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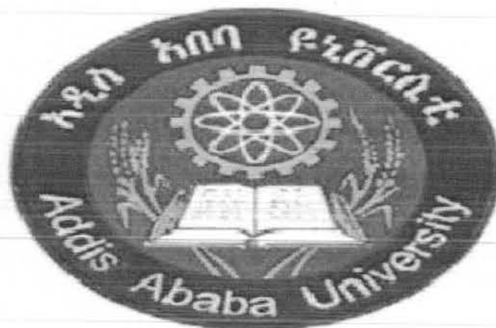

Factors Influencing the Utilization of Antenatal Care Services in Ethiopia: Application of Zero-Inflated Negative Binomial Model

By

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This is to certify that the thesis prepared by Enyew Assefa, entitled: *Factors Influencing the Utilization of Antenatal care Services in Ethiopia: Application of zero-inflated negative binomial model* and submitted in partial fulfillment of the requirements for the Degree of Master of Science in Statistics complies with the regulations of the University and meets the accepted standards with respect to originality and quality.

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Abstract

Factors influencing the utilization of antenatal care services in Ethiopia: Application of zero-inflated negative binomial model

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Pregnancy and delivery are still the leading causes of maternal mortality and morbidity among women of reproductive age in developing countries. Antenatal care is an important determinant of high maternal mortality and one of the basic components of maternal care on which the life of mothers and babies depend. The objective of this study was to identify and examine factors that affect utilization of antenatal care services using the 2011 Ethiopia Demographic and Health Survey data. The study analyzed the number of antenatal care utilization of mothers aged 15 to 49 years who have used antenatal care in their last pregnancy period. Zero-inflated negative binomial model was used to explore the major factors influencing utilization of antenatal care services in Ethiopia. More than 55% of the mothers did not use antenatal care services; more than 77% of the women utilized antenatal care less than four times. More than half of the women (52%) who had access of health services used at least four antenatal care visits. For such data the zero-inflated negative binomial model is more appropriate, and it was used to analyze the data. Place of residence was found to be significantly associated with use of antenatal care services. Also age of mothers, woman's educational level, employment status, mass media exposure, religion and access of health services were all significant predictors for the use of antenatal care. Accordingly, all possible efforts must be made to increase women's educational level. In addition, it is necessary to initiate programs to promote pregnant women to start receiving antenatal care early.

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ACRONYMS

AIC	Akaike's Information Criteria
ANC	Antenatal Care
ANCUM	Antenatal Care Utilization Model
BIC	Bayesian Information Criteria
CSA	Central Statistical Agency
EDHS	Ethiopian Demographic and Health Survey
FMOH	Federal Ministry of Health
LRT	Likelihood Ratio Test
MCH	Maternal and Child Health care
MDGs	Millennium Development Goals
MOH	Ministry of Health
NB	Negative Binomial
PNC	Postnatal Care
PR	Poisson Regression
SAS	Statistical Analysis System
SNNP	Southern Nations Nationalities and Peoples
SPSS	Statistical Packages for Social Sciences
SSA	Sub-Saharan Africa
STI	Sexually Transmitted Infections
TBA	Traditional Birth Attendance
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
ZINB	Zero-Inflated Negative Binomial

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CHAPTER ONE

1. INTRODUCTION

1.1 Background of the Study

Pregnancy and birth of a baby is generally a celebrated event in most of the communities. However, in many families, these events may become a symbol of sorrow and grief where mothers depart from their babies and families because of inadequate and poor or nil maternal health services provided to these innocent mothers.

Pregnancy challenges the health care system in a unique way in that it involves at least two individuals – the woman and the fetus. The death rates of both pregnant women (maternal mortality) and newborns (prenatal mortality) are often used to indicate the quality of care the health system is providing. Care given to pregnant women, and thus the level of care in general, is reviewed through the assessment of maternal deaths.

Globally, at least 160 million women become pregnant annually. Of these, 15% develop a serious complication. Over 30 million women in the developing world suffer from serious diseases and disabilities which include uterine prolapsed, pelvic inflammatory disease, fistula, incontinence, infertility, and pain during sexual intercourse as a result of inadequate or inappropriate care during pregnancy, delivery or the first critical hours after birth (WHO, 2005).

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.

The World Health Organization estimates that about 536,000 women of reproductive age die each year from pregnancy related complications (WHO, 2005). Nearly all of these deaths (99%) occur in the developing world (WHO, 2005). These deaths are almost equally divided between Africa (251,000) and Asia (253,000), with about 4% (22,000) occurring in Latin America and the Caribbean and less than 1% (2,500) in the more developed regions of the world. Maternal mortality rate also shows the same disparity among regions. The world is estimated to be 400 per 100,000 live births. It is higher in Africa (830), followed by Asia (330), Oceania (240), Latin America and the Caribbean (190), and at the bottom the developed countries (20) (AbouZahr, 2003).

Maternal mortality is one of the greatest development and health challenges facing the developing world. Maternal mortality ratios have barely fallen in the last fifty years, even as other health indicators have improved. The average woman in sub Saharan Africa (SSA) faces a 1:16 life risk of dying in pregnancy and childbirth, compared with a 1 in 2800 chances for a woman in a developed country (WHO, 2003).

Maternal mortality in developing countries and economically restrained settings remains a daunting and largely unmet public health challenge. Thus, improving maternal health and reducing the 1990 level of maternal mortality rates by 75% by 2015 is set as a key goal in the UN Millennium Development Goals (MDGs). Economic development has its own contribution in improving maternal health in developing countries. There are examples that confirm that combining a strategy of professionalization of delivery care with a strong

public commitment works. In Sri Lanka, for example, maternal mortality levels, compounded by malaria epidemics, had remained well above 1,500 during the first half of the twentieth century. From around 1947 they started to drop, "closely following the development of facilities for health care in the country" (Seneviratne and Rajapaksa, 2000).

Ethiopia is one of the largest countries in SSA which covers an area of 1.14 million km^2. According to the third Ethiopian 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). It is a country with great geographical diversity. Its topographical features range from the highest peak of Ras Dashen, 4,620 meters above sea level (masl), down to the lowest and hottest point of the earth in the Afar, Danakil depression, 110 meter below sea level (mbsl).

As in many developing countries, Ethiopia experiences a poor health condition. The main health problems that account for about 60-80% of the disease burden in the country are communicable diseases and nutritional deficiencies. In addition, widespread poverty, low educational level, poor socio-economic status, inadequate access to clean water and sanitation facilities, low health care utilization and poor knowledge on disease prevention are major contributors to the current ill-health of the population.

In Ethiopia, the levels of maternal and infant mortality and morbidity are among the highest in the world. Maternal mortality rate in the country continues to be at an unacceptably high level. An estimated 2.9 million women give a birth every year; of these approximately over

25,000 women and girls die each year and more than 500,000 suffer from serious injuries and permanent damage to their health, such as obstetric fistulas (FMOH, 2005).

Though the issue of improving maternal health care services has been high on the international agenda for two decades, the ratio of maternal mortality seems to have changed little in regions where most deaths occur, i.e. Sub-Sahara Africa and Southern Asia. Adequate reproductive health services and family planning are essential in improving maternal health. Therefore, adequate utilization of the maternal health services would contribute substantially in achieving this goal.

Good care during pregnancy is important for the health of the mother and the development of the unborn baby. Pregnancy is a crucial time to promote healthy behaviors and parenting skills. Good antenatal care links the woman and her family with the formal health system, increases the chance of using a skilled attendant at birth and contributes to good health through the life cycle. Inadequate care during this time breaks a critical link in the continuum of care, and affects both women and babies.

Antenatal care (ANC) is an important determinant of high maternal mortality rate and one of the basic components of maternal care on which the life of mothers and babies depend (McCarthy and Maine, 1992). Systematic antenatal care was first introduced early in the 20th century in Europe and North America and is now almost universal in the developed world (WHO, 1992).

Antenatal care is defined as a dichotomous variable, having had one or more visits to a trained person during the pregnancy (WHO, 1991). It includes routine follow up provided

to all pregnant women at primary care level from screening to intensive life support during pregnancy and up to delivery (Jafarey, 1993 and McDonagh, 1996).

Antenatal care clinics are expected to provide pregnancy surveillance of the woman and her unborn child, preventive measures, including immunization (especially with tetanus toxoid) and screening for underlying conditions and diseases such as anemia, malaria, sexually transmitted infections (of which syphilis is particularly important owing to its negative impact on maternal and neonatal health and the links to a high incidence of stillbirth and low birth weight), HIV infection, and symptoms of stress. They are also expected to provide management of pregnancy-related complications, treatment of diseases (particularly prevention of HIV transmission from mother to child), advice and support to women and their family in developing a birth and emergency preparedness plan as well as health education and promotion for women and their family, including nutritional support (WHO, 2006).

In recognition of the potential of care during the antenatal period to improve a range of health outcomes for women and children, the world summit for children in 1990 adopted antenatal care as a specific goal, namely "Access by all pregnant women to antenatal care, trained attendants during child birth and referral facilities for high risk pregnancies and obstetric emergencies" (WHO, 1990).

Antenatal care is the monitoring of mother and fetus by trained health personnel throughout the whole pregnancy with the necessary examination and recommendation by regular intervals. According to the World Health Organization's recommendation, a minimum of four antenatal visiting (at least 20 minutes duration for each) is needed to accomplish the

essential level of ANC (Overbosch, G., 2002). If for any reason the women cannot make the recommended number of visits, then a minimum of four visits are to be made at 10th, 20th, 30th, and 36th week of pregnancy since some empirical evidence have shown that four visits suffice for uncomplicated pregnancies, and more visits are only recommended in case of pregnancy complications (WHO 1991; Dana, 2003; Overbosch, et al. 2002 and UNICF/FMOH, 1987-1998).

Antenatal care is the third indicator towards universal access to reproductive health. The proportion of pregnant women in low- and middle-income countries who had at least one antenatal care visit increased from less than 55% in the early 1990s to almost 75% in a decade. Although this is an improvement, the recommended norm of four antenatal visits is still not accessible to many pregnant women worldwide: for example, 55% of those in sub-Saharan Africa (WHO, 2005).

One explanation for poor health outcomes among women and children is the non-use of modern health care services by a sizable proportion of women in Ethiopia. According to the 2007 report of the Ministry of Health of Ethiopia, about 52% Ethiopian women received antenatal care (ANC), less than 17% received professionally assisted delivery care.

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 antenatal care services utilization between rural and urban Ethiopia.

The antenatal period offers opportunities for delivering health information and services that can significantly enhance the health of women and their infant. Despite the fact that antenatal 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 Ethiopia. This paper therefore aims to fill this gap using data from the 2011 Ethiopia Demographic and Health Survey.

1.2 Statement of the Problem

Women 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. Maternal and child health care begins with the immediate health problems of mothers and children and extends to health throughout life and to the health of the community (WHO, 1976).

Ethiopia has given priority to improve maternal health services. Accordingly, various measures have been taken to increase skilled attendance at antenatal, delivery and postnatal care as well as access to emergency obstetric care, early referral system and training of Anti retroviral therapy (TBAs) and community health workers. Measures are tailored to address societal and cultural factors that influence women's health and their access to maternal health services.

Antenatal care is an integral component of maternal and child health care (MCH) as part of global strategies for achieving health for all (Mesham, 1992). It is an effective health intervention tool for reducing the risk of maternal morbidity and mortality, particularly in places where the general health status of women is poor (Lain and Erica, 1989). The purpose of antenatal care is to screen for sign of illness or other complications that may occur during pregnancy. For instance, blood-pressure measurements and urine analysis done during antenatal care visits can screen pregnant women for hypertensive disorders of pregnancy (including pre-eclampsia and eclampsia) and to seek medical attention when the condition appears (WHO, 2006). It is also an opportunity to treat existing diseases, which may be aggravated by pregnancy such as sexually transmitted diseases, anemia, hypertension, etc (UNICEF/WHO, 2004). The provision of iron tablets during pregnancy has been shown to reduce the risk of being anemic, which is an important risk for hemorrhage and cardiac failure during pregnancy (William, 1989). It also provides an opportunity to be immunized against tetanus toxiod. Both of these interventions are considered highly effective (WHO, 1990 and William, 1989). In late pregnancy, antenatal visits can help identify women at risk for difficult deliveries (including cephalo-pelvic disproportion and a breech or transverse presentation) and direct those to appropriate delivery care (UNICEF and WHO, 2001). Antenatal care use has been shown to influence women's use of delivery services, as well; neonatal and infant health has been shown to be significantly affected by women's use of antenatal care (Mesham, 1992 and Melkamu, 2005). The high rate of deaths of women during pregnancy, childbirth or in the immediate postpartum period is due to different influencing risk factors. These are directly linked to socio-economic, demographic, and health service factors.

The purpose of this study was to understand the current status of utilization of antenatal care services in Ethiopia by elucidating the various factors influencing the use of these services in the country. It is hoped that the results of the study would identify the most significant factors of utilization of antenatal care services and will improve policymakers' understanding of the determinants of maternal and child mortality and morbidity in the country and serve as an important tool for any possible intervention aimed at improving the low utilization of antenatal care services in the country.

1.3 Objective of the study

General objective

The general objective of this study is to assess the factors that affect the frequency of utilization of antenatal care services in order to improve maternal and child health services of reproductive age group women (15-49 years) in Ethiopia.

Specific objectives

1. To investigate the antenatal care coverage and its barriers.
2. To identify the most important socio-economic and demographic factors associated with the number of antenatal care visits by women of reproductive age group in Ethiopia.
3. To estimate an appropriate model that shows the relationship between the frequency of utilization of antenatal care services and demographic and socio-economic variables.

1.4 Significance of the study

- In this study an analysis of factors influencing the frequency of utilization of Antenatal Care Services is presented. This may help in solving the problem of no or low antenatal care utilization of reproductive age group women in Ethiopia.

- Much has been said and done about antenatal care utilization both in Ethiopia as well as in the world at large. Despite the fact that different findings about the utilization of antenatal care services have been reported, this research provides updated information of antenatal care utilization of reproductive age group Ethiopian women. The findings could enable concerned bodies know about the current status of antenatal care utilization in Ethiopia and evaluate the outcomes of maternal care and control maternal mortality which have been practiced in the past.
- The policy of the government is to increase maternal health care facilities and improve on the existing ones to make them easily accessible and therefore increase utilization. So, the study will help to guide the end user governmental and non-governmental organizations to develop antenatal care programs and set appropriate plans to tackle the existing problems related to health and antenatal care services utilization.
- Finally, the study may well be used as a stepping- stone for further studies.

1.5 Scope and limitation of the study

This study is based on data from the 2011 Ethiopia Demographic and Health Survey (EDHS 2011) and considered women aged 15-49 who were married during the five-year period before the survey. The study used information on women with the most recent birth only. Like any other source of data the EDHS 2011 has its own limitations.

- Generating accurate estimates of number of antenatal health care visits poses a considerable challenge because of the limited availability of high-quality data for many developing countries. Vital registration systems are the preferred source of data on antenatal care attendances because they collect information as events occur

(minimize recall errors from women) and cover the entire population. However, many developing countries like Ethiopia lack vital registration systems that accurately record all antenatal care attendances.

- Though there are many factors associated with utilization of antenatal care services as indicated by different studies in different countries, this study is undertaken to explore some of the socio-economic, demographic, health services related factors in Ethiopia as provided in the 2011 EDHS.

1.6 Organization of the Study

This study is presented in five chapters. In the first chapter, introduction and background of the study; statement of the problem; objectives, significance, scope and limitation of the study are presented. Chapter 2 deals with the review of related literature on factors influencing the utilization of antenatal health care services in Ethiopia and the rest of the world, whereas Chapter three specifies the data and methodology of thc study such as sources of data and variables included in the study with their coding and description. Methods of data analysis are also described in this chapter. Chapter 4 provides the results of the statistical data analysis. The last chapter presents discussion, conclusion and recommendations based on the findings of the study.

CHAPTER TWO

2. LITERATURE REVIEW

2.1 Review of Antenatal Care

The antenatal period is an occasion that brings the pregnant woman in contact with the health service, for many women the first contacts with the health care system. The provision of a high quality comprehensive care during this period could influence the general health of the woman and her unborn child. The antenatal period provides the primary health care professional nurse the opportunity to provide care and information related to the pregnancy. An example of information that should be provided is the danger signs of high risk conditions like a reduction in fetal movement, which if experienced by the woman, should motivate her to seek health care. The antenatal period also provides an opportunity to screen for and provide information on non-pregnancy related diseases such as HIV/AIDS and tuberculosis, which may influence the general health of the pregnant woman.

Several studies have shown that there exist an association between the use of antenatal care and positive maternal outcome. For example, a study in Vietnam, found that antenatal care reduced maternal mortality by improved nutrition and screening for high risk pregnancies (Swenson et. al 1993). Antenatal care use is also a major means of reducing maternal and child mortality in Nigeria as it provides opportunity for early detection of complications at pregnancy (Babalola and Fatusi, 2009). In addition, the study by Coria-Soto et al (1996 cited in Măgadi et. al 2000), found that inadequate number of visits was associated with 63% higher risk of intra uterine growth retardation. Work from Tanzania stated that 81% of risk factors could be identified in the antenatal period (Essex and Everett 1977 cited in

McDonagh 1996). The risk factors in here are associated with the women's medical obstetrical and social history or circumstances and those arising during the antenatal period.

Although antenatal care alone cannot prevent all obstetric emergencies, the information provided by antenatal service provider is important for the successful management of pregnancies and the subsequent wellbeing of the child. Antenatal care provides an entry point for women to the health care system. The objective of the system is to monitor the pregnant women regularly during their pregnancy, so that the risk factors can be identified (Llewellyn and Jones 1990 cited in McDonagh 1996). Antenatal care presents an opportunity to evaluate the mother's overall condition, diagnose and treat infections, screen for anemia and HIV/AIDS and prevent low birth weight (UNFPA, 2004). 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 might theoretically reduce maternal morbidity and mortality directly through detection and treatment of pregnancy related or inter current illness or indirectly through detection of women at increased risk of complication of delivery and ensuring that they deliver in a suitable equipped facility (Guilleromo C., Clean R. and Josen V. 1992). In addition to lack of sufficient maternity care services; low utilization of those services that are available to pregnant women in developing countries has been recognized as a problem. Recent studies indicate that less than one-third of women in developing countries receive ANC and only about 20% of births occur under the supervision of trained attendants (WHO, 1997 and Akala, 1993). The average number of visits among women who sought prenatal care was more than five in India and Indonesia, two in Bangladesh and 3.5 in Egypt. The

provider of ANC varied substantially among the four sites. In Egypt and India the government health center was the most important sources antenatal care services (Fortney and Smith, 1996; Guilleromo, Clean, Josen, 1992).

Many women living in developing countries including Ethiopia are at risk of pregnancy-related complications including hemorrhage, obstructed labor, pre-eclampsia/eclampsia, and infection. Previous studies in Ethiopia have clearly shown that 27% of Ethiopian women received antenatal care, and less than 10% received professionally assisted delivery care (Fantahun, 1992; Overbosh and Vanden et al, 2002; Sevkat and Ayse, 1998; UNICEF/FMOH, 1987-1998 and Omar, 1994). Approximately, more than half of all women in developing countries receive at least four antenatal care visits during pregnancy (UNFPA, 2004). However, there are a number of factors in developing countries that have the potential to be a hindrance to these aspects of antenatal care from being successful.

2.2 Importance of Antenatal Care

Antenatal care can play an important role in improving maternal health, not by itself but through encouraging women to use other services such as institutional delivery and advice on pregnancy or delivery complications. ANC motivate pregnant woman facing any pregnancy complication to seek advice for her problems. Level of ANC use does make a difference to the chances of delivering in an institution. A study on rural Uttar Pradesh shows the likelihood of women with high ANC use delivering in an institution three times higher than for women with no ANC use (Fausdar and Abhishek, 2006).

The effectiveness of ANC has provoked much debate about its usefulness because little is known about its effectiveness in the reduction of maternal and infant mortality and

morbidity (Carrole et al., 2001). Despite all these reservations, ANC in developing countries is important especially to pregnant women. Efficacy of ANC should also ensure dissemination of information on maintaining good health of pregnancy, danger signs and when and where to go for help should these appear (Yuster, 1995). The goal-oriented ANC guidelines using need-focused care have been designed to address aspect of quality, adequacy and effectiveness.

The value of a number of screening tests and interventions at ANC service centers is firmly established. Examples include the prevention and treatment of malaria and anemia, the early detection of hypertension and protein, urea, and the treatment of severe hypertension. Rooney (1992) reviewed the evidence of the various screening tests, diagnostic investigations and interventions. A WHO Technical Working Group has also produced recommendations on the content of antenatal care (WHO, 1996). In 2001 WHO then published the outcome of a randomized trial to test a new model of antenatal care (Villar, et al., 2001). For routine antenatal care in this new model four visits are recommended; details of the content of these visits are presented based on the available evidence (WHO, 2002). Data for 2000-2001 show that just over 70% of women worldwide have at least one visit with a skilled provider during pregnancy. In developed countries usage is as high as 98% whilst in developing countries the average is around 68% nearly 2 out of every 3 (Abou-Zahr, 2003).

While antenatal care can be an important tool in diagnosing and preventing risks during pregnancy, many women in developing countries do not use this service. Using a three level linear regression model, data from the 1993 Kenya Demographic and Health Survey were analyzed to determine the frequency and timing of use of antenatal care services. The result

showed that the median number of antenatal care visit was four and the first visits occur in the fifth month of the pregnancy on average (Magadi et al, 2000). Use of antenatal care is started later and is less frequent for unwanted and mistimed pregnancies. Even women who appear to use antenatal care frequently are less likely to use the services for a mistimed pregnancy. Long distance to the nearest antenatal care facility is an obstacle to antenatal care (Magadi et al, 2000).

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.

In Ethiopia, in addressing high priority health problem in women, the Safe Motherhood initiatives and health policies that are directed to reduction of deaths in women are being implemented (MOH, 1992-1996). The ANC coverage ranges from 10% in some rural areas to 39% of women in the third trimester never had a prenatal visit at the time of the survey (Fantahun, M., 1992 and Bachman S., 1997). The community-based study in South West Ethiopia revealed antenatal care attendance of 48% (Celik and Hotchkeriss, 2000). The difference in health service utilization between urban and rural was explained to be attributable to the fact that the urban mothers have more access to the different health services and better education levels.

The factors that prevent women in developing countries from getting the life saving health care needs include: cost (direct fees as well as the cost of transportation, drugs and supplies); multiple demands on women's time; women's lack of decision-making power within the family. The poor quality of services, including poor treatment by health providers, also makes some women reluctant to use the services (WHO, 1997).

2.3 Factors Influencing Utilization of Antenatal Care Services

The high rate of deaths of women during pregnancy, childbirth or in the immediate postpartum period is due to different influencing risk factors. The lifetime risk of death due to pregnancy-related complications is 250 fold higher among women in developing than in developed countries (Yanagisawa et al, 2006). These are directly linked to socio-economic, demographic and health service factors.

2.3.1 Socio-economic factors

The general socio-economic status of mothers, ability of women to manage resources and make independent decisions about their health has an impact on reduction of maternal mortality. Lack of education and poor knowledge about antenatal care can contribute to delays in seeking care during pregnancy and childbirth. Poverty is one of the major health determinants. Poor mothers are at high risk of developing pregnancy related complications. Almost all maternal deaths that occur in low and middle-income countries are mainly among the poorest of the poor (WHO, 2005).

Amongst the maternal characteristics, education of women has been found to have the strongest association with the use of antenatal care services. Educated mothers are considered to have a greater awareness of the existence of maternal health care services and

benefited in using such services. Educated mothers are likely to have better knowledge and information on modern medical treatment and have greater capacity to recognize specific illnesses. As education empowers women, they have greater confidence and capability to make decision to use modern health care services for themselves and for the children (Caldwell, 1979 and Schultz, 1984). Education also enables women to take personal responsibility for their own health and the health of their children. Finally, schooling reflects a higher standard of living and access to financial and other resources, because better educated women are more likely to marry wealthier men or they have increased earnings themselves (Schultz, 1984).

In Peru for example, formal education of women influences the use of maternal health care services. Results from both the cross-sectional and fixed-effects model, controlling for service availability and the socioeconomic status of the household, confirmed the importancc of maternal education on the utilization of both prenatal care and delivery assistance (Elo 1992). Similarly, in Thailand, one analysis showed that maternal education exerts a significant influence on the use of maternal health care services; the odds of using prenatal care and formal delivery assistance is much greater for women with primary schooling, compared to women with zero years of schooling (Raghupathy 1996).

Regassa (2011) investigated the antenatal and postnatal care service utilizations by women in the southern Ethiopia. A questionnaire was used to gather information on the factors that are significantly associated with antenatal Care and Postnatal Care usage. It was revealed in the study that women with high level of education and exposure to mass media as well as low parity have higher usage of antenatal and postnatal care. However, unlike previous

findings that revealed low utilization of antenatal care in the rural area, this study showed high antenatal care use in the rural population of Ethiopia.

Similarly, a few studies in Ethiopia revealed that education is a major factor determining utilization of antenatal care services. According to Ethiopian DHS 2005, about 75% of women with at least secondary schooling received antenatal care from health professionals. Another study conducted on determinants of antenatal care utilization in Arsi Zone, central Ethiopia found that 71% women with at least secondary schooling received antenatal care (Mekonnen 1998, WHO 1997, CSA, EDHS 2005).

A study in India reported that matriculate education has the largest and statistically significant impact on the probability of health care use. It increases the probability of pre and post natal care use by 10 percent and 8 percent respectively and the probability of the use of trained help at the time of delivery by 7 percent (Shariff and Singh 2002).

Existing research on health outcomes in developing countries has shown the important role of the media in disseminating information on health related issues. Three sources of information are usually used: radio, television and newspapers and magazines. Women's exposure to information through the radio, television and newspaper significantly increases the utilization rates for all services in India (Shariff and Singh, 2002). There is a 5 percent increase in the probability of the use of antenatal care for a woman who frequently listens to the radio compared to a woman who does not. Moreover, a study by Obermeyer (1993) in Morocco and Tunisia indicated that watching television weekly is associated with an increase in the likelihood of both prenatal care and hospital delivery.

Employment can increase women's economic autonomy and reproductive health status because it raises awareness and provides new ideas, behavior and opportunities through interaction with other people outside the home and community (Sharma et.al. 2007).

Elizabeth S. and, Slegfried Kunz et al, (2004) in their findings about the association between maternal occupational status and utilization of antenatal care in Germany as cited by Greenberg (1983); wrote that the use of antenatal care varies between different social groups of women. They stated that maternal socio-economic factors influence health behavior.

In many parts of Africa, women's decision-making power is extremely limited, particularly in matters of reproduction and sexuality. In this regard, decisions about maternal care are often made by husbands or other family members (UNICEF 1987-1998). Availability of women's time is also important. In developing countries, women spend more time on their multiple responsibilities for care of children, collecting water or fuel, cooking, cleaning, growing food, and trade than on their own health (World Bank 1994, Guillermo et al, 1992).

A study done in Egypt on the antenatal care use among women of reproductive age (Dina and Mohamed, 2012) using zero-inflated negative binomial regression, identified the impacts of women's background characteristics on the number of ANC visits. The study revealed that women's age, women's education, terminated pregnancy, reading newspaper, watching TV, relationship between spouses, place of residence, region, parental education, wealth index have significant influences on the number of ANC visits. The study also indicated that women's background characteristics have significant impact on the probability that women will have zero visits.

Study of rural Ghanaian women, posited that economic ability to access health is a major factor affecting health care seeking behaviors in general and reproductive health care of women in particular. For example, in Ghana, the majority of women have limited control over family property and household financial resources and limited access to credit from financial institutions. Women's financial dependence on their husbands affects their decision making because health care options must be supported by husbands (Tawiah, 2011).

The study conducted by the Ethiopian Society of Population Studies (2008) revealed that household decision making autonomy was 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.

2.3.2 Demographic factors

The risk of a woman of dying in pregnancy and childbirth depends on the general reproductive health of the mother and the number of pregnancies she has had in her lifetime. The higher the number of pregnancies, the greater the lifetime risk of pregnancy related deaths (WHO, 2005). Maternal age also has an impact on increasing the risk of dying. Girls below 18 years and women older than 35 years are more likely to have pregnancy related complications that may lead to maternal death (USAID, 2005).

Since older and younger women have different experience and influence, their behavior on seeking health care also vary. Commonly, younger women are more likely to utilize modern healthcare facilities than older women, as they are likely to have greater exposure and knowledge to modern health care, also more access to education. Older women, on the other hand, have accumulated knowledge on maternal health care and therefore likely to have

more confidence about pregnancy and childbirth or they may be less comfortable with modern medicine and more reluctant to take advantage of available services; consequently, they may give less importance to obtain institutional care (Raghupathy, 1996). In contrast, experience and skills acquired by older women should have a positive influence on the use of health services.

One study in Nepal (Sharma et.al 2007) showed that women over the age 35 are less likely to utilize prenatal care but more likely to utilize delivery and postnatal care. However, a study in Bangladesh indicated that type of assistance utilized at delivery does not differ significantly with the age of the mother (Paul and Rumsey, 2002). In the Philippines, older women tend to have fewer traditional visits both in urban and rural areas and to increase their private visits in urban areas (Wong et al., 1987).

According to Matua (2004), as cited by Chaibva C.N.M (2008), pregnant adolescents might avoid ANC services for fear of being labeled "promiscuous". On the other hand, older adolescent who have had uneventful pregnancies and deliveries with previous pregnancies might see no reason to attend ANC. In 19 out of 26 developing countries, women who were 19 years or younger were reportedly less likely than older women to seek ANC from health professionals (Reynold et al 2006).

Place of residence can also be an important determinant of the use of modern health care resources for childbirth. A higher proportion of births in urban areas occur in modern health care facilities compared to rural areas (Paul and Rumsey, 2002). A study in Morocco also indicated that place of residence is the strongest predictor of use of maternal health care, with urban women two or three times more likely to use health services (Obermeyer, 1993).

Wong et. al, (1987) in a study in Philippines, reported that 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).

Dairo and Owoyokun (2010) looked into the significant determinants of antenatal care service use in Nigeria, specifically focusing on Ibadan, using multivariate logistic regression. The study revealed a significant difference in residence, religion and age in relationship with antenatal care use in Ibadan. The women in the urban residence utilize antenatal care more than women in the rural residence. Therefore, the study suggested that intervention programs should target promoting antenatal care services in the rural areas and among younger women and Christian women. Also, religious organizations should help promote the use of antenatal carc in Nigeria.

According to a household survey in southern Iraq, the relationship between health unit and place of residence has shown that utilization rates decline sharply with increasing distance traveled (Habib and Vavgan, 1986). WHO also reported that distance from maternal and child health (MCH) services, and the time and the cost involved in traveling to services to be all highly significantly associated not only with ANC use but also with the use of institutional delivery, postnatal and infant care services (WHO, 2006). Urban rural differential in the use of antenatal care remain skewed towards the rural residents in Nigeria (Dairo and Owoyokun, 2010).

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 were more likely to use antenatal care services.

With respect to birth order, several studies show a strong negative association between birth order and the use of health care services. One study in Turkey (Celik and Hotchkiss, 2000) showed that women who delivered their first child were found to be significantly more likely to use prenatal care and trained assistance during the birth delivery than women in the higher order. Another study in urban areas of the Philippines found out that the probability of choosing either public or private modern care more frequently instead of traditional care decreases as the number of children aged zero to six years old increases (Wong et al., 1987).

There are perhaps, three possible explanations for this. Firstly, women with first child pregnancy were more cautious about their pregnancies and therefore sought out trained professional. Secondly, as the number of children born increases, women may tend to believe that modern health care is not as necessary and tend to rely more on her past experiences and knowledge. Thirdly, a higher birth order suggests a greater family size and hence lower resources (both time and money) available to seek formal healthcare. As the number of living children increases, the less likely she is to receive pregnancy care from a skilled health care provider. Findings by Obemeryer (1993), Awusi et al. (2009) and Assfaw (2010) in Morocco-Tunisia, Nigeria and Ethiopia, respectively, revealed that parity has a negative relationship with antenatal care usage. Reasons ascribed to this attitude include the experience women gain with each succeeding pregnancy and childbirth, and the time and cost pressures associated with larger families, which decrease utilization.

2.3.3 Health service factors

As several studies from developed and developing countries indicated, health service barriers and women's perception of quality of ANC were other important factors affecting women's attendance during pregnancy. Though women's knowledge and experience about childbearing might influence their use of ANC, if the attitude of the health provider and his/her treatment of the service seeker are deemed poor, the service seeker will be less likely to return and use the services. Several studies in both developed and developing countries have documented that a long wait for short consolation time, lack of respect for the client, and poor communication have been found to be major factors in women's perception of care (Paine 1989, Poland 1987 and Pettiti 1991).

The role that quality of care plays in the decision to seek care is related to people's own assessment of service delivery, which largely depends on their own experiences with the health system and those of people they know (Nnadi and Kaba, 1987; WHO, 1990). The two mechanisms through which quality of care affects the decision to seek care are satisfaction or dissatisfaction with the outcome (e.g. effectiveness of the treatment and remedies prescribed), and satisfaction or dissatisfaction with the service received (e.g. staff attitude, long waiting time, hospital procedure, and availability of supplies, efficiency) (Kloos H. 1987; WHO, 1996 and Nnadi and Kaba, 1987). These factors will act as inhibitors of future utilization, thus affecting the decision to seek care. As several studies from developed and developing countries indicate, health services barriers and women's perception of quality of ANC were important factors affecting women's attendance during pregnancy (WHO/UNICEF, 1990-2001). Studies on quality of ANC are scarce in Ethiopia and other developing countries.

Access to ANC is important in helping to modify women's risk behaviors and promote positive health practices for adolescents risk of future unplanned pregnancies and sexually transmitted infections (STI) (Slap, 1995). Antenatal care services should be accessible to all pregnant women irrespective of social status, age, race or level of education and HIV status, and should provide an environment of trust and confidentiality (Kluge, 2006 and Kathyryn, 1997).

One of the key factors that can contribute to reducing maternal and perinatal mortality is access to antenatal care services. These services permit detect in time complications that can arise during pregnancies or childbirth, as well as ensure that women have access to educational programs, vaccinations, diagnostic tests and treatment for infectious diseases (Di Mario, 2005 and Gross, 2011).

In most rural areas in Africa, one in three women lives more than five kilometers from the nearest health facility. The scarcity of vehicles, especially in remote areas, and poor road conditions can make it extremely difficult for women to reach even relatively nearby facilities. Walking is the primary mode of transportation, even for women in labor (World Bank, 1994b).

Since the use of reproductive health services in general, and antenatal care in particular are low, maternal and infant morbidity and mortality rates are very high in Ethiopia, The 2005 Ethiopian Demographic and Health Survey (EDHS) has shown that only 28% of women received antenatal care and only 6% of women were assisted by a health professional for their most recent birth (EDHS 2005). Few studies have addressed the reasons for under utilization of antenatal care services in Ethiopia. Existing studies showed

that lack of awareness about ANC, inaccessibility of health services, lack of time due to women's work load, long waiting time, poor quality of ANC services and husband disapproval are among the major factors contributing for the low use of antenatal care services (Mekonnen and Mekonnen, 2002; Mekonnen, 2003; Materia and Mehari, 1993; Jara and Belachew, 2005 and Tesema et al, 2006).

This study examines whether antennal care service utilization is influenced by women education, educational status of husband, women's working status, women's age at birth, birth order, wealth index, region, the accessibility of health services and religion are some of the independent variables, which are assumed to have positive or negative associations with the utilization of antenatal care services. Given that reducing the high level of maternal mortality for Ethiopia's development agenda, determining the factors affecting antenatal care use is crucial. However, we cannot use the entire spectrum of determinants, because sufficient data are not available. Insights on the major factors that affect antenatal care utilization will help targeting interventions on factors with high impact on reducing maternal death in rural areas.

CHAPTER THREE

3. DATA AND METHODOLOGY

3.1 Data source

This study was based on data from the 2011 Ethiopia Demographic and Health Survey (EDHS) obtained from the Central Statistical Agency (CSA) of Ethiopia. The 2011EDHS was 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 (nine regions namely: Tigray, Affar, Amhara, Oromiya, Somali, Benishangul-Gumuz, Southern Nations, Nationalities and Peoples (SNNP), Gambela and Harari regional states and two city administrations: Addis Ababa and Dire Dawa).

The principal objective of the 2011 EDHS was 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 anemia.

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. 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.

The 2011 EDHS obtained information on ANC coverage from responses of women who were married in the five years preceding the survey. Only women aged 15-49 whose last birth was during the five-year period before the survey were included in the analysis, the EDHS data refer to the most recent birth only. This study considered 7,737 women aged 15-49 who gave birth during the five-year period before the survey.

3.2 Variables of the Study

Response Variable: The response variable of this study, Y_i, is a count, which gives the number of utilization of antenatal care services that each mother has experienced in her pregnancy period, Y_i= 0, 1, 2, … where i denotes the ith individual mother.

Response variable(Y_i)	Count
Number of antenatal care visits during pregnancy(No.ANC)	$Y_i = 0,1,2,...$

Predictor (explanatory) variables: The most important expected determinants of utilization of antenatal care services identified in various literatures were considered looking at their theoretical justification from the source data. The explanatory variables at individual and household level to be analyzed are grouped as socio-economic, demographic and health services related factors.

Detailed description of socio-economic, demographic, and health services related variables related to utilization of antenatal care services is presented as follows:

No.	Description and Name	Categories
1	Woman's age (AGE)	0=15-19 (younger mothers) 1=20-34 (adult mothers) 2=35-49 (older mothers)
2	Woman's educational level(WOMEDUC)	0=No-education 1=Primary 2=Secondary 3=Higher
3	Woman's employment Status(WOMEMP)	0= Non-Employed 1=Employed
4	Husband's education level(HUSEDUC)	0=No-education 1=Primary 2=Secondary 3=Higher
5	Wealth index of the household (WLTHINDEX)	0=poor 1=Middle 2=Rich
6	Mass media exposure of woman's(MMEXP)	0=No 1=Yes
7	Place of Residence(RESIDENCE)	1=Urban 2=Rural
8	Region(REGION)	1=Tigray 2=Affar 3=Amhara 4=Oromiya 5=Somali 6=Benishangul-Gumuz 7=SNNP 8=Gambela 9=Harari 10=Addis Ababa

		11=Dire Dawa
9	Religion(RELIGION)	1=Orthodox 2= Catholic 3=Protestant 4= Muslim 5=Others
10	Birth Order(BIRORD)	0=1 1=2-4 2=5+
11	Terminated Pregnancy (TP)	0=No 1=Yes
12	Access to health services(AHS)	0=No 1=yes

3.3 Methods of Data Analysis

When the response (dependent) variable is a count (which can take on non-negative integer values (0, 1, 2, ...), it is not appropriate to use linear models based on normal distribution to describe the relationship between the response variable and a set of predictor variables. Also, it is not appropriate use the binary logistic regression model when the response variable is not binary (0, 1). In this case the Poisson regression (PR) model is appropriate (Cameron and Trivedi, 1998).

The Poisson regression (PR) model is often applied to study the occurrence of small number of counts or events as a function of a set of predictor variables (Porodi and Bottarelli, 2006).

The Poisson regression model assumes that the mean and the variance of the response variable are equal but in practice, the observed variance of the data may be larger than the corresponding mean. In such cases, the data is said to have over dispersion, the variance is larger than the mean, for such situations, the PR model is not appropriate. Rather the negative binomial (NB) regression model is appropriate (Osgood, 2000).

Although the Poisson regression model and negative binomial regression model are rarely used in many recent applications a situation where a dependent variable with a very high count of zeros may make it necessary to use a zero-inflated negative binomial (ZINB) regression model for consistent estimation (Broek, 1995; Hall 2000; Ridout et.al., 2001; Lachenbruch, 2002; Berk and Lachenbruch, 2002 and Gupta, et.al.2005); therefore this option will be depicted subsequently.

3.3.1 Poisson Regression Model with Several Covariates

Suppose Y_i denotes the count of the number of antenatal care utilization visits from the ith pregnancy. It is assumed that the observed count Y_i is sampled from a Poisson distribution with the conditional mean μ_i given a vector of covariates/predictors x_i for each i^{th}subject. The count Y_i has the probability mass function:

$$p(Y_i = y/x_i) = \frac{\exp(-\mu_i)\mu_i^y}{y!}, \; y = 0,1,2,...$$

where: $\mu_i = \exp(x_i'\beta),\; i = 1, 2, ..., n$

$X_i = (x_{i1} = 1, x_{i2}, ..., x_{ip})'$, is the i^{th}row of data/design matrix X, and

$\beta = (\beta_1, \beta_2, . . ., \beta_p)'$, is unknown p-dimensional column vector of parameters.

$E(Y_i/x_i) = Var(Y_i/x_i) = \mu_i$, which unfortunately also becomes a major limitation of this model in applications.

Given independent observations with the density function, the log-likelihood function can be obtained by:

$$l(\beta) = \sum_{i=1}^{n}[Y_i\log(\mu_i) - \mu_i - \log(Y_i!)]$$

$$= \sum_{i=1}^{n}[Y_i x'_i\beta - \exp(x'_i\beta) - \log(Y_i!)]$$

The maximum likelihood estimator of the parameters of Poisson regression can be obtained very easily using software.

If there is over-dispersion, causing the variance to be larger than the mean, then the estimation using the poisson regression will be inefficient. The distribution of the Y_i , the number of antenatal care visits, during period of pregnancy is skewed to the right causing the variance to be much larger than the mean. Furthermore, given the large variation in the sample between each respondent, number of antenatal care utilization visits taken during pregnancy period, there is likely to be substantial unobserved heterogeneity. To address these issues, the negative binomial regression model includes an unobserved specific effect e_i (random term or error term) in to the parameter μ_i (Cameron and Trivedi, 1998; Long, 1997 and Greene, 2008).

3.3.2 Negative Binomial Regression

A negative binomial (NB) distribution can be used as it allows for over-dispersion and unobserved heterogeneity (not correlated with explanatory variables) of the data. Specifically, NB extends the Poisson by positing that the conditional mean μ_i of the response variable Y_i is not only determined by the independent variable x_i but also by an unobserved heterogeneity component e_i independent of x_i. If we assume that $\exp(e_i)$is distributed as a gamma distribution with $E(\exp(e_i)) = 1$ and $var(\exp(e_i)) = 1/\alpha$ (Dean et al., 1989 and Denuit et al., 2007), for the gamma mixture of the Poisson distribution yields the negative binomial distribution of Y_i. Therefore marginally Y_i has the probability mass function:

$$p(Y_i/x_i) = \frac{\Gamma(Y_i+1/\alpha)}{\Gamma(Y_i+1)\Gamma(1/\alpha)}\left(\frac{1/\alpha}{1/\alpha+\mu_i}\right)^{1/\alpha}\left(\frac{\mu_i}{1/\alpha+\mu_i}\right)^{Y_i}, \quad i = 1, 2, \ldots, n$$

Where: α is dispersion parameter and

$$\mu_i = \exp\left(x_i'\beta + e_i\right) = \exp(x_i'\beta)\exp(e_i)$$

Since $E(\exp(e_i)) = 1$ implies $E\left(\exp\left(x_i'\beta + e_i\right)\right) = E(\exp(x_i'\beta))$, that is, whether we assume a Poisson or a negative binomial distribution, the expected value of μ_i does not change. However, since the dispersion parameter, $\alpha > 0$, under the negative binomial distribution, $Var(Y_i/x_i) = \mu_i(1 + \alpha\mu_i) > 0$. Therefore, $Var(Y_i/x_i)/E(Y_i/x_i) = 1 + \alpha\mu_i$, that is, the higher the value of α, the more dispersed the distribution. When, $\alpha = 0$ the dependent variable has a Poisson distribution. When using NB regression model, the significance of the dispersion parameter α can be tested to identify whether this model is more appropriate than a Poisson one (Winkelmann, 2003; McCullagh and Nelder,1989 and Wooldridge, 1997).

The negative binomial log-likelihood function is given by:

$$l(\alpha, \beta) = \sum_{i=1}^{n}\left[\log\left(\frac{\Gamma(Y_i+1/\alpha)}{\Gamma(Y_i+1)\Gamma(1/\alpha)}\right) - (Y_i - 1/\alpha)\log(1 + \alpha\mu_i) + Y_i\log(\alpha\mu_i)\right]$$

The negative binomial regression model is a useful model for accounting data in which unobserved heterogeneity is present; however, it is not necessarily an optimal model for dealing with data that contain an excess mass of zeros at the corner of its empirical distribution. Greene (1994), introduced the idea of the Zero Inflated Negative Binomial (ZINB) regression model to handle both excess zeros and over-dispersion as a result of unobserved heterogeneity.

3.3.3 Zero Inflated Negative Binomial Regression

The main motivation for zero-inflated count models is that real-life data frequently display over-dispersion and excess zeros (Lambert, 1992; Greene, 1994, Cameron and Trivedi, 1998 and Long, 1997). Zero-inflated count models provide a way of modeling the excess zeros in addition to allowing for over-dispersion.

If the dependent variable presents a high proportion of zeros which could create problems for the negative binomial estimation, a modified count model is the zero inflated negative binomial (ZINB) model which takes the existence of excess zeros into account. When dealing with count response variables the number of zeros is often excessive. This is because there are two processes that generate zero responses, with one always generating zero counts and the other both zero and non-zero counts. Both of these outcomes present an identical zero response but the process through which they are reached is very different (Cameron and Trivedi, 1998 and Greene, 1994).

Given the two possible processes that give rise to zero outcomes and to the excessive number of these, a continuous mixture model - such as the ZINB - is appropriate to estimate the effect of the socio-economic and demographic factors on the number of antenatal care utilization as it models on one hand the binary process of sampling zero (not always, 1) and certain zero (structural zero, 0) five years before the survey that are non-use of antenatal care as a logit model; and on the other, the count process of the number of antenatal care utilization as a NB model when the binary process takes on value of sampling zero. If the binary process takes on value one, the count process takes on a discrete value (0, 1, 2. . . .). Zero antenatal care service utilization can therefore be generated in two ways: through the binary process and also due to a zero count given the binary process takes on value one.

The essential idea is that the zero antenatal care utilization comes from two regimes, in one regime (R_I) is that the outcome is always a zero count, while in the other regime (R_{II}) is the counts that follow a standard negative binomial process.

Suppose that

$$P(Y_i \epsilon R_I) = \omega_i \text{ ,and } P(Y_i \epsilon R_{II}) = 1 - \omega_i \text{ ; } \quad i = 1, 2, \ldots, n$$

Thus, a ZINB has the general form:

$$P(Y_i / x_i, z_i) = \begin{cases} \omega_i + (1 - \omega_i) g(\mu_i), & if\ Y_i = 0 \\ (1 - \omega_i) f(\mu_i), & if\ Y_i = 1, 2, \ldots \end{cases}$$

where:

- x_i *and* z_i are two sets of covariates linked to the count data and logit modules by:

$$\log(\mu_i) = x_i' \beta + e_i,$$

$$\text{logit}(\omega_i) = \log(\omega_i / (1 - \omega_i)) = z_i' \gamma \text{ ,}$$

$$\omega_i = \frac{e^{z_i' \gamma}}{1 + e^{z_i' \gamma}},$$

$$where{:}\ \beta = (\beta_1, \ldots, \beta_p)' \ and \ \ \gamma = (\gamma_1, \ldots, \gamma_q)'.$$

- $g(\mu_i) = p(Y_i = 0 / x_i, z_i)$, is the count data model, and $f(\mu_i)$ is the density of the negative binomial distribution. The binary process can be modeled using logit models for binary outcomes.

- The mean and variance of the ZINB are:

$$E(Y_i / x_i, z_i) = \mu_i (1 - \omega_i) \text{ ,}$$

$$var(Y_i / x_i, z_i) = \mu_i (1 - \omega_i)(1 + \mu_i(\omega_i + \alpha))$$

It follows;

$$\frac{var(Y_i/x_i, z_i)}{E(Y_i/x_i, z_i)} = 1 + \mu_i(\omega_i + \alpha)$$

$$= 1 + \frac{(\omega_i+\alpha)}{(1-\omega_i)} E(Y_i/x_i, z_i)$$

Form the above relationship, it is clear that, $var(Y_i/x_i, z_i) > E(Y_i/x_i, z_i)$, demonstrating that ZINB also has the capability to model over-dispersion. Since $\frac{(\omega_i+\alpha)}{(1-\omega_i)}$ is a function of both zero-inflated parameter ω_i and dispersion parameter α, ZINB accounts for both population heterogeneity and over-dispersion in the distribution of the NB component of ZINB. Observe that NB is capable to model over-dispersion due to unobserved heterogeneity, but doesn't distinguish between the two types of zeros.

Thus, the ZINB model is also over-dispersed and allows extra variation relative to the traditional NB model. If, $\omega_i = 0$ the ZINB model reduces to a classical NB regression model. For, $\alpha = 0$ and $\omega_i = 0$ the ZINB regression model reduces to a classical Poisson regression model (Gupta et al., 1996 and Long, 1997).

Now, consider an observed sample $(y_1, x_1, z_1), \ldots, (y_n, x_n, z_n)$ of n independent observations, where each observed response is denoted by y_i . Then, the log-likelihood function for the vector of parameters $\theta = (\alpha, \beta', \gamma')'$, given the observed sample, has the form:

$$l(\theta) = \sum_{i:y=0} l_1(\alpha, x_i'\beta, z_i'\gamma) + \sum_{i:y>0} l_2(\alpha, x_i'\beta, z_i'\gamma)$$

Where:

$$l_1(\alpha, x_i'\beta, z_i'\gamma) = -log[1 + \exp(z_i'\gamma)] + log\left[\exp(x_i'\beta) + \left(\frac{\alpha}{\alpha + \exp(x_i'\beta)}\right)^{\alpha}\right]$$

$$l_2(\alpha, x_i'\beta, z_i'\gamma) = -log[1 + \exp(z_i'\gamma)] + log[\Gamma(\alpha + y_i)] - log[\Gamma(1 + y_i)] - log[\Gamma(\alpha)]$$

$$+ y_i log\left[\frac{\exp(x_i'\beta)}{\alpha + \exp(x_i'\beta)}\right] + \alpha log\left[\frac{\alpha}{\alpha + \exp(x_i'\beta)}\right]$$

The maximum likelihood estimate $\hat{\theta}$ of the vector of unknown parameters can be calculated by maximizing the log-likelihood function given above.

The Vuong (1989) test is used to compare the negative binomial model to the zero-inflated negative binomial model. The Vuong test compares the predicted probabilities of two non-nested models and reveals the model that has a better fit. The null hypothesis is that both models (ZINB and NB) have identical explanatory capacity and the alternative hypothesis is that model 1(ZINB) is closer than model 2 (NB) to the actual model. A large positive statistic reveals that the first model fits the data better than the second model.

3.4 Model specification test

3.4.1 Test of over-dispersion

Poisson model is a special case of negative binomial model. The negative binomial regression model reduces to the Poisson regression model when the over-dispersion parameter $\alpha \rightarrow 0$. To assess the adequacy of the negative binomial model over the Poisson regression model, we can test the hypothesis:

$$H_o: \alpha = 0 \ vs. \ H_A: \alpha > 0$$

This is to test for the significance of the over-dispersion parameter α. The presence of the over-dispersion parameter α in the NB regression model is justified when the null hypothesis $H_o: \alpha = 0$ is rejected. A likelihood-ratio (LR) test is used for the over-dispersion parameter, α, in the negative binomial (NB) specification against the Poisson model specification (Winkelmann, 2003 and Wooldridge, 1997). In order to test the hypothesis the likelihood ratio test (LRT) is used. For a general negative binomial regression model, the LRT for α is given by:

$$LRT_\alpha = -2[l(\hat{\mu}) - l(\hat{\mu}, \hat{\alpha})]$$

Where: $l(\hat{\mu})$ *and* $l(\hat{\mu}, \hat{\alpha})$, are the maximized log-likelihood under the Poisson regression and NB regression models respectively. Standard asymptotic theory suggests that under H_{01} LRT $_\alpha$ has probability mass of one half at zero and one half – Chi-square distribution with 1 degree of freedom (Cameron and Trivedi, 1998). We can also use the asymptotic normal Wald type "t" statistic defined as the ratio of the estimate of α to its standard error.

3.4.2 Testing the zero-inflation in the model

Vuong test: The vuong test is used to check for the appropriateness of zero-inflated models against the standard count models (Vuong, 1989).

To define the test, we begin by assuming there are two non-nested models, where: $p_1(Y_i/x_i)$is the probability of observing Y_i based on the first model and $p_2(Y_i/x_i)$ is the observing Y_i based on the second model. If we further define:

$$m_i = ln\left[\frac{\widehat{p_1}(Y_i/x_i)}{\widehat{p_2}(Y_i/x_i)}\right], \qquad i = 1, 2, \ldots, n$$

where: n is the number of observation.

$\widehat{p_1}(Y_i/x_i)$ and $\widehat{p_2}(Y_i/x_i)$, are predicted probabilities of the corresponding models $p_1(Y_i/x_i)$ and $p_2(Y_i/x_i)$ respectively.

Let $\bar{m}$ represent the mean of the $m_i's$ and let s_m represent the standard deviation of the $m_i's$. Then the Vuong statistic takes the following form:

$$V = \frac{\sqrt{n}\bar{m}}{s_m}$$

The Vuong statistic under the null hypothesis is asymptotically distributed as a $N(0,1)$. Calculating a normal-based random confidence interval can be used to assess whether model 2 is favored over model 1, whether model 1 is favored over model 2, or whether insufficient evidence exists to claim either model is favored over the other (Long, 1997). Mathematically, if we let $C_\alpha = p(-C_\alpha < N(0,1) < C_\alpha) = 1 - \alpha$ be a critical threshold V that is less than $-C_\alpha$ evidence exists which favors the second model relative to the first. Conversely, if V is greater than C_α then evidence exists which favors the first model relative to the second. Finally, if is V less than or equal to $C_\alpha$and greater than or equal to $-C_\alpha$then weak evidence exists, and we cannot decisively determine which model is favored over the other (Long, 1997 and Greene, 2000).

3.4.3 Information Criteria

Information criteria techniques emphasize minimizing the amount of information required to express the data and model. This results in selection of models that are efficient representation of the data.

Akaike's Information Criteria (AIC): One of the most commonly used information criteria is AIC. The idea of AIC (Akaike, 1973) is to select the model that minimizes the negative likelihood penalized by the number of parameters. The AIC is defined as:

$$AIC = -2LL + 2k$$

Where: LL the log-likelihood and $k < p$ is the number of parameters in the model. For the best fitted model one must expect lowest AIC value.

Bayesian information criteria (BIC): Another widely used information criteria is the BIC. Unlike Akaike Information Criteria, BIC is derived within a Bayesian framework as an estimate of the Bayes factor for two competing models (Schwarz, 1978; Kass and Rafftery, 1995). BIC is defined as:

$$BIC = -2LL + kln(n)$$

Superficially, BIC differs from AIC only in the second term which now depends on sample size n . From a Bayesian perspective, BIC is designed to find the most probable model given the data. Performance of the model selection criteria in selecting good models for the observed data is examined using simulation studies. Such a comparison is not straightforward and even its relevance could be questioned, given that the two criteria are based on different theoretical motivations and objectives. However, for application purpose, the Akaike Information Criteria and the Bayesian Information Criteria do have the same aim of identifying good models even if they differ in their exact definition of a "good model". Comparing them is thus justified, at least to examine how each criterion performs according to recovery of the correct model or how they behave when both should prefer the same model (Akaike, 1973 and Schwarz, 1978).

3.5 Selection of Model Explanatory Variables

There seems to be a belief among many safety researchers that the more variables in an antenatal care utilization model (ANCUM) the better the model. Some researchers have even reported models containing variables with highly insignificant parameters based on the belief that such variables would still improve model prediction. Such variables are hardly of any value for explaining the variability of the specific ANC data used in generating the model much less of any value for predicting ANC frequencies at new individual not used in the model development. Explanatory variables that have statistically significant model parameter estimates, on the other hand, contribute to the explanation of the variability of the ANC data, and their inclusion in the model will improve the fit of the model to the observed data. Nevertheless, improvement of a model's fit to the ANC data is not enough justification for retaining a variable in the model. Appropriate methods will be used to select important explanatory variables to be including in an ANCUM. Various reasons could prevent many individuals from being included in the development of a model. For example, ANC data might not be available for some individuals at the time of model development. Another reason might be that some of these individuals simply did not exist at that time (Aitkin, et al., 1989 and Hinde, 1996).

If an ANCUM is to be used for studying the utilization of the particular set of individuals used to develop it, then a more accurate study would result by using a model that fits the ANC data as closely as possible. This best-fit model is achieved by including all the available statistically significant explanatory variables. The procedure for building best-fit models is explained in the next section (Aitkin, et al., 1989 and Hinde, 1996).

3.6 Parameter Estimation and Evaluation of model fitting

This section deals with two important aspects of practical application of alternative count data models: parameter estimation and evaluation of modeling fitting.

3.6.1 Parameter Estimation

Maximum Likelihood Estimation

Maximum likelihood estimation of the parameters of a statistical model involves maximizing the likelihood or, equivalently, the log likelihood with respect to the parameters. The parameter values at which the maximum occurs are the maximum likelihood estimates of the model parameters. The likelihood is a function of the parameters and of the data (Gupta et al., 1996; Lambert, 1992 and Long, 1997)

A cursory look at the mathematical expressions of the log-likelihood functions of alternative count data models seems to suggest that they are highly nonlinear, which may pose formidable problem for obtaining globally optimum parameter estimates. However, this impression needs to be tempered because most of these models have been studied thoroughly by statisticians. For example, Consul and Famoye (1992) addressed these estimation issues for the unrestricted and restricted versions of the generalized Poisson model and found that the maximum likelihood estimation procedure yields efficient parameter estimates. For the modified Yule regression model, the first and second derivatives of the log-likelihood function with respect to β, α and γ produced highly nonlinear expressions that required to be solved through the Newton-Raphson gradient algorithm (Dempsteret, et al., 1977).

3.6.2 Evaluation of model fitting

The reliability of any parametric specification for fitting the empirical data needs to be evaluated. Goodness-of- fit technique is crucial for this purpose. The aim of this study consisted of comparing the practical performance of alternative goodness-of-fit techniques for count data models in the context of a study of the determinants antenatal care services utilization in Ethiopia. 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.

3.6.2.1 Goodness-of- fit techniques

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 quality of the fit between the observed values (y) and predicted values ($\hat{\mu}$) can be measured by various test statistics. One useful statistic in this regard is the deviance and defined as:

$$D(y:\hat{\mu}) = -2[l(\hat{\mu}:y) - l(y:y)]$$

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 degree of freedom which equals the number of additional free regression

parameters. For a better model, one would expect smaller value of the $deviance, D(y: \hat{\mu})$, (McCullah and Nelder, 1987 and Agresti, 2007).

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 one (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:

$$Likelihood\ ratio\ test = G^2 = -2(\mathrm{LL_{null}} - \mathrm{LL_k})$$

Where: $\mathrm{LL_{null}}$ is the log-likelihood of the null model and $\mathrm{LL_k}$ is the log-likelihood of the model comprising k predictors.

Under the global null hypothesis, $H_o: all\ parametrs\ in\ the\ model\ are\ equal\ to\ zero$ the likelihood ratio test statistic, G^2 , follows a chi-square distribution with p degrees of freedom.

Test for individual predictors

The separate effects of each predictor variable in explaining the outcome variable was made by postulating the null hypothesis. The significance test for each coefficient in the model was done using Wald chi-square, the Wald statistic (w) is:

$$W = \left(\frac{individual\ estimated\ parameter}{s.e.(individual\ estimated\ parameter)}\right)^2$$

The Wald statistic under the null hypothesis is approximately chi-square distributed. Each Wald statistic is compared with a chi-square 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).

CHAPTER FOUR

4. STATISTICAL DATA ANALYSES AND RESULTS

The purpose of this chapter is to analyze the effect of different socio-economic, demographic and health services related potential factors on antenatal care utilization of mothers in Ethiopia using the data from the 2011 Ethiopian Demographic and Health Survey (EDHS). The data have been analyzed using the Statistical Packages for Social Sciences (SPSS) version 20, SAS version 9.2 and Stata version 11.

4.1 Descriptive Statistics

It is always a good idea to start with descriptive statistics and plots. Thus we start with the description of the variables presented in a cross tabulation table.

4.1.1 Antenatal care utilization

Table 4.1 shows frequency and percentage distribution of utilization of antenatal care services in Ethiopia based on information from 7,737 mothers in the sample. It can be seen that 55.14% of the mothers have not used antenatal care services, whereas 4.37%, 6.81%, 11.65% and 7.47% of them used only once, twice, thrice and four times respectively. However 14.62% of the women used antenatal care services for at least five times during their pregnancy. Moreover, more than 77% of the women have utilized antenatal health care services for less than four times. The results also indicate that the maximum frequency of antenatal care visit recorded for a woman was 20. From the summary in Table 4.1, it can be observed that the sample mean of the response variable is 1.82 while the sample variance is 6.634. The difference between the mean and the variance suggest a case of over-dispersion. The data has excess zeros and thus one might expect that both NB and ZINB would possibly

be better models to predict the number of antenatal care utilization. If we observe the overall pattern of antenatal care utilization at the national level, it is highly skewed to the right with excess zeroes (see Figure 4.1).

Table 4.1: Frequency and percentage distribution of utilization of antenatal care services in Ethiopia (n = 7,737) gain the table.

No. of antenatal care Utilization	Frequency	Percent	Cumulative Frequency	Cumulative Percent
0	4,266	55.14	4,266	55.14
1	338	4.37	4,604	59.51
2	527	6.81	5,131	66.32
3	901	11.65	6,032	77.96
4	574	7.42	6,606	85.38
≥ 5	1,131	14.62	7,737	100.00
Total	7,737	100.00		
Minimum	0			
Maximum	20			
Mean	1.82			
Variance	6.634			
Skewness	1.648			

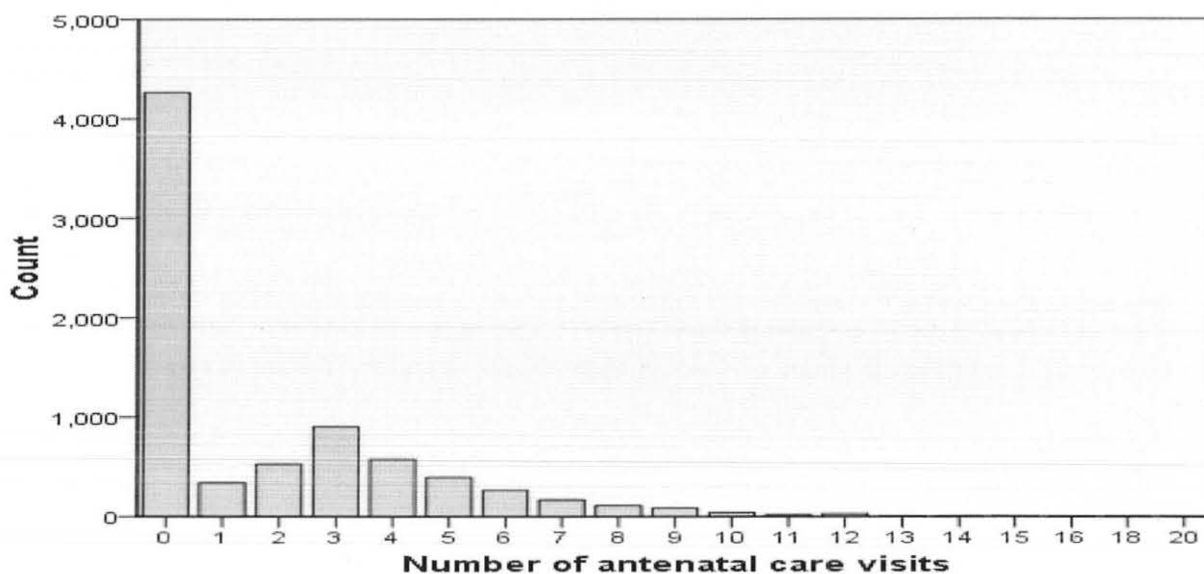

Figure 4.1. A bar graph of number of antenatal care visits in Ethiopia

4.1.2 Antenatal Care Utilization According To Influencing Factors

Table 4.2 presents percentage distribution of socio-economic, demographic, and health service related characteristics of antenatal care utilization in Ethiopia. The total number of women covered in the study is 7,737. Among these, 80.7% resided in rural areas whereas 19.3% resided in urban centers. Of these, only 13.89% of rural resident mothers had at least four antenatal care services while 43.99% of urban resident mother's received less than four antenatal care services.

Moreover, there were marked regional variations in ANC coverage. The proportion of mothers that have received at least four ANC services from a health professional was highest for Addis Ababa (86.93%) followed by Dire Dawa and Harari regions (35.92%, and 34.39% respectively). For the other regions, the proportions were: Tigray (29.79%), Gambela (22.65%), Oromiya (18.73%), SNNP (17.22%), Benishangul-Gumuz (15.07%), Amhara (11.89%), Affar (8.42%) and Somali (7.52%).

With regards to women age, there existed marked variation in the utilization frequency of antenatal care services as a function of women's background characteristics. The data in Table 4.2 showed that 4.93 % of mothers in the age group 15-19 (the younger mothers), 28.73% of mothers aged 20-34 (the adult mothers), and 19.20% of mothers aged 35-49 (the older mothers) used at least four antenatal care services.

The results from Table 4.2 also indicated that only 13% of mothers with no education received four or more antenatal care services while 32.5%, 70.84%, and 79.17% of mothers with primary, secondary, and higher educational levels respectively) received at least four antenatal care services.

In addition, 26.28% of mothers whose husband's had primary education, 47.84% of mothers whose husband had secondary education, and 59.56% of mothers whose husband had higher education used four or more ANC services. Likewise, 11.48% of mother's whose husband had no formal education used at least four ANC services.

With regard to employment status, 29.41% employed mothers used at least four antenatal care services during their last pregnancy while the percentage of employed mothers that used less than four antenatal care services was 70.59 %.

Another variable considered as influencing the utilization of antenatal care services was terminated pregnancy. Table 4.2 showed that mother's that ever had terminated last pregnancy accounted for 13.2% of the women in the sample. Among these, 81.18% received less than four antenatal health care services.

Table 4.2 also showed that the proportion of the utilization of antenatal care varied by the households' economic status. The highest proportion (41.31%) of four or more antenatal care services received were among rich households whereas the lowest proportion (9.08%)of four or more antenatal care services received was among women residing in poor households.

Similarly, the proportion of utilization of antenatal care, as can be seen in Table 4.2, differs by number of birth order. Accordingly, 34.55 percent of the mothers of children of birth order 1 used at least four antenatal care services while 23.06% of mothers of children in the birth order category 2-4 had at least four antenatal care services and the share for the birth order category 5+ was14.47%.

Exposure to the mass media was also another potential determinant of the frequency of utilization of antenatal care services considered in the study. The results showed that, 12.71 percent of women who did not have exposure to mass media received four or more antenatal health care services during their last pregnancy while this percentage was 35.47 among women with exposure to mass media.

The proportion of the number of antenatal care services used varied by religion of mothers. The highest proportion (31.38%) of Orthodox follower mothers had at least four antenatal care services. On the other hand, 79.49% of Catholic follower mothers had less than four antenatal health care services. The percentage of mothers who had less than four antenatal health care services for the other religion categories were: Muslim (82.71%), Protestant (83.06%) and Other religions (95%).

Furthermore, more than half of the women (52.09 percent) who had access to health services used at least four antenatal care services during their last pregnancy while the percentage that have received less than four antenatal care services was 86.71 percent among women who did not have access to health services.

Table 4.2: Percentage distribution of socio-economic, demographic, and health service related characteristics of antenatal care utilization in Ethiopia (n =7,737).

Explanatory variables	Categories		Number of antenatal care visits during pregnancy		Total	
			Less than 4	4 or more	Freq.	%
Pregnancy terminated	No	Freq.	5204	1513	6,717	86.8
		%	77.48	22.52		
	Yes	Freq.	828	192	1,020	13.2
		%	81.18	18.82		
Woman's age	15-19	Freq.	1328	69	1,397	18.1
		%	95.07	4.93		
	20-34	Freq.	3134	1263	4,397	56.8
		%	71.27	28.73		
	35-49	Freq.	1570	373	1,943	25.1
		%	80.80	19.20		
Place of Residence	Urban	Freq.	658	838	1,496	19.3
		%	43.99	56.01		
	Rural	Freq.	5374	867	6,241	80.7
		%	86.11	13.89		
Region	Tigray	Freq.	594	252	846	10.9
		%	70.21	29.79		
	Affar	Freq.	653	60	713	9.2
		%	91.58	8.42		
	Amhara	Freq.	845	114	959	12.4
		%	88.11	11.89		
	Oromiya	Freq.	894	206	1,100	14.2
		%	81.28	18.72		
	Somali	Freq.	517	42	559	7.2
		%	92.49	7.51		
	Benishangul-Gumuz	Freq.	569	101	670	8.7
		%	84.92	15.08		
	SNNP	Freq.	870	181	1,051	13.6
		%	82.78	17.22		
	Gambela	Freq.	468	137	605	7.8
		%	77.35	22.65		
	Harari	Freq.	288	151	439	5.7
		%	65.61	34.39		
	Addis Ababa	Freq.	45	299	344	4.5
		%	13.07	86.93		
	Dire Dawa	Freq.	289	162	451	5.8
		%	64.08	35.92		
Woman's educational level	No education	Freq.	4496	671	5,167	66.8
		%	87.01	12.99		
	Primary	Freq.	1410	680	2,090	27
		%	67.47	32.53		
	Secondary	Freq.	91	221	312	4
		%	29.16	70.84		
	Higher	Freq.	35	133	168	2.2

		%	20.84	79.16		
Religion	Orthodox	Freq.	1839	841	2,680	34.6
		%	68.62	31.38		
	Catholic	Freq.	62	16	78	1.0
		%	79.49	20.51		
	Protestant	Freq.	1303	266	1,569	20.3
		%	83.06	16.94		
	Muslim	Freq.	2771	579	3,350	43.3
		%	•82.71	17.29		
	Others	Freq.	57	3	60	0.8
		%	95.00	5.00		
Wealth index of the household	Poor	Freq.	3298	329	3,627	46.9
		%	90.92	9.08		
	Middle	Freq.	1049	190	1,239	16.0
		%	84.66	15.34		
	Rich	Freq.	1685	1186	2,871	37.1
		%	58.69	41.31		
Birth Order	1	Freq.	963	508	1,471	19.0
		%	65.45	34.55		
	2-4	Freq.	2600	779	3,379	43.7
		%	76.94	23.06		
	5+	Freq.	2469	418	2,887	37.3
		%	85.53	14.47		
Husband's education level	No education	Freq.	3470	450	3,920	50.7
		%	88.52	11.48		
	Primary	Freq.	2099	748	2,847	36.8
		%	73.72	26.28		
	Secondary	Freq.	315	289	604	7.8
		%	52.16	47.84		
	Higher	Freq.	148	218	366	
		%	40.44	59.59		4.7
Woman's employment Status	Non-Employed	Freq.	4309	987	5,296	68.5
		%	81.36	18.64		
	Employed	Freq.	1723	718	2,441	31.5
		%	70.59	29.41		
Mass media exposure of woman's	No	Freq.	3986	580	4,566	59.0
		%	87.29	12.71		
	Yes	Freq.	2046	1125	3,171	41.0
		%	64.53	35.47		
Access to health services	No	Freq.	5197	797	5,994	77.5
		%	86.71	13.29		
	Yes	Freq.	835	908	1,743	22.5
		%	47.91	52.09		

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 variable, number of antenatal health care usage, and the other predictor variables independently. In this study, bivariate chi-square analysis has been used and all of the 12 variables considered were found to be statistically significant at 1% (since, $p<0.01$) significance level. The chi-square test shows that frequency of utilization of antenatal health care visits is associated with the different predictor variables (see Table 4.3 in the Appendix). Thus, the frequency of antenatal health care utilization was found to be associated with region, place of residence (urban or rural), mother's education, religion, husband education, mother's age, number of birth order, employment status of mothers, ever had terminated pregnancy, mass media exposure of mothers, wealth index of the household and access to health services.

4.3 Factors influencing Utilization of ANC: Model identification

In the previous section, a bivariate analysis was conducted to examine the relationship of each of the selected predictor variables with the frequency of antenatal health care utilization in Ethiopia. A significant association between the predictor variables and antenatal health care use was observed. 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 operate 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.

In dealing with count data such as the number of antenatal care visits, which are non-negative and discrete in nature, it makes more sense to model them using Poisson, Negative Binomial (NB) or Zero-inflated Negative Binomial (ZINB) distributions. Regardless of whether the assumed model is Poisson, NB or ZINB, it will be assumed that the occurrences will be independent of each other.

4.3.1 Model fitting

The multiple Poisson regression analysis with and without the over-dispersion parameter was used to identify the basic determinants of utilization frequency of antenatal care at national level. The fitted over-dispersion parameter (α) for Poisson model is tested to check whether it is significant and if found significant, the negative binomial model is the immediate solution to accommodate the observed over-dispersion. Sometimes when analyzing a count response variable, the number of zeros may be excessive. When analyzing a dataset with an excessive number of outcome zeros, a zero-inflated model should be considered. In this study three different count models are fitted: Poisson, negative binomial and Zero-inflated negative binomial regression models.

4.3.1.1 Goodness-of-fit and Test for dispersion

Table 4.4 showed the results of the Poisson and negative binomial regression fit statistics. As shown in the summary table, the likelihood-ratio chi-square values for the Poisson and negative binomial regression model were found 10,696.38 with $P< 0.0001$ and 2,700.95 with $P< 0.0001$, respectively. Thus, both Poisson and NB regression models are significant.

Choosing between Poisson and negative binomial models depends on the nature of the distribution of the dependent variable. Measuring the distribution of count data is a fairly

straightforward process. Particularly, the deviance goodness-of-fit tests can be incorporated along with exploratory negative binomial regression models to measure the distribution of the dependent variable. This simple test identifies the distribution of the data and ensures the selection of the correct statistical model.

As shown in Table 4.4, the AIC and BIC for the Poisson model were 27,208.74 and 27,431.26 respectively while the AIC and BIC for the negative binomial model were 24,504.39 and 24,733.86 respectively. Since both the AIC and BIC values for the negative binomial model were less than the corresponding values for the Poisson model, the negative binomial regression model is better than that of the Poisson model. A negative binomial is better implies that the data are over-dispersed. Table 4.4 also presented the estimate of the over-dispersion parameter as $\alpha = 1.07$. However, we have to apply a formal statistical test of over-dispersion. Given $Var(Y_i/x_i) = \mu_i(1 + \alpha\mu_i)$, we test $H_o: \alpha = 0$. Since likelihood-ratio test statistic is 2,706.35 with $p<0.0001$ we reject H_o that there is no over-dispersion, and conclude that there is significant over-dispersion in the data and the negative binomial is favored over the Poisson regression model.

Table 4.4: Test for Goodness of fit between Poisson and Negative binomial regression models.

Criteria	Poisson regression model	Negative binomial regression model
Log-likelihood (LL)	-13,572.369	-12,219.194
-2LL	27,144.738	24,438.388
Likelihood Ratio (LR) Chi-Square test	10,696.38(0.0000)	2,700.95(0.0000)
Pseudo R2	0.2827	0.0995
AIC	27,208.74	24,504.39
BIC	27,431.26	24,733.86
Over-dispersion(α)	-	1.064778
Likelihood-ratio test of α	2,706.35(0.000)	

NB: The P-values of the model fitted and Likelihood-ratio test of $\alpha = 0$ is presented within parenthesis

4.3.1.2. Testing the zero-inflation in the model

Table 4.5 showed the results of the negative binomial regression and zero-inflated negative binomial regression model fit statistics. As shown from the summary table, the likelihood ratio chi-square for the ZINB regression model is 1,265.48 with P< 0.0001. Thus, the ZINB regression model is significant.

As pointed out in the preceding section, the data set exhibited over-dispersion indicating that the NB model would be the more appropriate model than the Poisson regression model. However, the over-dispersed data are characterized by excess zeroes, excess large outcomes, or both. The ZINB regression model therefore accounted for these excess zeroes and also for the extra heterogeneity in the positive outcome. After fitting the data to the ZINB regression model with the same covariates, Vuong test was used to compare it with the negative binomial regression model. Table 4.5 showed the computed values of the Vuong statistic to be 34.23 with p< 0.0001 indicating that over-dispersion existed due to zero observations and unobserved heterogeneity. Table 4.5 also displays the information criteria, AIC (21,259.09) and BIC (21,711.08) which also supported the conclusion that the ZINB regression model is a better fit to the frequency of antenatal care utilization data.

Table 4.5: Test for goodness of fit between Negative binomial regression models and Zero inflated negative binomial regression model.

Criteria	Negative binomial regression model	Zero-inflated negative binomial regression model
Log-likelihood (LL)	-12219.194	-10564.54
-2(LL)	24438.388	21129.08
Likelihood Ratio (LR) Chi-Square test	2700.95(0.0000)	1265.48(0.0000)
AIC	24504.39	21259.09
BIC	24733.86	21711.08
Over-dispersion(α)	1.064778	-4.667568
Ln(α)	0.0627664	0.6236845
Vuong statistic	34.23(0.0000)	

NB: The P-values of the model fitted and Vuong test of ZINB vs. standard Negative binomial is presented within parenthesis.

4.3.1.3. Model Assessment: Prediction

Our objective here is to compare the models (Poisson, NB and ZINB) and obtain for the one that better predicts the response variable. We will fit the models and then predict the number of antenatal health care visits. For a better model, one would expect the predicted frequencies to be close to the corresponding observed frequencies.

We fitted Poisson, Negative Binomial (NB), and Zero-Inflated Negative Binomial (ZINB) regression models to the utilization frequency of antenatal health care services data. Based on the descriptive statistics, the variance of the number of antenatal health care visits was more than three times greater than the mean (see Table 4.1), and it appeared that both NB and ZINB models performed better than the Poisson model for the zero inflated and over-dispersed count data.

Table 4.6 shows that 55.14% of the married women in the sample have not used antenatal care services within the last five years before the survey. But the fitted Poisson regression model predicts that only 32.49% of the women have not received antenatal care services. Clearly the model has underestimated the probability of zero counts. The fitted negative binomial regression model, on the other hand, predicted that 47.29% of the women have not received antenatal care services during the last five years before the survey. However, the fitted ZINB regression model predicted that 55.12% of the mothers have not used antenatal care services within the last five years before the survey, very close to the observed value of 55.14% compared to the Poisson and negative binomial regression models respectively.

Table 4.6: Prediction of zero observation based on the fitted Poisson, Negative binomial and zero inflated negative binomial regression models.

	Total Sample observation consider	Predicted Percentage of zero
Sample observation	7737	55.14
Poisson regression model	7737	32.49
NB regression model	7737	47.29
ZINB regression model	7737	55.12

More importantly, the negative binomial regression model would imply that once a respondent passes the over-dispersion (due to unobserved heterogeneity) the number of utilized antenatal care services will be negative binomial distributed, hence the use of the negative binomial regression models. This is reasonable in some settings, but not in the one considered here, since some of the potential supporters of antenatal care utilization might still choose a corner solution and states a zero response. Then the zero-inflation (ZINB) models can handle this situation better, since they separate the sample between an 'always zero' (structural zero) group and a 'not-always zero' (sampling zero) group, which allows for corner solutions for the latter. Therefore, the rest of the results will be described in terms of the ZINB.

4.4 Zero-Inflation Negative Binomial Regression Model Analysis

The objective of this subsection is to study the impact of socio-economic, demographic and health related factors on the number of antenatal care visits using zero-inflated negative binomial regression model. The explanatory variables in the model are women's age, women's education, employment status, exposure to a terminated pregnancy, exposure to mass media, husband's education, wealth index of the household, place of residence, religion, number of birth order, region, and access to health services. Accordingly, the most important determinants of number of antenatal care visits could be identified.

The zero-inflated negative binomial regression generates two separate models and then combines them. First, a logit model is generated for the "certain zero", predicting whether or not women would be in this group. Then, a negative binomial model is generated predicting the counts for those women who are "not certain" zeros. Finally, the two models are combined. When running zero-inflated negative binomial in Stata, both models must be specified: first the count model, then the model predicting the certain zeros.

Table 4.7 and Table 4.8 display the estimates of the regression coefficients for various covariates of both portions of the ZINB model. For ZINB, the results of both parts of the models together help in understanding the role of the factors on utilization of antenatal care distribution. The coefficients of the output of the ZINB regression model are interpreted as follows: the expected number of antenatal care visits changes by exp (coefficient) for each unit increase in the corresponding predictor while holding all other variables in the model constant.

4.4.1 Interpretations of Negative Binomial Part of the Model

Table 4.7 shows the independent variables in the negative binomial part of the zero-inflated negative binomial regression model for examining the impact of socio-economic, demographic and health related factors on the number of antenatal care visits.

As shown in Table 4.7, place of residence had a significant impact on the number of antenatal care visits. The expected number of antenatal care visits for woman from rural areas had decreased by a factor of 0.08 compared to the expected number of antenatal care visits for woman from urban residences while holding all other variables in the model constant.

The model also revealed that region of residence had a statistically significant impact on the number of antenatal care visits. For example, the expected number of antenatal care visits for women from Amhara, Affar and Somali regions were 0.9, 0.84 and 0.82 times the expected number of antenatal care visits of women in Tigray respectively controlling for the other variables in the model. Conversely, the expected number of antenatal care visits for women from Addis Ababa, Dire Dawa and Harari were 1.45, 1.24 and 1.09 times the expected number of antenatal care visits for women from Tigray, respectively, controlling for other variables in the model.

The finding of this study also revealed that the current age of women had a significant impact on the number of antenatal care visits. The expected number of antenatal care visits for women aged 20 to 34 was 1.10 times the expected number of antenatal care visits for women in the age group 15 to 19. Also, the expected number of antenatal care visits for woman aged 35 to 49 was 1.18 times the expected number of antenatal care visits for woman in the age group 15 to 19 while holding all other variables in the model constant.

It can be observed that woman's education level had a positive significant impact on the number of antenatal care visits. As shown in Table 4.7, the higher the level of woman's education, the higher predicted number of antenatal care visits. The expected number of antenatal care visits for women with primary education was 1.09 times the expected number of antenatal care visits for women with no education. Moreover, the expected number of antenatal care visits for a woman with secondary level of education was 1.17 times the expected number of antenatal care visits for a woman with no education. In addition the expected number of antenatal care visits for a woman with higher education was 1.24 times

the expected number of antenatal care visits for woman with no education while holding all other variables in the model constant.

Furthermore, the expected number of antenatal care visits for women whose husband had secondary level education was 1.08 times the expected number of antenatal care visits for women whose husband had no education. Also the expected number of antenatal care visits for women whose husband had higher education was 1.13 times the expected number of antenatal care visits for woman whose husband had no education while holding all other variables in the model constant.

The results of the fitted model reveals that a woman's employment status had a significant impact on the number of antenatal care visits with the expected number of antenatal care visits for an employed woman being 1.07 times the expected number of antenatal care visits for unemployed woman while holding all other variables in the model constant.

The results of table 4.7 also shows that wealth index of the household had a positive significant impact on the number of antenatal care visits. The expected number of antenatal care visits for women in the rich quintile was 1.18 times the expected number of antenatal care visits for woman in the poor quintile while holding all other variables in the model constant.

Moreover, exposure to the mass media increased significantly the number of antenatal care visits. Table 4.7 showed that the expected number of antenatal care visits for women who were exposed to mass media was 1.04 times the expected number of antenatal care visits for women with no mass media exposure while holding all other variables in the model constant.

Table 4.7 also shows that religion had negative impact on the number of antenatal care visits. For example, the expected number of antenatal care visits for Muslim women decreased by a factor of 0.06 compared to the expected number of antenatal care visits for Orthodox follower women. Also the expected number of antenatal care visits for women that were follower of Protestant, Catholic and Other decreased by a factor of 13%, 20% and 37% respectively compared to the expected number of antenatal care visits for Orthodox women while holding all other variables in the model constant.

The access of health services had a positive significant impact on the number of antenatal care visits. Table 4.7 shows that the expected number of antenatal care visits for women who have a access to health services was 1.14 times the expected number of antenatal care visits for women who did not have a access of health services while holding all other variables in the model constant.

The analysis also revealed that after adjustment for other factors, the variables namely exposure to a terminated pregnancy, number of birth order, husband's education level (primary) when compared with no education, wealth index of the household (middle quintile) when compared with poor quintile and region (Oromiya, Benishangul-Gumuz, SNNP and Gambela) when compared with those from the reference category (Tigray) appeared to had no significant influence on the expected number of antenatal care visits in Ethiopia.

Table 4.7: Parameter estimates of Negative binomial part of the ZINB regression model for examining the impact of socio-economic, demographic and health related factors on number of antenatal care visits.

Explanatory Variables	Coef.	Exp(Coef)	Std. Err.	z	P>|z|	[95% Conf. Interval]	
TP, No(ref.)							
Yes	.010	1.010	.029	0.330	0.739	-.048	.067
AGE, 15-19(ref.)							
20-34	.097	1.100	.048	2.000	0.046**	.002	.191
35-49	.165	1.180	.056	2.970	0.003*	.056	.274
RESIDENC, Urban(ref.)							
Rural	-.084	0.920	.029	-2.940	0.003*	-.141	-.028
REGION, Tigray(ref.)							
Affar	-.176	0.840	.055	-3.210	0.001*	-.283	-.067
Amhara	-.105	0.900	.041	-2.580	0.010*	-.184	-.025
Oromiya	.031	1.030	.039	0.790	0.430	-.046	.107
Somali	-.196	0.820	.062	-3.140	0.002*	-.318	-.073
Benishangul-Gumuz	-.031	0.970	.047	-0.660	0.510	-.122	.061
SNNP	.054	1.060	.043	1.250	0.212	-.031	.139
Gambela	.033	1.030	.047	0.700	0.486	-.060	.126
Harari	.081	1.090	.044	1.850	0.064***	-.005	.168
Addis Ababa	.357	1.450	.039	9.270	0.000*	.281	.432
Dire Dawa	.215	1.240	.043	4.980	0.000*	.131	.300
WOMEDUC, No education (ref.)							
Primary	.082	1.090	.023	3.530	0.000*	.037	.128
Secondary	.161	1.170	.036	4.430	0.000*	.090	.232
Higher	.214	1.240	.046	4.660	0.000*	.124	.303
HUSEDUC, No education (ref.)							
Primary	.023	1.020	.024	0.940	0.346	-.025	.071
Secondary	.076	1.080	.034	2.230	0.026**	.0091	.142
Higher	.121	1.130	.041	2.980	0.003*	.041	.200
RELIGION, Orthodox(ref.)							
Catholic	-.226	0.800	.103	-2.200	0.028**	-.427	-.025
Protestant	-.141	0.870	.034	-4.210	0.000*	-.207	-.076
Muslim	-.059	0.940	.025	-2.370	0.018**	-.108	-.010
Others	-.467	0.630	.192	-2.430	0.015**	-.844	-.090
BIRORD, 1(ref.)							
2-4	.000	1.000	.023	.000	0.999	-.045	.045
5+	-.026	0.980	.033	-0.780	0.438	-.091	.040
WLTHINDE, Poor(Ref.)							
Middle	.053	1.060	.034	1.560	0.119	-.014	.120
Rich	.167	1.180	.030	5.600	0.000*	.108	.225
WOMEMP, No(ref.)							
Yes	.070	1.070	.019	3.690	0.000*	.033	.108
MMEXP, No(ref.)							
Yes	.042	1.040	.023	1.820	0.068***	-.003	.086
AHS, No(ref.)							
Yes	.129	1.140	.023	5.600	0.000*	.084	.1741
Constant	1.086	2.960	.083	13.120	0.000*	.924	1.248

*Significant at 1%, ** Significant at 5%, *** Significant at 10%, ref. = reference category of the variable

4.4.2 Interpretations of Zero-inflation part of The Model

Zero inflated models are interpreted as a mix of structural and sampling zeros from two processes; the process that generates excess zeros from a binary distribution which are the structural zeros, and the process that generates both non-negative and zero counts from NB distributions which are the sampling zeros.

The results of Table 4.8 below indicates that the parameter estimates of the Zero-Inflation (logit model) part of the ZINB regression model for examining the impact of socio-economic, demographic and health related factors on the probability of being an excessive zero. Table 4.8 shows that place of residence had a significant impact on the probability of being an excessive zero. The probability of rural woman to be in the excess zeros group will be 1.39 times higher than the probability of urban being in excess group holding all other variables in the model constant. In other words, the more women lived in rural, the more likely that the zero would be due to structural zero.

The results of logit mode of ZINB model suggest significant regional variations on the probability of being an excessive zero. The model showed that the likelihood women will group in excess zero were 2.86, 2.88, 3.40, 3.96, 4.11 and 5.53 times higher among women residing in SNNP, Amhara, Gambela, Benishangul-Gumuz, Oromiya and Affar region compared to women in Tigray, respectively. The model also suggested that the excess zero was 3.94 times higher among women residing in Dire Dawa and Harari region compared to those in Tigray. The model further suggested that the woman will group excess zero in Addis Ababa was 1.90 higher than the woman will group in excess zero in Tigray. Somali region was found to have the highest and exaggerated zero antenatal care visits and was 9.40 times higher than Tigray. In summary, the higher the number of women reside in Addis

Ababa, SNNP, Amhara, Gambela, Dire Dawa, Harari, Benishangul-Gumuz, Oromiya, Affar and Somali regions, respectively, the more likely that the zero would be due to a certain zero in the respective order.

The age of women had a negative significant impact on the probability of being an excessive zero. The probability that a woman will be in the excess zeros group will decreased by 88 percent if the woman was in the age group 20-34 when compared with woman in the age group 15-19. Additionally, the probability that a woman will be in the excess zeros group will decreased by 79 percent if the woman in the 35-49 age group in comparison with woman in the age group 15-19 controlling for other variables in the model. In other words, the more women in the age group 20-34 and 35-49, the less likely that the zero would be due to constant zero. Thus, the higher the age of a woman, the less likely the woman will be group in excess zero due to constant zero.

Women's education had a negative significant impact on the probability of being an excessive zero. The probability that a woman will be in the excess zeros group will decreased by 44 percent if the woman had primary level of education in comparison with a woman with no education. Additionally, the probability of having a woman in the excess zeros antenatal care group will decreased by 74% and 67% if the woman had completed secondary school and higher education in comparison with a woman with no education respectively. In other words, the higher the education level of women, the less likely that the zero would be due to structural zero.

Husband's education level had a negative significant impact on the probability of being excessive zero. For instance, as compared to the reference category (no education), the

woman whose husband had primary , secondary and higher education were 34%, 25% and 47% less likely to be in excess zero antenatal care group respectively controlling for other variables in the model. In other words, the higher the education level of husband/ partner, the less likely that the zero would be due to structural zero.

Women's employment status had a significant influence on the probability of being an excessive zero antenatal care. The probability that a woman will be in the excess zeros group decreased by 12 percent if the women were employed in comparison with an unemployed woman. In other words, for an employed woman, it is less likely that the zero would be due to certain zero.

Wealth index of the household had a negative significant influence on the probability of being in excessive zero. For example, the probability that a woman will be in the excess zero antenatal care group will decrease by 34% and 40% if the woman was in middle quintile and rich quintile groups, respectively compared with women in the poor quintile after controlling all other variables and indicators constant. In other words, the more for a woman in the middle and rich quintile group, it is less likely that the zero would be due to structural zero.

Exposure to a terminated pregnancy had a positive significant impact on the probability of being an excess zero. The probability that a woman will be in the zero group will increased by 39 percent if the woman had a terminated pregnancy in comparison with the woman that had not terminated pregnancy. In other words, the more exposure women had to terminate pregnancy, the more likely that the zero would be due to certain zero.

Woman's exposure to mass media had negative significant effect on the probability of being an excessive zero. A woman will be in group of excess zero antenatal care will decreased by 26 percent if the woman had exposure to mass media compared to a woman with no media exposure before the survey controlling for other variables in the model. In other words, the more women had exposure to mass media, the less likely that the zero would be due to always zero.

The higher the number of birth order, the more likely is a woman to have zero antenatal care visits. For example, the probability that a woman will be in an excess zero group was 1.64 times higher if the number of birth order was above five compared with woman with children with number of birth order one. Also, the probability that a woman will be in the excess zero group was 1.48 times higher if the number of birth order was between two and four as compared to woman in the reference category (with children of birth order one) controlling for all other variables. In other words, the more women had children of birth order above five and between two and four, the more likely that the zero would be due to certain zero.

Followers of Protestant and Islam were more to be in excessive zero. For instance, as compared to the reference category (Orthodox), Muslim women were 15% less likely to be in an excess zero antenatal care group. While the probability that a woman will be in an excess zero group was 1.45 times higher if the woman were Protestant compared to Orthodox women. In other words, the more women were Muslim, the less likely that the zero would be due to certain zero. More protestant women, the more likely belong to certain zero group.

Availability of health services had a negative significant impact on the probability of being an excess zero visits. For example, the probability that a woman will belong to an excess zero visits would decreased by 84 percent if the woman had access to health services compared to a woman who had no access to health services holding all other variables in the model constant. In other words, the more women had access to health services, the less likely that the zero would be due to certain zero.

Table 4.8: Parameter estimates of Zero-Inflation part of ZINB regression model for predicting a latent binary outcome.

Explanatory Variables	Coef.	Exp(Coef.)	Std. Err.	z	P>|z|	[95% Conf. Interval]	
TP, No(ref)							
Yes	.330	1.390	.090	3.690	0.000*	.155	.506
AGE, 15-19(ref.)							
20-34	-2.101	0.120	.104	-20.200	0.000*	-2.306	-1.897
35-49	-1.551	0.210	.125	-12.460	0.000*	-1.795	-1.307
RESIDENC, Urban(ref.)							
Rural	.327	1.390	.112	2.910	0.004*	.107	.547
REGION, Tigray(ref.)							
Affar	1.709	5.530	.169	10.130	0.000*	1.379	2.040
Amhara	1.059	2.880	.124	8.540	0.000*	.816	1.302
Oromiya	1.412	4.110	.139	10.140	0.000*	1.139	1.685
Somali	2.240	9.400	.181	12.370	0.000*	1.886	2.595
Benishangul-Gumuz	1.377	3.960	.152	9.080	0.000*	1.079	1.674
SNNP	1.051	2.860	.150	6.990	0.000*	.757	1.346
Gambela	1.223	3.400	.171	7.140	0.000*	.887	1.558
Harari	1.370	3.940	.186	7.390	0.000*	1.007	1.734
Addis Ababa	.643	1.900	.291	2.210	0.027**	.0730	1.212
Dire Dawa	1.371	3.940	.186	7.350	0.000*	1.005	1.736
WOMEDUC, No education(ref.)							
Primary	-.576	0.560	.076	-7.590	0.000*	-.725	-.428
Secondary	-1.331	0.260	.278	-4.790	0.000*	-1.876	-.787
Higher	-1.109	0.330	.437	-2.540	0.011**	-1.965	-.253
HUSEDUC, No education(ref.)							
Primary	-.420	0.660	.070	-5.990	0.000*	-.557	-.282
Secondary	-.282	0.750	.143	-1.970	0.049**	-.563	-.001
Higher	-.628	0.530	.209	-3.000	0.003*	-1.038	-.218
RELIGION, Orthodox(ref.)							
Catholic	.164	1.180	.312	0.530	0.599	-.447	.774
Protestant	.372	1.450	.117	3.170	0.002*	.142	.602
Muslim	-.169	0.850	.100	-1.690	0.091***	-.364	.027
Others	.024	1.030	.379	0.060	0.949	-.719	.767
BIRORD, 1(ref.)							
2-4	.393	1.480	.095	4.160	0.000*	.208	.579
5+	.494	1.640	.108	4.590	0.000*	.283	.705
WLTHINDE, Poor(ref.)							
Middle	-.420	0.660	.085	-4.930	0.000*	-.587	-.253
Rich	-.511	0.600	.083	-6.130	0.000*	-.675	-.348
WOMEMP, No(ref.)							
Yes	-.128	0.880	.066	-1.940	0.053***	-.258	.0015
MMEXP, No(ref.)							
Yes	-.304	0.740	.068	-4.470	0.000*	-.437	-.170
AHS, No(ref.)							
Yes	-1.830	0.160	.092	-19.980	0.000*	-2.010	-1.651
Constant	.749	2.120	.274	2.740	0.006*	.212	1.286
ln (α)	-4.668	0.010	.624	-7.480	0.000*	-5.890	-3.445
α	.009	1.009	.006			.003	.0319

*Significant at 1%, ** Significant at 5%, *** Significant at 10%, ref. = reference category of the variable

CHPTER FIVE

5. DISCUSSION, CONCLUSION AND RECOMMENDATIONS

5.1 Discussion

The main objective of this study was to identify factors influencing the frequency of utilization of antenatal care services based on Ethiopian Demographic and Health Survey (EDHS 2011) data. The distribution of the number of antenatal care visits among women in Ethiopia had been given. Determinant the factors that are associated with the frequency of utilization of Antenatal Care (ANC) services in Ethiopia had been identified. Accordingly descriptive analysis and count regression model techniques were used.

Three count models were fitted to identify acknowledged causes of over-dispersion, and to assess the predictive performance of these models with regard to the number of antenatal care visits in a population of pregnant women. We also illustrated the significance of using zero-inflated (zero-inflated negative binomial) regression models in count data involving zeros that emanate from the subjects that are all "reproductive age group (15-49)" of the event of interest.

As for most of the count data, this study found excess variability in distribution of the frequency of utilization of antenatal care services than that expected by a Poisson model. It was assumed that the cause of over-dispersion to be solely due to unobserved heterogeneity, and therefore used the NB model to fit and describe utilization of antenatal care frequency data. However, data on the frequency of utilization of antenatal care services often involve excess zeros, which also cause over-dispersion. This indicates a need to explore fitting zero inflated (ZINB) model, which can also account for variability due to excessive zeros.

The ZINB regression model provided the best fit when predicting the number of antenatal care visits by pregnant women. This confirmed that the distribution of the frequency of utilization of antenatal care services contained over-dispersion not only due to unobserved heterogeneity but also due to excessive zeros (certain zeros). As expected, the Poisson regression model had the lowest prediction ability for the frequency of utilization of antenatal care services. Accounting only one source of over-dispersion, either due to excessive zeros or due to unobserved heterogeneity, the prediction ability of utilization of antenatal care frequency improved when the negative binomial regression model was employed. However, use of ZINB model, which assumes involvement of more than just one source of over-dispersion, provided the smallest level of prediction error. The ZINB model was consistent for factor-identification in the extent of utilization of antenatal care as well as for prediction of number of antenatal care.

The findings revealed that place of residence was one of the main determinants of number of antenatal care visits. The expected number of antenatal care visits for women from rural areas was less than the expected number of antenatal care visits for women from urban areas. These findings agree with the findings of Dairo and Owoyokun (2010) and Regassa (2011) that a woman living in urban areas has higher likelihood of receiving checkup during pregnancy than the woman living in rural areas. This study showed that there was an observed regional discrepancy partly with respect to the number of antenatal health care utilization. As compared to the reference region (Tigray), mothers in Amhara, Affar and Somali regions were less likely to use antenatal care services. On the other hand mothers who live in Harari, Dire Dawa and Addis Ababa were more likely to use ANC services than

those in Tigray. This is similar to the Ethiopian Society of Population Studies (2008) finding, which revealed that antenatal care use was not the same in all regions.

The result of this study also indicated that age of women was one of the important determinant factors of utilization of antenatal health care services in Ethiopia. The frequency of utilization of antenatal care services was higher for mothers aged 35-49 years (older mothers) than the other age groups, as age increased the number of utilization of antenatal care services also increased. In 19 out of 26 developing countries, women who were 19 years or younger were reportedly less likely than older women to seek ANC from health professionals (Reynold et al 2006), which is consistent with the finding of this study. This finding also contradicts the findings of previous studies conducted by Sharma et.al (2007) and Wong et al., (1987), which revealed that women over the age 35 are less likely to utilize prenatal care. However, experience and skills acquired by older women should have a positive influence on the use of antenatal health care services.

In this study, partner's and mother's education were important predictor factors for usage of antenatal care services. It was also likely that educated husbands/partner and mothers would tend to seek out higher quality services. The results revealed that women used of antenatal care increased as their educational attainment and that of their partners increased from secondary to higher levels. There is a strong consistency in the relationship between husbans/partners and mother's education, and utilization of antenatal health care services (Shariff and Singh, 2002; Caldwell, 1979; Schultz, 1984 and Dina and Mohamed, 2012). Most of the findings in this study are consistent with the findings in the above researches. A similar study in Ethiopia by Regassa (2011) found that the most important determinant of antenatal health care services was mother's educational status. This study also showed that

mother's education had strong and positive association with antenatal health care utilization. The Ethiopian Society of Population Studies (2008) found that utilization of antenatal health care services was higher among educated mothers than non-educated. A study in Peru, using DHS data (Elo, 1992) found that mother's education has positive effect on the use of prenatal care services.

Employment status of the mother was found to be specifically associated with utilization of the number of antenatal care services in this study. The result showed that mother's employment status (being employed) was positively associated with the utilization of number of antenatal care services from health professionals imply that employed mothers were more likely to use antenatal health care services than unemployed mothers. 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. Studies by Tawiah (2011) and Sharma et.al (2007) showed that employed mothers used antenatal health care services more than unemployed mothers, consistent with the finding of this study.

In addition, this study revealed that mothers from poor households were less likely to use antenatal care services than mothers from rich households. This finding is consistent with other studies by Regassa (2011) and Schultz (1984) who showed women in rich quintile households had better access to antenatal care services than poor quintile households.

The current study showed that exposure to the mass media had a positive significant influence on the number of antenatal care visits. Women who are exposed to mass media are more likely to receive antenatal health care (Shariff and Singh 2002). Obermeyer (1993) in a

study in Morocco and Tunisia indicated that watching television weekly was associated with an increase in the likelihood of prenatal cares, which is also consistent with the finding of this study.

In this study religion was found to have significant impact with the use of antenatal care services. It was observed that the Muslim, Protestant, Catholic and Other religion follower women were less likely to received antenatal care services than Orthodox women. Significant difference was found in the use of antenatal care services among different religious groups in Nigeria (Babalola and Fatusi, 2009), which is consistent with the finding of this study.

Access to health services was also found to be significantly associated with the number of antenatal care use in Ethiopia. Women who had problem reaching health facilities were less likely to use antenatal care than women who had access to health services. This finding is consistent with other studies (World Bank, 1994b; Tesema et.al, 2006 and Mekonnen, 2003) which revealed that Antenatal care services should be accessible to all pregnant women.

The zero-inflation (logit model) part of the zero inflated negative binomial regression method of analysis in this study allowed the examination of the impact of socio-economic, demographic and health related factors on the probability of being an excessive zero. Part of the model suggests that the higher the women was exposed to terminated pregnancy, number of birth order, live in rural areas, reside in different regions and Protestant followers, the more likely that the zero would be due to certain zero. Also the model revealed that the more the women had education, the aged mothers, employed mothers, exposure to mass media, level of wealth index of the household, partners education and access to health services, the

less likely that the zero would be due to certain zero. These findings are consistent with the study that had indicated that the women's background characteristics had significant impact on the probability that women will have zero visits (Dina, M. and Mohamed, A. 2012).

5.2 Conclusion

The results of this study revealed that the factors influencing the utilization of antenatal care health care services are mostly socio-economic, demographic and health service related.

The findings further suggested the following: the rural-urban differential in utilization of antenatal care services was significant and rural women were more disadvantaged than their urban counterparts; the rural women, the more likely that the zero ANC would be due to structural zero. The age of the mothers had positive significant association with the number of ANC services used; the older a woman, the less likely the woman will group in excess zero due to constant zero. Husband's educational level and mother's education had significant and positive effect on the frequency of utilization of ANC services; and the higher the level of education of mothers and husbands, the less likely that the zero ANC would be due to structural zero. Wealth index of the household was considered to be the most important determinant of receiving antenatal care visits. The higher the level of wealth index, the higher predicted number of antenatal care visits and less likely that the zero ANC would be due to certain zero. The employment status of women had a significant effect on the usage of the number of antenatal care services; and for employed mothers it was less likely that the zero ANC would be due to certain zero. Also the exposure of mass media had positive significant impact on the utilization of the number of ANC services; the more exposure women had to mass media, the less likely that the zero would be due to certain zero and access to health services had a positive impact on the number of antenatal care

visits; the more women had access of health services, the less likely that the zero would be due to certain zero.

5.3 Recommendations

Based on the above mentioned findings of both descriptive and zero inflated negative binomial regression analysis of the number of antenatal health care utilization, the following recommendations can be made:

- Since the level of education significantly influences the frequency of usage of antenatal care services, the government policies have to encourage women to get higher education
- Wealth index of the household is considered to be the most important determinant of receiving antenatal health care. Women from higher wealth index are more likely to receive regular antenatal care than women from lower wealth index. This situation calls for concerted efforts comprehensive enough to improve the attendance and quality of antenatal care.
- The Ministry of Health could also use mass media to disseminate consistent messages promoting the use of antenatal health care services by all women, in order to attain the minimum recommended number of antenatal health care services.
- The rural women were less likely to use the service means that antenatal health care programs should be expanded and intensified in rural areas.

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Appendix

Table 4.3: Results of bivariate statistical analysis of antenatal care visits

Explanatory variables	Categories		Number of antenatal care visits 0	1	2	3	4	≥ 5	Total	Chi-square (Sign.)
Pregnancy terminated	No	Freq.	3,624	304	464	812	512	1,001	6,717	30.82 (0.000)
		%	53.95	4.53	6.91	12.09	7.62	14.90	100.00	
	Yes	Freq.	642	34	63	89	62	130	1,020	
		%	62.94	3.33	6.18	8.73	6.08	12.75	100.00	
	Total	Freq.	4,266	338	527	901	574	1,131	7,737	
		%	55.14	4.37	6.81	11.65	7.42	14.62	100.00	
Woman's age	15-19	Freq.	1,219	23	37	49	33	36	1,397	894.13 (0.000)
		%	87.26	1.65	2.65	3.51	2.36	2.58	100.00	
	20-34	Freq.	1,874	246	384	630	408	855	4,397	
		%	42.62	5.59	8.73	14.33	9.28	19.45	100.00	
	35-49	Freq.	1,173	69	106	222	133	240	1,943	
		%	60.37	3.55	5.46	11.43	6.85	12.35	100.00	
	Total	Freq.	4,266	338	527	901	574	1,131	7,737	
		%	55.14	4.37	6.81	11.65	7.42	14.62	100.00	
Place of Residence	Urban	Freq.	310	39	70	239	169	669	1,496	1600 (0.000)
		%	20.72	2.61	4.68	15.98	11.30	44.72	100.00	
	Rural	Freq.	3,956	299	457	662	405	462	6,241	
		%	63.39	4.79	7.32	10.61	6.49	7.40	100.00	
	Total	Freq.	4,266	338	527	901	574	1,131	7,737	
		%	55.14	4.37	6.81	11.65	7.42	14.62	100.00	
Region	Tigray	Freq.	301	59	82	152	102	150	846	1800 (0.000)
		%	35.58	6.97	9.69	17.97	12.06	17.73	100.00	
	Affar	Freq.	509	35	51	58	25	35	713	
		%	71.39	4.91	7.15	8.13	3.51	4.91	100.00	
	Amhara	Freq.	594	77	64	110	41	73	959	
		%	61.94	8.03	6.67	11.47	4.28	7.61	100.00	
	Oromiya	Freq.	662	32	62	138	95	111	1,100	
		%	60.18	2.91	5.64	12.55	8.64	10.09	100.00	
	Somali	Freq.	416	22	25	54	20	22	559	
		%	74.42	3.94	4.47	9.66	3.58	3.94	100.00	
	Benishangul-Gumuz	Freq.	417	25	51	76	49	52	670	
		%	62.24	3.73	7.61	11.34	7.31	7.76	100.00	
	SNNP	Freq.	632	33	83	122	91	90	1,051	
		%	60.13	3.14	7.90	11.61	8.66	8.56	100.00	
	Gambela	Freq.	341	30	36	61	56	81	605	
		%	56.36	4.96	5.95	10.08	9.26	13.39	100.00	
	Harari	Freq.	181	7	42	58	30	121	439	
		%	41.23	1.59	9.57	13.21	6.83	27.56	100.00	
	Addis	Freq.	21	2	3	19	28	271	344	

	Ababa	%	6.10	0.58	0.87	5.52	8.14	78.78	100.00	
	Dire Dawa	Freq.	192	16	28	53	37	125	451	
		%	42.57	3.55	6.21	11.75	8.20	27.72	100.00	
	Total	Freq.	4,266	338	527	901	574	1,131	7,737	
		%	55.14	4.37	6.81	11.65	7.42	14.62	100.00	
Woman's educational level	No education	Freq.	3,393	258	322	523	279	392	5,167	1500 (0.000)
		%	65.67	4.99	6.23	10.12	5.40	7.59	100.00	
	Primary	Freq.	839	76	187	308	227	453	2,090	
		%	40.14	3.64	8.95	14.74	10.86	21.67	100.00	
	Secondary	Freq.	26	3	15	47	46	175	312	
		%	8.33	0.96	4.81	15.06	14.74	56.09	100.00	
	Higher	Freq.	8	1	3	23	22	111	168	
		%	4.76	0.60	1.79	13.69	13.10	66.07	100.00	
	Total	Freq.	4,266	338	527	901	574	1,131	7,737	
		%	55.14	4.37	6.81	11.65	7.42	14.62	100.00	
Religion	Orthodox	Freq.	1,164	144	176	355	245	596	2,680	323.95 (0.000)
		%	43.43	5.37	6.57	13.25	9.14	22.24	100.00	
	Catholic	Freq.	43	0	10	9	9	7	78	
		%	55.13	0.00	12.82	11.54	11.54	8.97	100.00	
	Protestant	Freq.	963	66	114	160	112	154	1,569	
		%	61.38	4.21	7.27	10.20	7.14	9.82	100.00	
	Muslim	Freq.	2,053	124	221	373	205	374	3,350	
		%	61.28	3.70	6.60	11.13	6.12	11.16	100.00	
	Others	Freq.	43	4	6	4	3	0	60	
		%	71.67	6.67	10.00	6.67	5.00	0.00	100.00	
	Total	Freq.	4,266	338	527	901	574	1,131	7,737	
		%	55.14	4.37	6.81	11.65	7.42	14.62	100.00	
Wealth index of the household	Poor	Freq.	2,563	179	241	315	154	175	3,627	1300 (0.000)
		%	70.66	4.94	6.64	8.68	4.25	4.82	100.00	
	Middle	Freq.	729	62	118	140	99	91	1,239	
		%	58.84	5.00	9.52	11.30	7.99	7.34	100.00	
	Rich	Freq.	974	97	168	446	321	865	2,871	
		%	33.93	3.38	5.85	15.53	11.18	30.13	100.00	
	Total	Freq.	4,266	338	527	901	574	1,131	7,737	
		%	55.14	4.37	6.81	11.65	7.42	14.62	100.00	
Birth Order	1	Freq.	603	62	107	191	149	359	1,471	302.03 (0.000)
		%	40.99	4.21	7.27	12.98	10.13	24.41	100.00	
	2-4	Freq.	1,807	145	241	407	254	525	3,379	
		%	53.48	4.29	7.13	12.04	7.52	15.54	100.00	
	5+	Freq.	1,856	131	179	303	171	247	2,887	
		%	64.29	4.54	6.20	10.50	5.92	8.56	100.00	
	Total	Freq.	4,266	338	527	901	574	1,131	7,737	
		%	55.14	4.37	6.81	11.65	7.42	14.62	100.00	
Husband's education	No education	Freq.	2,665	179	240	386	194	256	3,920	1100 (0.000)
		%	67.98	4.57	6.12	9.85	4.95	6.53	100.00	

level	Primary	Freq.	1,357	129	237	376	265	483	2,847	
		%	47.66	4.53	8.32	13.21	9.31	16.97	100.00	
	Secondary	Freq.	174	21	37	83	60	229	604	
		%	28.81	3.48	6.13	13.74	9.93	37.91	100.00	
	Higher	Freq.	70	9	13	56	55	163	366	
		%	19.13	2.46	3.55	15.30	15.03	44.54	100.00	
	Total	Freq.	4,266	338	527	901	574	1,131	7,737	
		%	55.14	4.37	6.81	11.65	7.42	14.62	100.00	
Woman's employment Status	No	Freq.	3,102	256	374	577	330	657	5,296	142.03 (0.000)
		%	58.57	4.83	7.06	10.90	6.23	12.41	100.00	
	Yes	Freq.	1,164	82	153	324	244	474	2,441	
		%	47.69	3.36	6.27	13.27	10.00	19.42	100.00	
	Total	Freq.	4,266	338	527	901	574	1,131	7,737	
		%	55.14	4.37	6.81	11.65	7.42	14.62	100.00	
Mass media exposure of woman's	No	Freq.	2,993	212	334	447	246	334	4,566	726.49 (0.000)
		%	65.55	4.64	7.31	9.79	5.39	7.31	100.00	
	Yes	Freq.	1,273	126	193	454	328	797	3,171	
		%	40.15	3.97	6.09	14.32	10.34	25.13	100.00	
	Total	Freq.	4,266	338	527	901	574	1,131	7,737	
		%	55.14	4.37	6.81	11.65	7.42	14.62	100.00	
Access of health services	No	Freq.	3,968	238	393	598	376	421	5,994	1800 (0.000)
		%	66.20	3.97	6.56	9.98	6.27	7.02	100.00	
	Yes	Freq.	298	100	134	303	198	710	1,743	
		%	17.10	5.74	7.69	17.38	11.36	40.73	100.00	
	Total	Freq.	4,266	338	527	901	574	1,131	7,737	
		%	55.14	4.37	6.81	11.65	7.42	14.62	100.00	

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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Signature:

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

Date of submission: June, 2013

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

Mekonnen Tadesse (Ass. Prof.)

Advisor's Name Signature