) = -2.767. If we exponentiate both sides of this equation we find that our predicted odds [Exp($\hat{\beta}$)] = 0.063. That is, the predicted odd of using delivery care is 0.063.

Block 1: Method = Enter

Table 4.13 Omnibus Tests of Model Coefficients for delivery care

		Chi-square	df	Sig.
Step 1	Step	384.602	22	.000
	Block	384.602	22	.000
	Model	384.602	22	.000

Consider the model which includes all predictors. Omnibus Tests of Model Coefficients gives us a Chi-Square of 384.602which is significant at 0.05. This is a test of the null hypothesis that adding the predictors to the model has not significantly increased our ability to predict mother‟s utilization of delivery care. Since our omnibus test is significant we can conclude that adding the predictors to the model has significantly increased our ability to predict mother‟s utilization of delivery care.

Table 4.14 Hosmer and Lemeshow test for delivery care

Hosmer and Lemeshow Test

Step	Chi-square	df	Sig.
1	9.094	8	.334

Contingency Table for Hosmer and Lemeshow Test

		DC = 0		DC = 1		Total
		Observed	Expected	Observed	Expected	
Step 1	1	608	608.447	5	4.553	613
	2	629	629.904	10	9.096	639
	3	603	603.755	13	12.245	616
	4	621	627.688	23	16.312	644
	5	597	598.730	21	19.270	618
	6	596	589.597	18	24.403	614
	7	591	583.163	24	31.837	615
	8	573	568.736	40	44.264	613
	9	539	548.991	77	67.009	616
	10	433	430.989	133	135.011	566

Hosmer and Lemeshow test also a goodness of fit test of the null hypothesis that the model adequately fits the data, since the value of the Hosmer-Lemeshow goodness-of-fit test statistic significance value is greater than 0.05 (i.e. 0.334>0.05), we fail to reject the null hypothesis that there is no difference between observed data and model-predicted values, 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.

Table 4.15 Measure of classification accuracy for delivery care

Area Under the Curve

Test Result Variable(s): Predicted probability

Area	Std. Error[a]	Asymptotic Sig.[b]	Asymptotic 95% Confidence Interval	
			Lower Bound	Upper Bound
.706	.007	.000	.692	.719

a. Under the nonparametric assumption

b. Null hypothesis: true area = 0.5

The area under the ROC curve, which ranges from zero to one, provides a measure of the model's ability to discriminate between those subjects who experience the outcome of interest versus those who do not. The area under the ROC, 0.706, lies between 0.7 and 0.8, and statistically significant, the classification is acceptable. Therefore the fitted model is adequate

Table 4.16 Variables in the Equation for delivery care

		$\hat{\beta}$	S.E. ($\hat{\beta}$)	Wald	df	Sig.	Exp($\hat{\beta}$)	95% C.I.for EXP($\hat{\beta}$)	
								Lower	Upper
Step 1[a]	sexhhh(1)	.437	.139	9.821	1	.002	1.548	1.178	2.034
	husedu.(1)	-.341	.132	6.676	1	.010	.711	.549	.921
	birthorder			68.369	2	.000			
	birthorder(1)	1.379	.189	53.384	1	.000	3.970	2.743	5.747
	birthorder(2)	.273	.162	2.846	1	.092	1.314	.957	1.806
	wealth			43.092	2	.000			
	wealth(1)	-.826	.135	37.570	1	.000	.438	.336	.570
	wealth(2)	-.757	.168	20.371	1	.000	.469	.338	.652
	religion			19.234	3	.000			
	religion(1)	1.004	.424	5.594	1	.018	2.729	1.188	6.271
	religion(2)	.388	.412	.886	1	.346	1.474	.657	3.309
	religion(3)	.261	.434	.361	1	.548	1.298	.554	3.041
	mothedu.(1)	-.703	.130	29.322	1	.000	.495	.384	.638
	mothage			8.968	2	.011			
	mothage(1)	-.512	.257	3.968	1	.046	.599	.355	1.011
	mothage(2)	.022	.201	.012	1	.913	1.022	.689	1.517
	moth.work (1)	-.401	.120	11.215	1	.001	.670	.530	.847
	region			51.756	9	.000			
	region (1)	-1.323	.351	14.206	1	.000	.266	.134	.530
	region (2)	-1.910	.461	17.173	1	.000	.148	.060	.365
	region (3)	-1.149	.340	11.437	1	.001	.317	.163	.617
	region (4)	-1.110	.304	13.336	1	.000	.330	.182	.598
	region (5)	-.506	.348	2.112	1	.146	.603	.305	1.193
	region (6)	-.919	.318	8.365	1	.004	.399	.214	.744
	region (7)	-1.311	.339	14.920	1	.000	.270	.139	.524
	region (8)	-.339	.340	.998	1	.318	.712	.366	1.386
	region (9)	-.430	.334	1.653	1	.199	.651	.338	1.253
	Constant	-1.432	.539	7.060	1	.008	.239		

a. Variable(s) entered on step 1: sexhhh, husedu.,birthorder, wealth, religion, mothedu., mothage, moth.work, region.

4.3.3 Binary logistic regression analysis of PNC

Table 4.17 Case Processing Summary for PNC

UnweightedCases[a]		N	Percent
Selected Cases	Included in Analysis	5957	100.0
	Missing Cases	0	.0
	Total	5957	100.0
Unselected Cases		0	.0
Total		5957	100.0

a. If weight is in effect, see classification table for the total number of cases.

Block 0: Beginning Block

Variables in the Equation

		$\hat{\beta}$	S.E.($\hat{\beta}$)	Wald	df	Sig.	Exp($\hat{\beta}$)
Step 0	Constant	-2.284	.045	2607.435	1	.000	.102

In the model equation we see that the intercept-only model or null model is ln(odds) = -2.284. If we exponentiate both sides of this equation we find that our predicted odds [Exp($\hat{\beta}$)] = 0.102. That is, the predicted odd of using PNC is 0.102.

Block 1: Method = Enter

Table 4.18 Omnibus Tests of Model Coefficients for PNC

		Chi-square	df	Sig.
Step 1	Step	278.640	22	.000
	Block	278.640	22	.000
	Model	278.640	22	.000

Consider the model which includes all predictors. Omnibus Tests of Model Coefficients gives us a Chi-Square of 278.640which is significant at 0.05. This is a test of the null

hypothesis that adding the predictors to the model has not significantly increased our ability to predict utilization of PNC. Since our omnibus test is significant we can conclude that adding the predictors to the model has significantly increased our ability to predict utilization of PNC.

Table 4.19 Hosmer and Lemeshow test for PNC

Hosmer and Lemeshow Test

Step	Chi-square	df	Sig.
1	8.987	8	.343

Contingency Table for Hosmer and Lemeshow Test

		PNC = 0		PNC = 1		Total
		Observed	Expected	Observed	Expected	
Step 1	1	583	579.721	12	15.279	595
	2	569	572.355	26	22.645	595
	3	573	573.287	29	28.713	602
	4	550	563.106	47	33.894	597
	5	570	562.893	33	40.107	603
	6	552	553.470	48	46.530	600
	7	548	541.090	49	55.910	597
	8	527	527.367	69	68.633	596
	9	506	504.520	90	91.480	596
	10	428	428.190	148	147.810	576

Hosmer and Lemeshow test also a goodness of fit test of the null hypothesis that the model adequately fits the data, since the Hosmer-Lemeshow goodness-of-fit test statistic significance value is greater than 0.05 (i.e. 0.343>0.05), we fail to reject the null hypothesis that there is no difference between observed data and model-predicted values, 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.

Table 4.20 Measure of classification accuracy for PNC

Area Under the ROC Curve

Test Result Variable(s): Predicted probability

Area	Std. Error[a]	Asymptotic Sig.[b]	Asymptotic 95% Confidence Interval	
			Lower Bound	Upper Bound
.713	.010	.000	.693	.733

a. Under the nonparametric assumption

b. Null hypothesis: true area = 0.5

The area under the ROC curve, which ranges from zero to one, provides a measure of the model's ability to discriminate between those subjects who experience the outcome of interest versus those who do not. The area under the ROC, 0.713, lies between 0.7 and 0.8, and statistically significant, the classification is acceptable. Therefore the fitted model is adequate.

Table 4.21 Variables in the Equation for PNC

		$\hat{\beta}$	S.E. ($\hat{\beta}$)	Wald	df	Sig.	Exp($\hat{\beta}$)	95% C.I.for EXP($\hat{\beta}$)	
								Lower	Upper
Step 1[a]	sexhhh(1)	.425	.115	13.564	1	.000	1.530	1.220	1.919
	husedu.(1)	-.280	.105	7.099	1	.008	.756	.615	.929
	birthorder			24.977	2	.000			
	birthorder(1)	.608	.159	14.664	1	.000	1.836	1.345	2.505
	birthorder(2)	-.082	.119	.472	1	.492	.921	.730	1.164
	wealth			44.015	2	.000			
	wealth(1)	-.732	.113	42.249	1	.000	.481	.386	.600
	wealth(2)	-.547	.135	16.483	1	.000	.579	.444	.754
	religion			22.862	3	.000			
	religion(1)	1.283	.413	9.622	1	.002	3.606	1.603	8.108
	religion(2)	.817	.283	8.334	1	.004	2.263	1.029	4.977
	religion(3)	.603	.417	2.098	1	.147	1.828	.808	4.137
	mothedu.(1)	-.418	.110	14.460	1	.000	.659	.531	.817
	mothage			6.672	2	.034			
	mothage(1)	-.137	.065	4.394	1	.039	.872	.568	1.337
	mothage(2)	.215	.148	2.099	1	.147	1.240	.927	1.658
	moth.work(1)	-.161	.059	7.446	1	.006	.852	.698	1.039
	region			57.620	9	.000			
	region (1)	-.487	.300	2.634	1	.105	.614	.341	1.106
	region (2)	-.305	.284	1.153	1	.283	.737	.423	1.286
	region (3)	-.807	.298	7.311	1	.007	.446	.249	.801
	region (4)	-.825	.271	9.288	1	.002	.438	.258	.745
	region (5)	-.835	.338	6.107	1	.013	.434	.224	.841
	region (6)	-.420	.276	2.312	1	.128	.657	.382	1.129
	region (7)	-1.035	.302	11.767	1	.001	.355	.197	.642
	region (8)	-.221	.309	.512	1	.474	.801	.437	1.470
	region (9)	.364	.121	9.049	1	.003	1.439	.829	2.498
	Constant	-1.885	.505	13.943	1	.000	.152		

a. Variable(s) entered on step 1: sexhhh, husedu.,birthorder, wealth, religion, mothedu., mothage, moth.work, region.

4.4 Logistic regression diagnostics results

After model fitting, the next important step in logistic regression model building is to perform an analysis of residuals and diagnostics to study the influence of observations and taking appropriate remedial measure. A failure to detect outliers and hence influential cases can have severe distortion on the validity of the inferences drawn from the model. It would be reasonable to use diagnostics to check if the model is adequate or not. The main focus here will be to detect outliers and influential cases that have a substantial impact on the fitted logistic regression model through appropriate graphical methods.

The diagnostic test results for detection of outliers and influential cases are included in the Appendix 4 and 6. A check of the standardized residuals for the three maternal healthcare services (i.e. ANC, delivery care and PNC) presented in Appendix 6A, 6B and 6C reveals that all have values less than absolute value of 3 indicating the absence of outliers in the model implying the models are adequate. Another method of detecting outliers is leverage value. The greater the value of leverage h_j(i.e. h_j>1), the more potential that observation has for influencing the model fit. From the three scatter plots of leverage values for the three maternal healthcare services models, the leverage values are less than one indicating the absence of outlying observation.

In addition, Cook‟s distance is proposed to measure the effect of excluding any specific observation on the set of parameter estimates. Cook (1977) gives the value of D, d>1 identifies cases that might be influential. Since there are no large values of Cook‟s distance (D_i<1), means that there are no influential cases having an effect on the model. Finally, from the result presented in Table 4.5 and 4.6, there are no high values of

DFBETAS (all values less than 0.025) which means that there are no influential observations for the individual regression coefficients. Thus, from the above goodness of fit tests and diagnostic checking, we can say that all the three of our models are adequate.

4.5 Interpretation and Discussion of the results

4.5.1 Interpretations

The estimated coefficients $\hat{\beta}_j$ of the explanatory variables in the logistic regression model can be interpreted as logarithms of the ratio of odds of the maternal healthcare utilization to the reference group. This means that estimates of this odds ratio ($\widehat{OR}$), and corresponding confidence intervals, can easily be found from the fitted model. The interpretation of different estimates corresponding to different variables which are found significant in the fitted model is described in the following section.

4.5.1.1 Interpretations for ANC

In Table 4.12 above the multivariate logistic regression result is shown. This analysis shows the effect of each variable on the status of use of ANC services. The results show that the sex of household head and religion are not significant indicators of use of ANC services.

For women whose husband‟s had no formal education the odds of use of ANC could be about 26% lower when compared to those with husbands who had primary or above education ($\widehat{OR}$ 0.737, 95% CI: 0.646-0.841) controlling for all the other variables in the model.

Lower birth orders have the highest ANC utilization. At their first birth mothers are about 47% more likely to use ANC compared to the reference group at their fifth birth and more ($\widehat{OR}$ 1.466, 95% CI: 1.182-1.818) controlling for all the other variables in the model.

The estimated odds ratio for mothers whose household wealth index is poor and middle compared to those mothers whose wealth index is rich are 0.441 ($\widehat{OR}$ 0.441, 95% CI: 0.381-0.512) and 0.678 ($\widehat{OR}$ 0.678, 95% CI: 0.572-0.803), respectively. This means that the utilization of ANC by mothers whose wealth index is poor and middle is about 56% and 32% lower, respectively, than mothers whose wealth index is rich (reference group) controlling for all the other variables in the model.

The odds of using ANC service was about 45% lower when mothers have no education as compared to mothers with primary or above education ($\widehat{OR}$ 0.551, 95% CI: 0.478-0.635) controlling for all the other variables in the model.

The odds of using ANC service was about 25% lower when mothers age at birth is 15 to 19 as compared to those mothers whose age at birth is 35 to 49 ($\widehat{OR}$ 0.752, 95% CI: 0.571-0.992) controlling for all the other variables in the model.

The estimated odds ratio of ANC utilization for mothers not employed compared to those who are employed is 0.721 ($\widehat{OR}$ 0.721, 95% CI: 0.633-0.821). Utilization of ANC by mothers who are not employed is lower by around 28% relative to those mothers who are employed controlling for all the other variables in the model.

The reference category for region where mothers live is Dire Dawa. The estimated odds ratio for the mothers who live in Oromiya, Somali, and SNNP is 0.664 ($\widehat{OR}$ 0.664, 95% CI: 0.474-0.932), 0.559 ($\widehat{OR}$ 0.559, 95% CI: 0.374-0.836), and 0.628 ($\widehat{OR}$ 0.628, 95% CI: 0.433-0.921), respectively. This implies that utilization of ANC for mothers who live in Oromiya, Somali, and SNNP is lower by about 34%, 44%, and 37%, respectively than mothers who live in Dire Dawa. In contrast the estimated odds ratio of ANC utilization for mothers who live in Tigray compared those mothers who live Dire Dawa is 1.691($\widehat{OR}$ 1.691, 95% CI: 1.515-2.484) indicating that mothers who live in Tigray were about 69% more likely to receive ANC from a health professional as compared to women living in Dire Dawa controlling for all the other variables in the model.

4.5.1.2 Interpretation for delivery care

Table 4.16 presents the results of the multivariate analyses of the use of delivery care services. Although professionally assisted delivery service is low in Ethiopia, there is substantial variation in the use of professionally assisted delivery care by region, sex of household head, mother‟s education, religion, husband education, mothers age at birth, birth order the child, employment status of mothers and wealth index. The results of the multivariate analysis for the overall sample show that region, sex of household head, mother‟s education, religion, husband education, mothers age at birth, birth order the child, employment status of mothers and wealth index are predictors that affect utilization of delivery care services in rural Ethiopia.

Mothers with female household head use delivery care more than household headed by a man. The estimated odds ratio 1.548 implies mothers who were living in house where the

head of household is female were about 55% more likely to receive delivery care from a health professional ($\widehat{OR}$=1.548, 95% CI: 1.178-2.034) as compared to women living in house where the head of household is male while controlling for all the other variables in the model.

The estimated odds ratio of mothers whose husband had no formal education as compared to mothers whose husband had primary or above education is 0.711($\widehat{OR}$=0.711, 95% CI: 0.549-0.921).The odds ratio 0.711 means that the odds of using delivery care has decreased by around 29% for mothers whose husband had no formal education compared to those whose husbands had primary or higher education controlling for other variables in the model.

Similar to the result we obtained in ANC above here also lower birth orders have the highest professionally assisted delivery care utilization. The estimated odds of delivery care usage by mothers at their first birth compared to the reference group at their fifth birth and more is 3.970 ($\widehat{OR}$=3.970, 95% CI: 2.743-5.747). This means at first birth mothers nearly 4-fold more likely to use delivery care compared to mothers at their fifth birth and more controlling for all the other variables in the model.

In contrast to the result we obtained from the logistic regression analysis of ANC, religious affiliation of mothers would affect delivery care utilization. The estimated odds ratio of using delivery care for mothers who follow Coptic-orthodox religion could be nearly 3-fold as compared to those following the reference group other traditional religions ($\widehat{OR}$ 2.729, 95% CI: 1.188-6.271) controlling for all the other variables in the model.

Another important predictor of mother‟s delivery care service utilization is wealth index. Mothers from the lowest wealth index are less likely to receive delivery care services than those in the rich category. The odds ratio of delivery care utilization by mothers from poor and middle wealth index compared to those mothers from rich wealth index are 0.438 ($\widehat{OR}$ 0.438, 95% CI: 0.336-0.570) and 0.469 ($\widehat{OR}$ 0.469, 95% CI: 0.338-0.652), respectively. This means the odds of delivery care utilization by mothers from poor and middle wealth index group is lower by about 56% and 53%, respectively compared to mothers from rich wealth index group controlling for other variables in the model.

There is also a strong association between mother‟s education and the use of delivery care services. The odds ratio of using delivery care service was about 50% lower if the mothers have no formal education as compared to mothers with primary or above education ($\widehat{OR}$ 0.495, 95% CI: 0.384-0.638) controlling for all the other variables in the model.

The estimated odds ratio of using delivery care service was about 40% lower when mother‟s age at birth is 15 to 19 as compared to those age at birth is 35 to 49 ($\widehat{OR}$ 0.599, 95% CI: 0.355-1.011) controlling for all the other variables in the model.

The estimated odds ratio of delivery care utilization for mothers who are not employed compared to those who are employed is 0.670 ($\widehat{OR}$ 0.670, 95% CI: 0.530-0.847). This means odds ratio of using delivery care services was 33% lower if mothers are not employed as compared to mothers who are employed controlling for all the other variables in the model.

The estimated odds ratio for the mothers who live in Tigray, Affar, Amhara, Oromiya, Benishangul-Gumuz, and SNNP compared to mothers who live in Dire Dawa are 0.226 ($\widehat{OR}$ 0.226, 95% CI: 0.134-0.530), 0.148 ($\widehat{OR}$ 0.148, 95% CI: 0.060-0.365), 0.317 ($\widehat{OR}$ 0.317, 95% CI: 0.163-0.617), 0.330 ($\widehat{OR}$ 0.330, 95% CI: 0.182-0.598), 0.339 ($\widehat{OR}$ 0.339, 95% CI: 0.214-0.744), and 0.270($\widehat{OR}$ 0.270, 95% CI: 0.139-0.524), respectively. This implies that utilization of delivery care for mothers who live in Tigray, Affar, Amhara, Oromiya, Benishangul-Gumuz, and SNNP is lower by factors of 0.226, 0.148, 0.317, 0.330, 0.339, and 0.270, respectively compared to mothers who live in Dire Dawa (reference group) controlling for all the other variables in the model.

4.5.1.3 Interpretation for PNC

In Table 4.21 above the multivariate logistic regression result of PNC service utilization is shown. The results show that women living in household where the head of household is female were 53% more likely to receive PNC from a health professional ($\widehat{OR}$=1.53, 95% CI 1.220-1.919) as compared to women where the head of household is male while controlling for all the other variables in the model.

For mothers whose husband‟s had no formal education the odds of use of PNC could be about 24% lower when compared to those with husbands who had primary or above education ($\widehat{OR}$ 0.756, 95% CI: 0.615-0.929) controlling for all the other variables in the model.

The odds of using PNC service was about 34% lower when mothers have no education as compared to mothers with primary or above education ($\widehat{OR}$ 0.659, 95% CI: 0.531-0.817) controlling for all the other variables in the model.

The estimated odds ratio of using PNC for mother‟s who follow Coptic-orthodox religion is nearly 3.6 times higher compared to mother‟s who follow the reference group “others” ($\widehat{OR}$ 3.606, 95% CI: 1.603-8.108). The odds ratio for protestant religion follower mothers is 2.263 ($\widehat{OR}$2.253, 95% CI: 1.029-4.977). The interpretationof this is that protestant religion follower mothers use PNC nearly twice higher compared to followers of “others” controlling for all the other variables in the model.

The estimated odds ratio for mothers whose household wealth index is poor and middle compared to those mothers whose wealth index is rich are 0.481 ($\widehat{OR}$ 0.486, 95% CI: 0.386-0.6) and 0.579 ($\widehat{OR}$ 0.579, 95% CI: 0.444-0.754), respectively. This means that the utilization of PNC for mothers whose wealth index is poor and middle is about 51% and 42% lower, respectively, than mothers whose wealth index is rich (reference group) controlling for all the other variables in the model.

Mothers who experienced first birth are about 84% more likely to use PNC compared to the reference group birth order five and more ($\widehat{OR}$=1.836, 95% CI: 1.345-2.505) controlling for all the other variables in the model.

The odds of using PNC service was about 13% lower when mothers age at birth is 15 to 19 as compared to those age at birth is 35 to 49 ($\widehat{OR}$ 0.872, 95% CI: 0.568-1.337) controlling for all the other variables in the model.

The estimated odds of PNC utilization for non-employed mothers compared to those who work as employed is 0.852 ($\widehat{OR}$ 0.852, 95% CI: 0.698-1.039). Utilization of PNC by mothers who are unemployed is lower by around 15% relative to those mothers who work as employee controlling for all the other variables in the model.

The reference category for region is Dire Dawa. The estimated odds ratio for the mothers who live in Amhara, Oromiya, Somali, and SNNP is 0.446 ($\widehat{OR}$ 0.446, 95% CI: 0.249-0.801), 0.438 ($\widehat{OR}$ 0.438, 95% CI: 0.258-0.745), 0.434 ($\widehat{OR}$ 0.434, 95% CI: 0.224-0.841), and 0.355 ($\widehat{OR}$ 0.355, 95% CI: 0.197-0.642), respectively. This implies that utilization of PNC for mother‟s who live in Amhara, Oromiya, Somali, and SNNP are respectively lower by about 55%, 56%, 56%, and 64% than mothers who live in Dire Dawa. In contrast the estimated odds ratio of PNC utilization for mothers who live in Harari compared those mothers who live Dire Dawa is 1.439 ($\widehat{OR}$ 1.439, 95% CI: 0.829-2.498) indicating that mothers who live in Harari were about 44% more likely to receive PNC from health professionals as compared to women living in Dire Dawa controlling for all the other variables in the model.

4.6 Discussion

The results of the analysis presented in this study identified factors that are significantly associated with utilization of maternal healthcare services (i.e. antenatal care, delivery care and postnatal care). The results could be useful in improving utilization of maternal healthcare services.

Lower rates of use of ANC, delivery assistance and postnatal care services have been established as contributing factors for higher rate of maternal mortality. In developing regions of the world like Ethiopia where such service are poorly developed, maternal mortality remained to be a big challenge in public health. To address these issues different stakeholders at international, national and regional levels have been

implementing different strategies. The MDG has been one of the internationally coordinated biggest initiatives.

In this study the factors: sex of household head, mother age at birth, mother education, husband education, birth order, religion, wealth index, region and mother‟s work status are significantly associated with improved utilization of maternal healthcare services.

Strong association has been found between household wealth and the use of maternal health services which is also supported by other studies (Babalola and Fatusi, 2009; Ethiopian Society of Population Studies 2008). This can be explained by the fact that women should be able to cover the costs needed in order to access healthcare services. Even in areas where maternal healthcare services are provided for free, women still have to pay for transportation and additional costs. As a result only those women who can afford to pay for such costs are able to visit health facilities.

The result of predicted probabilities for use of ANC, delivery care and PNC in this study showed that women in the highest wealth index group despite differences in place of residence and educational level were found to have higher level of use of ANC, delivery care and PNC. This depicts that household wealth is a very strong determinant of health service utilization. The Ethiopian Society of Population Studies (2008) also found that women in households with the lowest wealth index are less likely to seek maternal healthcare services than women in households with middle wealth quintile and the probability of seeking healthcare services is higher among women with the highest wealth index. This finding is also consistent with a study done in Philippines (Wong *et al.* 1987).

Birth order of the child shows significant association with use of ANC, delivery care and PNC services. Use of these maternal health services was shown to decrease with increase in birth order. As regards the effect of birth order on the utilization of maternal health care services, the results appear to be consistent with most studies done elsewhere, which indicate that women are significantly more likely to use the services for their first child than later children (Kemal 2009; Mesfin and Getnet, 2004; Ethiopian Society of Population Studies 2008). One possible explanation for this may be that adolescents who are pregnant for the first time are usually more likely to have difficulties, excitement and horror during labor and delivery than women who have had previous experiences of pregnancy and child-delivery.

In this study religion is found to be significantly related with use of delivery care and PNC services but not with use of ANC services. It was observed that Coptic-orthodox women received delivery care service more when compare with those who follow other religion. Similar to this we observed that women who follow Coptic-orthodox religion receive PNC service more when compare with those who follow other traditional religious beliefs. A study in Ethiopia by Yared and Asnaketch (2002) found that mothers who follow orthodox religion use ANC, delivery care, and PNC more than mothers who follow any other religion. In contrast a result obtained from the study by the Ethiopian Society of Population Studies (2008), showed that mothers religious affiliations do not influence utilization of ANC and PNC, but have significant effect on the delivery care services use. A study in Bangladesh (Kamal, 2009) found that utilization of skilled birth attendance was relatively higher among non-Muslim women than among Muslims, a significant association for the use of antenatal care and institutional delivery was not

apparent. No significant difference was found in the use of antenatal care among different religious groups in Nigeria (Babalola and Fatusi, 2009).

In this study, mother‟s education was an important predictive factor for usage of ANC, delivery care and PNC services. It is also likely that educated mothers will tend to seek out higher quality services. In the literature, there is strong consistency in the relationship between mother‟s education and utilization of maternal healthcare services. Mother education was found to be a strong determinant of maternal health services utilization with uneducated women less likely to use maternal healthcare services for delivery (Chakraborty *et al*. 2003;Yared and Asnaketch2002). A similar study in Bangladesh by Munsur *et al.* (2010) also found that the most important determinant of maternal healthcare services was mother‟s educational status; this study also showed that mother‟s education has strong and positive association with maternal healthcare utilization. The Ethiopian Society of Population Studies (2008) found that utilization of maternal healthcare services was higher among educated mothers than non-educated. In a study in Peru using DHS data Elo (1992) found that mother‟s education has positive effect on the use of prenatal care and delivery care services. Becker *et al*.,(1993) found that mother‟s education was positively related to utilization of maternal healthcare services.

Age of the mother at birth was found to be significantly related to both use of ANC, delivery care and PNC in the total sample. The result of this study also shows that mothers giving birth at older ages are more likely to use maternal healthcare services than adolescents and young mothers. A study by Addai (2000) found that older mothers are more likely to use maternal health care services than younger mothers. The result of this study is also consistent with Chakraborty et al. (2003). In contrast, the Ethiopian Society

of Population Studies (2008) showed the non-significant effect of mother‟s age at birth on maternal healthcare services utilization.

We expect that utilization of maternal healthcare services by mothers from households headed by females is higher than among household headed by males. The lower rate of utilization of delivery care and PNC services by mothers from male headed households as compared to female headed households found in this study coincides with our expectation. But it is found that the sex of household head does hasno influence on utilization of ANC services.

Work status of the mother was found to be specifically associated with utilization of ANC, delivery care and PNC services in this study. The result shows that mothers working status as employee is positively associated with utilization of ANC, delivery care and PNC services from health professionals. This implies mothers who are working as employees use maternal healthcare services more likely than those who are unemployed. Experiences and roles as economic providers might empower mothers through increased control over income which, in turn, may increase their power in decision-making about healthcare and their ability to access and pay for the services that they need. In contrast, a study by the Ethiopian Society of Population Studies (2008), found that mothers work status does not have any effect on utilization of maternal healthcare services. Yared and Asnaketch (2002) showed that mothers who work as employees use maternal healthcare services more than mothers who are not employed, which is consistent with the finding of this study. McCaw-Binns *et al.* (1995) also found positive associations between ANC use and the work status of mothers.

The results of this study also showed that mothers married to husbands with primary or higher educational level tend to use the service more than those mothers who had uneducated husband. A study in Bangladesh showed that mothers who have husband with secondary or above education level are more likely to use maternal healthcare services from health professional‟s than mothers who had uneducated husband (Kamal 2009). Elo (1992) also found that husband‟s education is found to have a significant positive association with maternity care service utilization.

This study showed that there is an observed regional discrepancy with respect to maternal healthcare utilization. As compared to the reference region namely, Dire Dawa mother‟s in Oromiya, Somali and SNNP regions are less likely to use ANC, delivery care and PNC services. On the other hand mothers who live in Tigray region are more likely to use ANC services than those in Dire Dawa. In addition mothers who live in Tigray, Affar and Benishangul-Gumuz regions (for delivery care only) and Amhara (for both delivery care and PNC services) use less of these services than mothers who live in Dire Dawa. Mothers in Harari region are more likely to use PNC than those in Dire Dawa. A study conducted by the Ethiopian Society of Population Studies (2008) showed that as compared to the reference category (Oromiya Region), women in Tigray, Benishangul-Gumuz, Gambela, SNNP, Addis Ababa and Dire Dawa regions are more likely to use antenatal care services. The probability of giving birth at health institutions is also higher among women in Gambela, Harari, Addis Ababa and Dire Dawa. This also holds true for PNC services.

CHAPTER FIVE

CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

Despite the progress that has been made in the country to improve maternal and child health, maternal and child mortality remain high in Ethiopia. The findings of this study demonstrate the prevalence of inadequate utilization of maternal healthcare services among women in rural Ethiopia, as clearly shown by the major maternity care indicators: antenatal care, delivery care and postnatal care. The results of this study show that the factors influencing the utilization of skilled maternal health care services are mostly socio-economic and demographic related.

The major factors identified in this study include mother‟s education, mother‟s work status, birth order, husband‟s educational status and economic status. The findings further suggest the following: husband‟s educational status and mother‟s education have a significant and positive effect on the utilization of maternal healthcare services, that is, mothers with primary or above education are more likely to utilize maternal healthcare services than mothers with no formal education and mothers whose husbands had primary or above education utilize maternal healthcare services more than those with husbands who had no formal education. In addition, household wealth has a very significant impact on the utilization of maternal healthcare services, with wealthier mothers more likely to use the health service. Also mothers who work as employee use health services more than mothers who are not employed. Birth order is also found to

have contribution to maternal healthcare utilization. Mothers use healthcare services more at their first birth than second and more birth.

5.2 Recommendations

The findings of this study have important policy implications. The identification of factors those are significantly associated with a mother‟s decision to use healthcare services. This knowledge now needs to be converted into development of adequate interventions that aim to increase service use.

- Female education is associated with patterns of maternal healthcare service use, that is, the higher the level of education of a mother the higher utilization pattern. Education levels in rural Ethiopia need to be improved. In the sample studied, most of the women had either no or just primary education. Education affects maternal healthcare service use by exchanging ideas and knowledge about maternal health and attitudes toward risk prevention by using the maternal healthcare services.
- In addition, policies and efforts have to be put in place to improve men education and creating job opportunity to mothers in rural Ethiopia.
- In this study, household wealth has a very significant impact on the utilization of maternal healthcare services, with wealthier families more likely to use the health service. Increasing the economic situation of the population is a long term national objective and goes beyond the responsibility of the Ministry of Health. Nevertheless, the Ministry of Health could align its plan of actions to meet the objectives of the poverty reduction strategy and of the Ethiopian vision 2025.

- The role of birth order points to the need for messages that target specifically higher birth order mothers when establishing safe motherhood programs. It is better to educate mothers the disadvantage of higher birth order to overcome the problem, so that this group of mothers would be encouraged to have health facility services. The Ministry of Health could also use media to disseminate consistent messages promoting the use of maternal healthcare services by all women and most particularly higher birth order women.

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APPENDIX

Appendix 1: Categorical variables codings

		Parameter coding								
		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Region	Tigray	1	0	0	0	0	0	0	0	0
	Affar	0	1	0	0	0	0	0	0	0
	Amhara	0	0	1	0	0	0	0	0	0
	Oromiya	0	0	0	1	0	0	0	0	0
	Somali	0	0	0	0	1	0	0	0	0
	Benishangul-Gumuz	0	0	0	0	0	1	0	0	0
	SNNP	0	0	0	0	0	0	1	0	0
	Gambela	0	0	0	0	0	0	0	1	0
	Harari	0	0	0	0	0	0	0	0	1
	Dire Dawa	0	0	0	0	0	0	0	0	0
Religion	Orthodox	1	0	0						
	Protestant	0	1	0						
	Muslim	0	0	1						
	Others	0	0	0						
Mother age at birth	15-19	1	0							
	20-34	0	1							
	35-49	0	0							
Birth order	1	1	0							
	2-4	0	1							
	5+	0	0							
Wealth index	Poor	1	0							
	Middle	0	1							
	Rich	0	0							
mother working status	No	1								
	Yes	0								
Husband education	No education	1								
	Primary & above edu.	0								
Mother education	No education	1								
	Primary & above edu.	0								
Sex of household head	Female	1								
	Male	0								

Appendix 2: Summary of descriptive statistics

Table 4.1 Descriptive statistics of ANC and delivery careservices usage status of mothers

Explanatory variable	Categories	Maternal healthcare use									
		Delivery care					Antenatal care (ANC)				
		No		Yes		Total	No		Yes		Total
		Count	%	Count	%		Count	%	Count	%	
Mother age at birth	15-19	634	91	63	9	697	474	68	223	32	697
	20-34	4005	93.9	259	6.1	4264	3051	71.6	1213	28.4	4264
	35-49	1151	96.5	42	3.5	1193	894	74.9	299	25.1	1193
Women‟s educational status	No education	4424	96.3	169	3.7	4593	3523	76.7	1070	23.3	4593
	Primary and above education	1366	87.5	195	12.5	1561	896	57.4	665	42.6	1561
Educational status of husband	No education	3445	96.3	131	3.7	3576	2756	77.1	820	22.9	3576
	Primary and above education	2345	91	233	9	2578	1663	64.5	915	35.5	2578
Employment status	employed	1609	91.5	149	8.5	1758	1158	65.9	600	34.1	1758
	Non-employed	4181	95.1	215	4.9	4396	3261	74.2	1135	25.8	4396
Birth order	1	817	85.6	137	14.2	954	603	63.2	351	36.8	954
	2-4	2480	94.7	139	5.3	2619	1863	71.1	756	28.9	2619
	5+	2493	96.6	88	3.4	2581	1953	75.7	628	24.3	2581
Wealth index	Poor	3368	96.2	134	3.8	3502	2751	78.6	751	21.4	3502
	Middle	1145	95.3	56	4.7	1201	835	69.5	366	30.5	1201
	Rich	1277	88	174	12	1451	833	57.4	618	42.6	1451
Region	Tigray	672	93.5	47	6.5	719	411	57.2	308	42.8	719
	Affar	601	98.9	7	1.1	609	488	80.1	121	19.9	609
	Amhara	813	94.3	49	5.7	862	627	72.7	235	27.3	862
	Oromiya	915	94.3	55	5.7	970	720	74.2	250	25.8	970
	Somali	382	95.5	18	4.5	400	337	84.2	63	15.8	400
	Benishangul-Gumuz	565	94.2	35	5.8	600	423	70.5	177	29.5	600
	SNNP	931	95.5	44	4.5	975	747	76.6	228	23.4	975
	Gambela	453	87.5	65	12.5	518	328	63.3	190	36.7	518

	Harari	236	90.8	24	9.2	260	165	63.5	95	36.5	260
	Dire- Dawa	221	91.7	20	8.3	241	173	71.8	68	28.2	241
Sex of household head	Male	4797	94.5	277	5.5	5074	3667	72.3	1407	27.7	5074
	Female	993	91.9	87	8.1	1080	752	69.6	328	30.4	1080
Religion	Coptic – Orthodox	1780	92.1	152	7.9	1932	1266	65.5	666	34.5	1932
	Protestant	1209	93.5	84	6.5	1293	938	72.5	355	27.5	1293
	Muslim	2597	95.5	121	4.5	2718	2046	75.3	672	24.7	2718
	Others	204	96.7	7	3.3	211	169	80.1	42	19.9	211

Table 4.2 Descriptive statistics of PNC usage status of mothers

Explanatory variable	Categories	Postnatal care (PNC)				
		No		Yes		Total
		Count	%	Count	%	
Mother age at birth	15-19	566	87.9	78	12.1	644
	20-34	3748	90.5	394	9.5	4142
	35-49	1092	93.3	79	6.7	1171
Women‟s educational status	No education	4153	92.6	330	7.4	4483
	Primary and above education	1253	85	221	15	1474
Educational status of husband	No education	3225	93	244	7	3469
	Primary and above education	2181	87.7	307	12.3	2488
Employment status	Employed	3893	89.1	365	10.9	4258
	Non-employed	1507	91.4	185	8.6	1692
Birth order	1	717	83.8	139	16.2	856
	2-4	2343	91.4	221	8.6	2564
	5+	2346	92.5	191	7.5	2537
Wealth index	Poor	3184	93.2	232	6.8	3416
	Middle	1063	91.6	97	8.4	1160
	Rich	1159	83.9	222	16.1	1381
Region	Tigray	603	86.3	96	13.7	699
	Affar	557	93.1	41	6.9	598
	Amhara	759	91.6	70	8.4	829
	Oromiya	874	92.4	72	7.6	946
	Somali	365	95.5	17	4.5	382
	Benishangul-Gumuz	526	90.4	56	9.69	582
	SNNP	898	93.6	61	6.4	959

	Gambela	418	86.2	67	13.8	485
	Harari	201	80.7	48	19.3	249
	Dire- Dawa	205	89.9	23	10.1	228
Sex of household head	Male	4491	91.4	425	8.6	4916
	Female	915	87.9	126	12.1	1041
Religion	Coptic –Orthodox	1631	87.8	228	12.3	1859
	Protestant	1148	91.2	111	8.8	1259
	Muslim	2472	92.2	205	7.8	2632
	Others	200	96.6	7	3.4	207

Appendix 3: Results of bivariate statistical analysis

Table 4.3 Results of bivariate statistical analysis of ANC and delivery care

Explanatory variable	Categories	Maternal healthcare use								
		Delivery care					ANC			
		No	Yes	Total	df.	Chi-square (Sign.)	No	Yes	Total	Chi-square (Sign.)
Mother age at birth	15-19	634	63	697	2	24.706 (.000)	474	223	697	10.885 (0.004)
	20-34	4005	259	4264			3051	1213	4264	
	35-49	1151	42	1193			894	299	1193	
Women‟s educational status	No education	4424	169	4593	1	162.58 (.000)	3523	1070	4593	214.46 (0.000)
	Primary and above education	1366	195	1561			896	665	1561	
Educational status of husband	No education	3445	131	3576	1	77.762 (.000)	2756	820	3576	116.77 (0.000)
	Primary and above education	2345	233	2578			1663	915	2578	
Employment status	employed	1609	149	1758	1	28.998 (.000)	1158	600	1758	42.844 (0.000)
	Non-employed	4181	215	4396			3261	1135	4396	
Birth order	1	817	137	954	2	153.13 (.000)	603	351	954	54.443 (0.000)
	2-4	2480	139	2619			1863	756	2619	
	5+	2493	88	2581			1953	628	2581	
Wealth index	Poor	3368	134	3502	2	127.12 (.000)	2751	751	3502	230.45 (0.000)
	Middle	1145	56	1201			835	366	1201	
	Rich	1277	174	1451			833	618	1451	
Region	Tigray	672	47	719			411	308	719	

	Affar	601	7	609	9	78.984 (.000)	488	121	609	169.8 (0.000)
	Amhara	813	49	862			627	235	862	
	Oromiya	915	55	970			720	250	970	
	Somali	382	18	400			337	63	400	
	Benishangul -Gumuz	565	35	600			423	177	600	
	SNNP	931	44	975			747	228	975	
	Gambela	453	65	518			328	190	518	
	Harari	236	24	260			165	95	260	
	Dire- Dawa	221	20	241			173	68	241	
Sex of household head	Male	4797	277	5074	1	10.786 (.001)	3667	1407	5074	3.067 (0.080)
	Female	993	87	1080			752	328	1080	
Religion	Coptic - Orthodox	1780	152	1932	3	27.035 (.000)	1266	666	1932	61.288 (0.000)
	Protestant	1209	84	1293			938	355	1293	
	Muslim	2597	121	2718			2046	672	2718	
	Others	204	7	211			169	42	211	

Table 4.4 Results of bivariate statistical analysis of PNC usage

Explanatory variable	Categories	Maternal healthcare use				
		PNC				
		No	Yes	Total	df.	Chi-square (Sign.)
Mother age at birth	15-19	566	78	644	2	15.367 (0.000)
	20-34	3748	394	4142		
	35-49	1092	79	1171		
Women‟s educational status	No education	4153	330	4483	1	76.975 (0.000)
	Primary and above education	1253	221	1474		
Educational status of husband	No education	3225	244	3469	2	95.889 (0.000)
	Primary and above education	2181	307	2488		
Employment status	Employed	3893	365	4258	1	8.05 (0.005)
	Non-employed	1507	185	1692		
Birth order	1	717	139	856	2	59.973 (0.000)
	2-4	2343	221	2564		
	5+	2346	191	2537		
Wealth index	Poor	3184	232	3416	2	102.327 (0.000)
	Middle	1063	97	1160		
	Rich	1159	222	1381		
Region	Tigray	603	96	699	9	86.664 (0.000)
	Affar	557	41	598		
	Amhara	759	70	829		
	Oromiya	874	72	946		
	Somali	365	17	382		
	Benishangul-Gumuz	526	56	582		
	SNNP	898	61	959		
	Gambela	418	67	485		
	Harari	201	48	249		
	Dire- Dawa	205	23	228		
Sex of household head	Male	4491	425	4916	1	12.242 (0.000)
	Female	915	126	1041		
Religion	Coptic –Orthodox	1631	228	1859	3	35.597 (0.000)
	Protestant	1148	111	1259		
	Muslim	2472	205	2632		
	Others	200	7	207		

Appendix 4: Descriptive statistics of DFBET(s)

Table 4.5 Descriptive statistics of DFBETA(s) for ANC and delivery care

	N	ANC		Delivery care	
		Min.	Max.	Min.	Max.
DFBETA for constant	6154	-.01969	.02468	-.01256	.01520
DFBETA for sexhhh(1)	6154	-.00400	.00486	-.00960	.01763
DFBETA for husedu.(1)	6154	-.00342	.00311	-.01500	.01471
DFBETA for birthorder(1)	6154	-.00546	.00921	-.02176	.01897
DFBETA for birthorder(2)	6154	-.00318	.00465	-.01873	.02338
DFBETA for wealth(1)	6154	-.00356	.00346	-.01187	.01538
DFBETA for wealth(2)	6154	-.00337	.00414	-.01169	.02369
DFBETA for religion(1)	6154	-.02182	.01902	-.01570	.02179
DFBETA for religion(2)	6154	-.02362	.01967	-.02322	.02229
DFBETA for religion(3)	6154	-.02366	.01841	-.02395	.02084
DFBETA for mothedu.(1)	6154	-.00385	.00338	-.01458	.01306
DFBETA for mothage(1)	6154	-.01071	.01179	-.01959	.02318
DFBETA for mothage(2)	6154	-.00666	.00447	-.02487	.01895
DFBETA for moth.work (1)	6154	-.00334	.00243	-.01203	.00879
DFBETA for region (1)	6154	-.01914	.01347	-.01825	.01869
DFBETA for region (2)	6154	-.01949	.01269	-.02125	.01183
DFBETA for region (3)	6154	-.01889	.01329	-.01969	.01082
DFBETA for region (4)	6154	-.01824	.01468	-.01615	.02064
DFBETA for region (5)	6154	-.01915	.01787	-.02112	.01040
DFBETA for region (6)	6154	-.01853	.01421	-.02373	.01639
DFBETA for region (7)	6154	-.01824	.01453	-.01625	.02232
DFBETA for region 4(8)	6154	-.01847	.01570	-.02267	.01969
DFBETA for region (9)	6154	-.01807	.01617	-.02358	.01097
Valid N (listwise)	6154				

Table 4.6 Descriptive statistics of DFBETA(s) for PNC

	N	Minimum	Maximum
DFBETA for constant	5957	-.02359	.00523
DFBETA for sexhhh(1)	5957	-.00717	.01091
DFBETA for husedu.(1)	5957	-.00963	.01006
DFBETA for birthorder(1)	5957	-.01225	.01734
DFBETA for birthorder(2)	5957	-.00923	.01328
DFBETA for wealth(1)	5957	-.01009	.00962
DFBETA for wealth(2)	5957	-.00803	.01288
DFBETA for religion(1)	5957	-.01994	.02466
DFBETA for religion(2)	5957	-.02052	.02006
DFBETA for religion(3)	5957	-.02469	.01915
DFBETA for mothedu.1)	5957	-.01241	.00905
DFBETA for mothage(1)	5957	-.02146	.02449
DFBETA for mothage(2)	5957	-.02108	.00930
DFBETA for moth.work(1)	5957	-.00975	.00548
DFBETA for region(1)	5957	-.01772	.02413
DFBETA for region (2)	5957	-.01980	.01072
DFBETA for region (3)	5957	-.00917	.01936
DFBETA for region (4)	5957	-.02436	.02466
DFBETA for region (5)	5957	-.02386	.02237
DFBETA for region (6)	5957	-.01725	.02098
DFBETA for region (7)	5957	-.01609	.02196
DFBETA for region (8)	5957	-.01730	.02391
DFBETA for region (9)	5957	-.02089	.02441
Valid N (listwise)	5957		

Appendix 5: Variables not in the equation

Table 4.22 Variables not in the Equation of ANC and delivery care

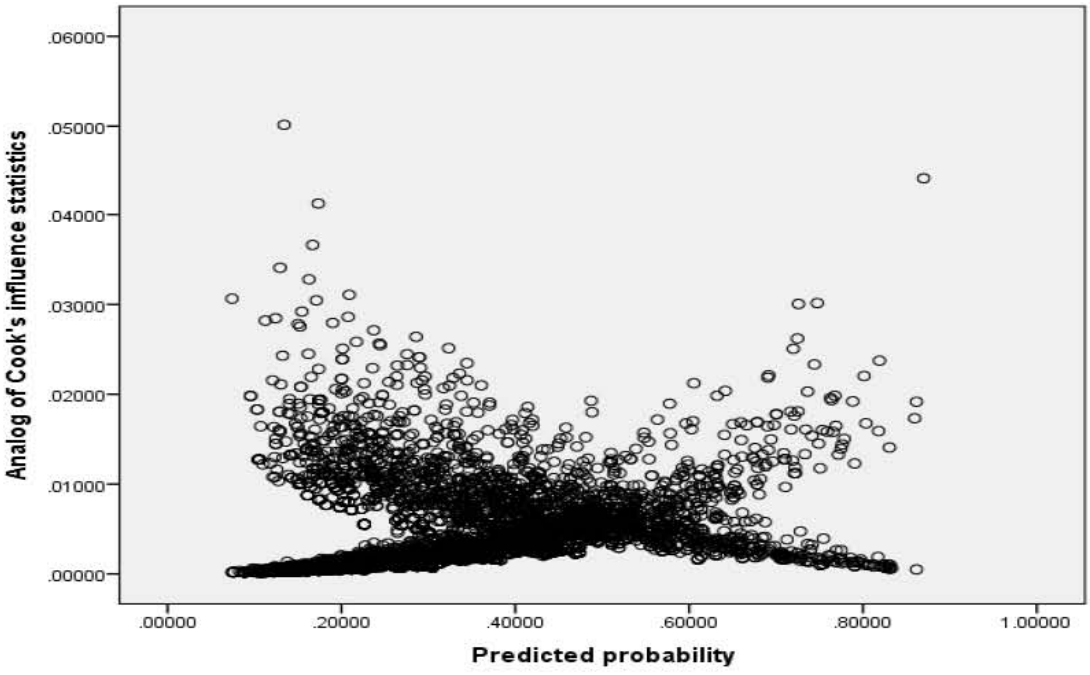
			ANC			Delivery care	
			Score	df	Sig.	Score	Sig.
Step 0	Variables	sexhhh(1)	3.067	1	.080	10.786	.001
		husedu.(1)	116.770	1	.000	77.762	.000
		Birthorder	54.443	2	.000	153.128	.000
		birthorder(1)	41.241	1	.000	144.715	.000
		birthorder(2)	1.020	1	.313	3.023	.082
		Wealth	230.448	2	.000	127.117	.000
		wealth(1)	182.794	1	.000	63.693	.000
		wealth(2)	3.837	1	.050	4.204	.040
		Religion	61.288	3	.000	27.035	.000
		religion(1)	54.843	1	.000	19.294	.000
		religion(2)	.440	1	.507	.995	.318
		religion(3)	28.937	1	.000	18.724	.000
		mothedu.1)	214.464	1	.000	162.582	.000
		Mothage	10.885	2	.004	24.706	.000
		mothage(1)	5.610	1	.018	13.784	.000
		mothage(2)	.444	1	.505	.633	.426
		moth.work (1)	42.844	1	.000	28.998	.000
		Region	169.791	9	.000	78.984	.000
		region (1)	86.240	1	.000	.566	.452
		region (2)	23.135	1	.000	27.581	.000
		region (3)	.429	1	.512	.096	.757
		region (4)	3.331	1	.068	.124	.725
		region (5)	32.718	1	.000	1.539	.215
		region (6)	.561	1	.454	.008	.929
		region (7)	13.232	1	.000	4.092	.043
		region (8)	20.122	1	.000	44.722	.000
		region (9)	9.339	1	.002	5.364	.021
	Overall Statistics		566.332	22	.000	446.369	.000

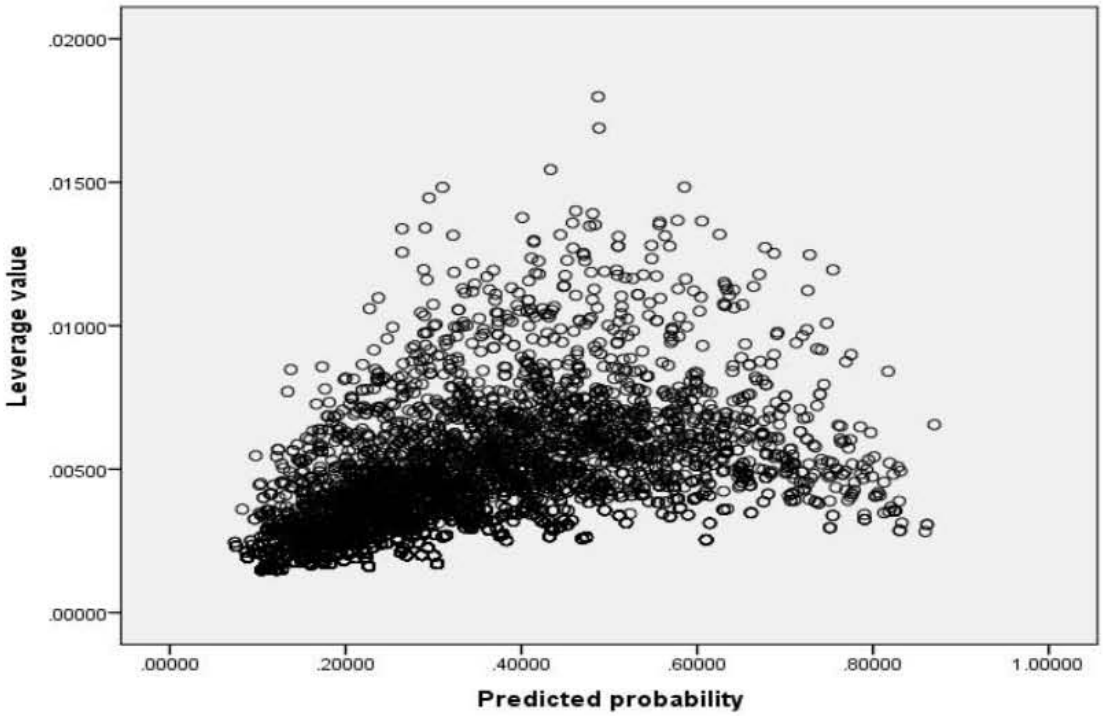
Table 4.23 Variables not in the Equation of postnatal care

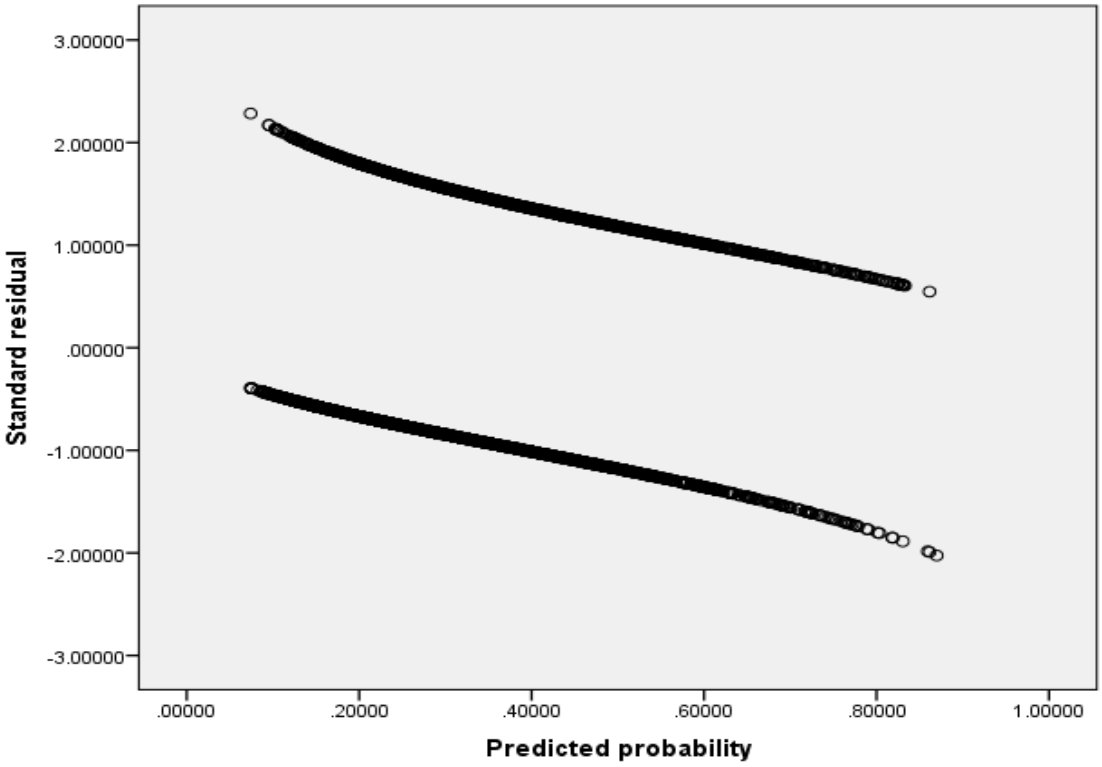
			Score	df	Sig.
Step 0	Variables	sexhhh(1)	12.242	1	.000
		husedu.(1)	48.586	1	.000
		Birthorder	59.973	2	.000
		birthorder(1)	58.166	1	.000
		birthorder(2)	2.130	1	.144
		Wealth	102.327	2	.000
		wealth(1)	57.644	1	.000
		wealth(2)	1.352	1	.245
		Religion	35.597	3	.000
		religion(1)	29.265	1	.000
		religion(2)	.357	1	.550
		religion(3)	11.989	1	.001
		mothedu.(1)	76.975	1	.000
		Mothage	15.367	2	.000
		mothage(1)	7.047	1	.008
		mothage(2)	1.118	1	.290
		moth.work (1)	8.164	1	.004
		Region	86.664	9	.000
		region (1)	18.971	1	.000
		region (2)	4.536	1	.033
		region (3)	.745	1	.388
		region (4)	3.597	1	.058
		region (5)	11.201	1	.001
		region (6)	.107	1	.744
		region (7)	11.364	1	.001
		region (8)	13.107	1	.000
		region (9)	31.128	1	.000
	Overall Statistics		300.687	22	.000

Appendix 6: Scatter plots for diagnostic checking

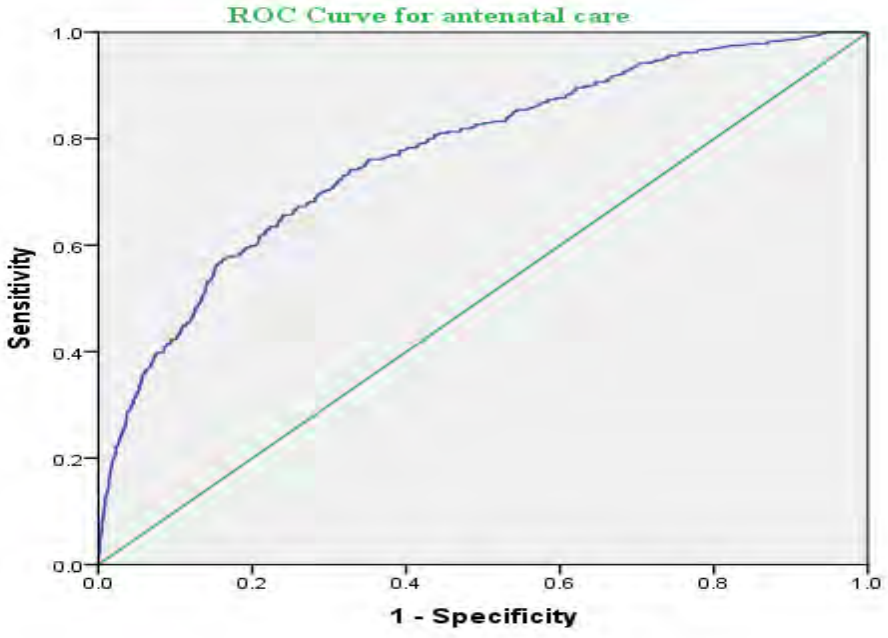
A. Antenatal care



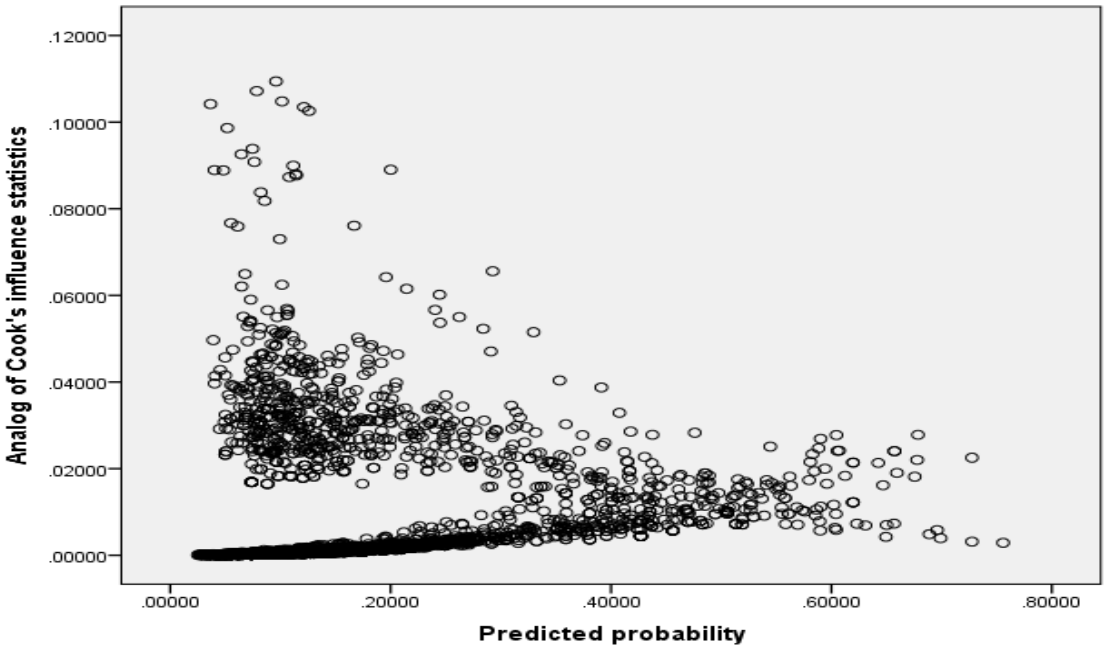


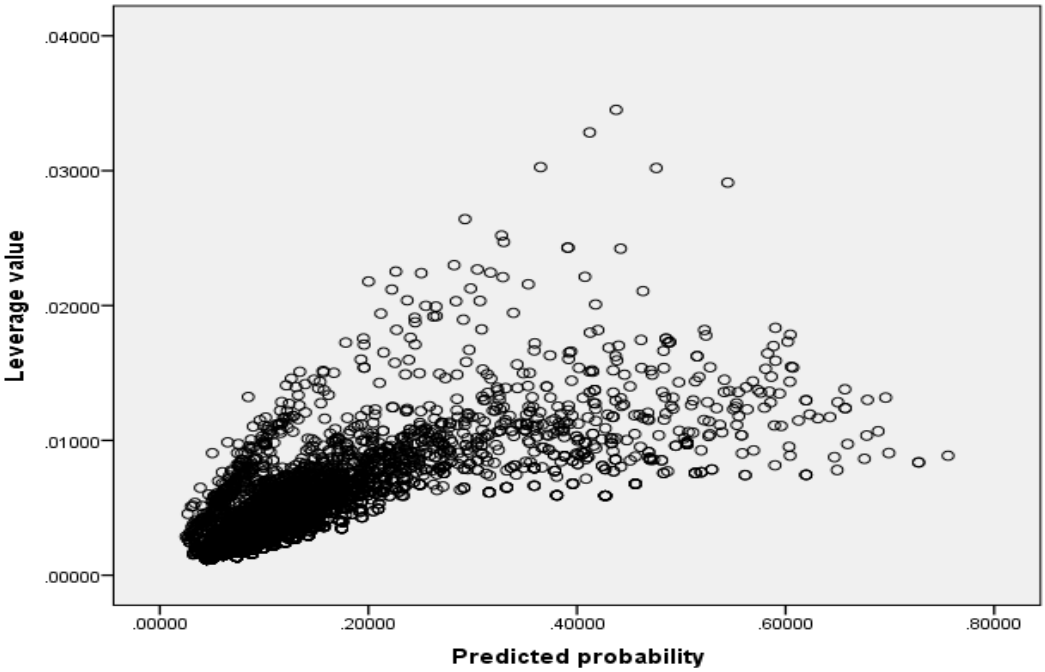


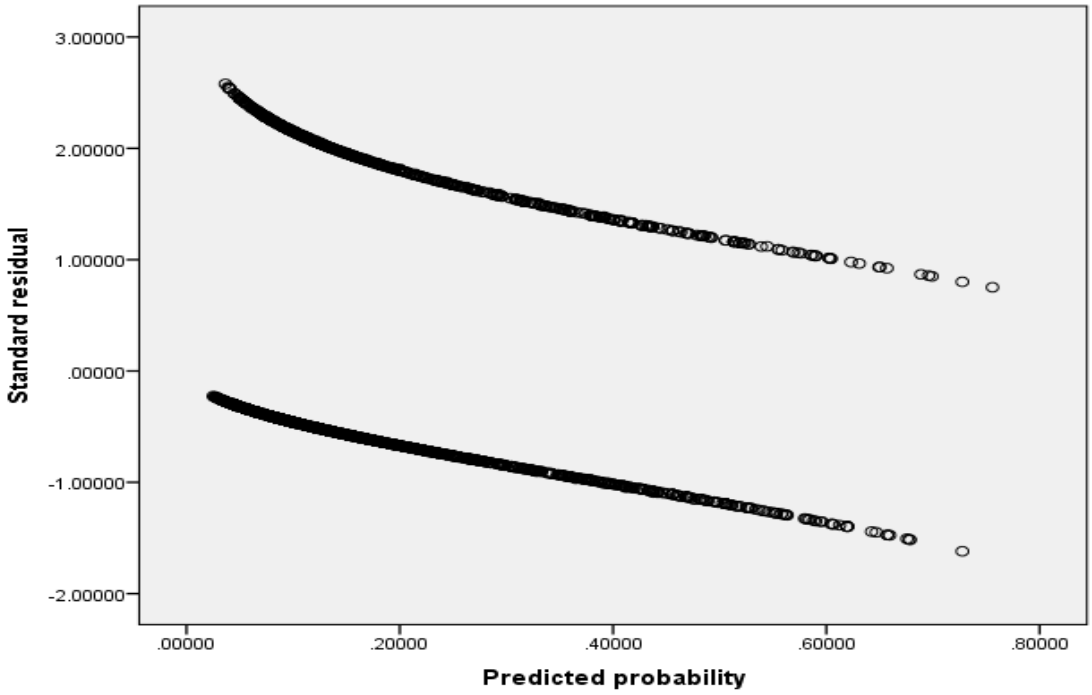
The ROC curve



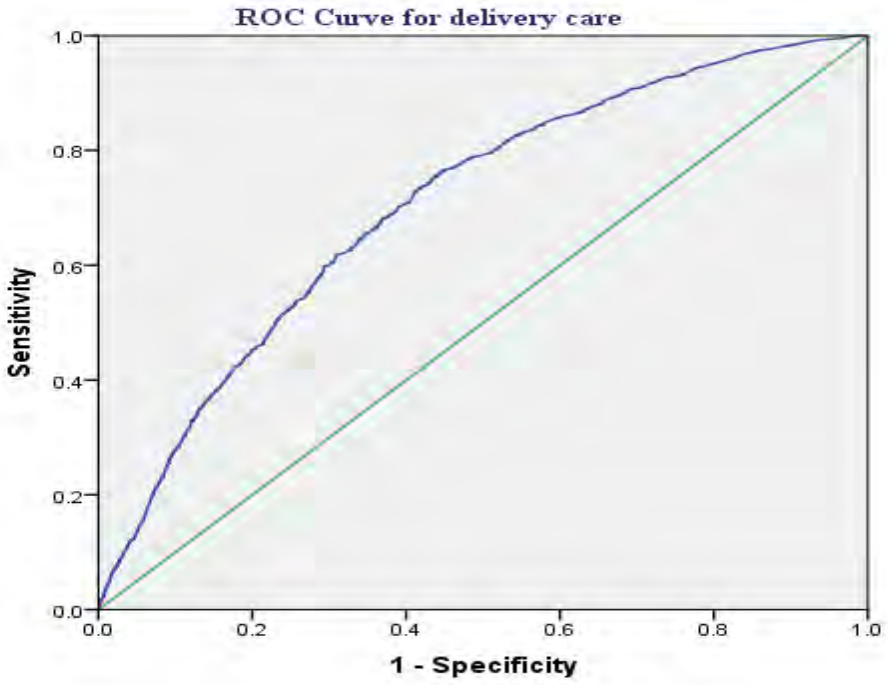
B. Delivery care



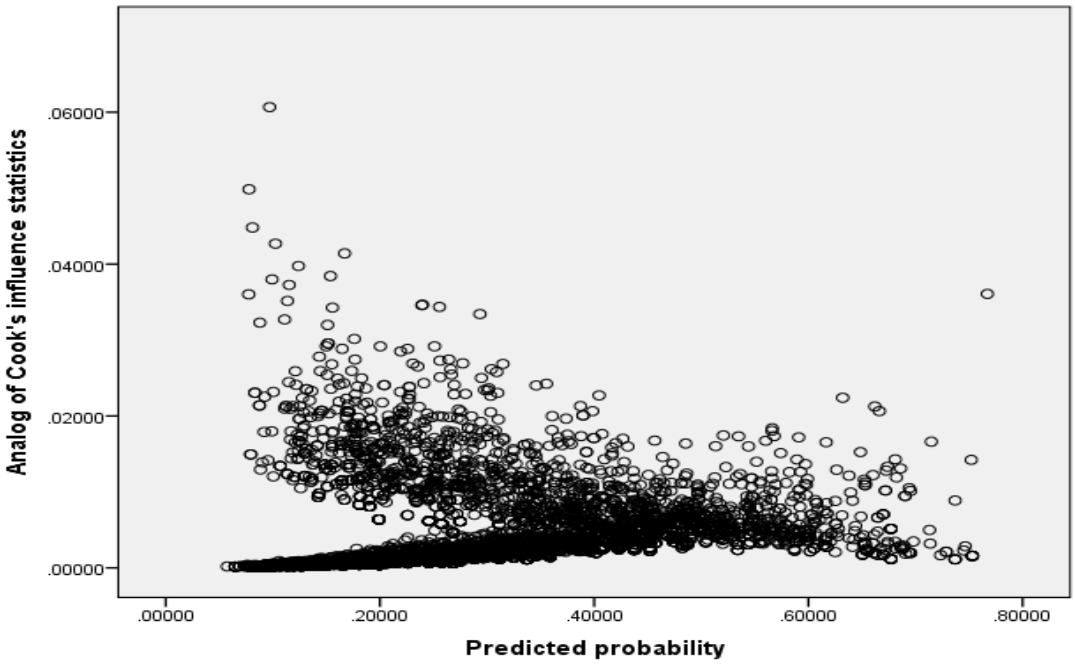


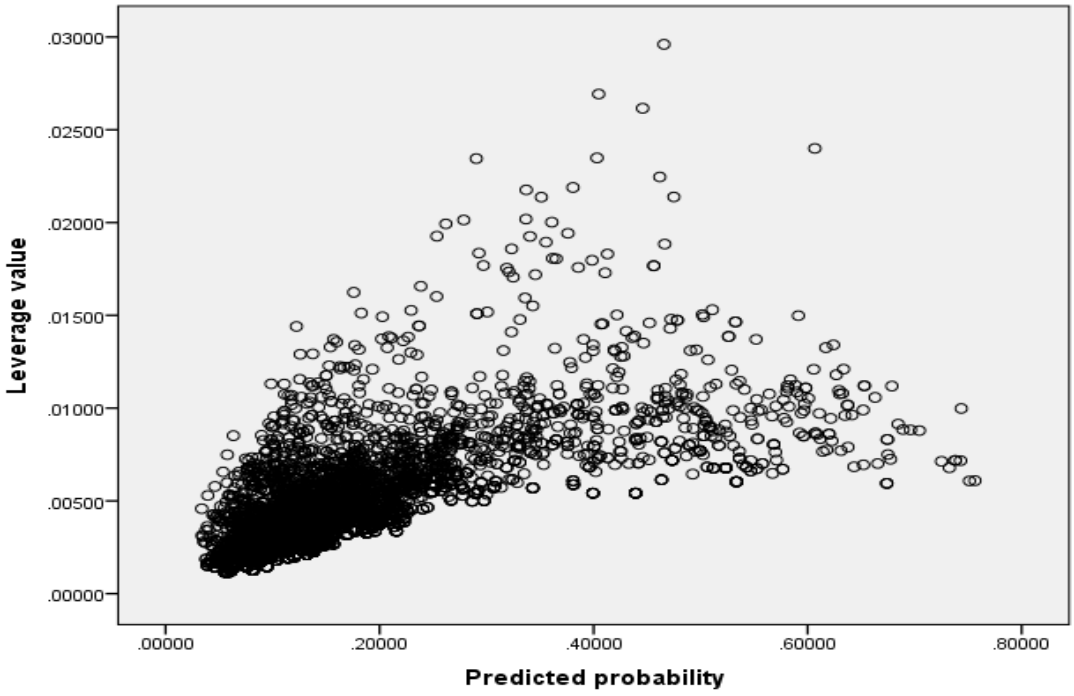


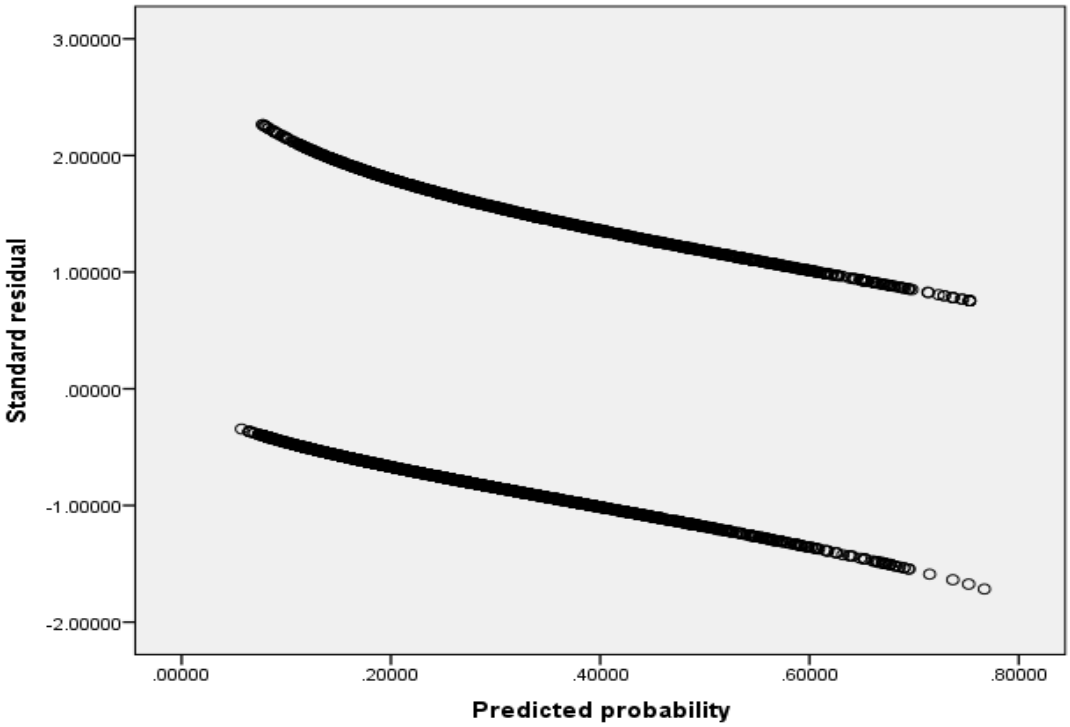
The ROC curve



C. Postnatal care







The ROC curve