
**Addis Ababa University**

**College of Natural and Computational Sciences**

**Department of Statistics**

# Factors associated with the number of antenatal care visits in four disadvantaged regions of Ethiopia

**By: Tilahun Abate**

**Advisor:ShibruTemsgen (PhD)**

**A thesis submitted to the Department of statistics in partial fulfillment of the requirements for the degree of Master of Science in Statistics**

**June,2021**

**Addis Ababa,Ethiopia**

## Addis Ababa University

## Graduate Program

This is to certify that the thesis prepared by Tilahun Abate, entitled: Factors associated with the number of antenatal care visits in four disadvantaged regions of Ethiopiaand submitted in partial fulfillment of the requirements for the Degree Master of Science in Statistics (Biostatistics) compiles with the regulations of the University and meets the accepted standards with respect to originality and quality.

Signed by the examining committee:

Examiner_____signature_____Date_____

Examiner_____signature_____Date_____

Advisor_____signature_____Date_____

_____

Chair of Department or Graduate Program Coordinator

# Declaration

I, Tilahun Abate, hereby declare that this thesis is my own work and that it has not previously been submitted for assessment or completion of any post graduate qualifications to another University or for another qualifications.

Name: Tilahun Abate Zeleke

Signature---------- Date----------

Submitted to: The Department of Statistics, College of Natural and Computational Sciences Addis Ababa University.

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

ShibruTemesgen(PhD) Signature ----------

**Addis Ababa University**

**College of Natural and Computational Sciences**

**Department of Statistics**

# Factors associated with the number of antenatal care visits in four disadvantaged regions of Ethiopia: Application of Zero Inflated Negative Binomial model

Tilahun Abate

A Thesis Submitted to Addis Ababa University Department of Statistics in Partial Fulfillment of the Requirement for Degree of Masters of Science in Statistics (Biostatistics)

Advisor: ShibruTemsgen (PhD)

June, 2021

Addis Ababa, Ethiopia

## Abstract

*The coverage and the quality of antenatal care play a significant role in maternal health. Antenatal care is crucial to managing preventive measures and identifying potential complications which will occur at birth. The objectiveof the study is to examine the determinant factors of the socioeconomic and demographic characteristics on the frequency of antenatal care attendances in Somalia, Afar, Gambela and BenishangulGumuzregionsof Ethiopia. The2016 Ethiopian Demographic and Health Survey (EDHS), which is obtained from Central Statistical Agency (CSA) were used for this study.A total of 2386 child-bearing mothers were selected. Among the child-bearing mothers who received ANC from skilled providers about 1116 (47.8%) of the child-bearing mothers had not received ANC service during their pregnancy period, while 687 (28.8%) of the child-bearing mothers had received one up to three time ANC service. In total, 583 (24.33%) of childbearing mothers had received 4 and more times ANC service, whereas 1250(52.2%) had visited at least one times). Four models Poisson, negative binomial, zero inflated Poisson and zero-inflated negative binomial regression models were fitted to the data. Zero Inflated Negative Binomial Regression model was found to be relatively better to fit the data.Through the analysis, Husband's education, literacy, decision maker for healthcare, and media exposure like listening radio, watching television and , Wealth index, and age of women were found to be important factors significantly associated with the use of ANC visits. The average number of ANC visit (2.08) in the four economically disadvantaged regions did not meet the recommended number (at least four) of ANC visits by WHO.From the descriptive statistical result ,it seems that, on average Gambelaregion child-bearing mothers had higher number of ANC visits thanAfar,Somali and BenishangulGumuz regions. There is an indication that there were differences observed among the four regions on the average number of antenatal care visits.Thus we recommend that special needs in promoting ANC across regions should be prioritized and structured for better implementations in all respective regions.*

## Abbreviations

**AIC**Akaki Information Criterion

**ANC**Antenatal Care

**AOR**Adjusted Odds Ratio

**BIC** Bayesian Information Criterion

**CSA**Central Statistical Agency Demographic and Health Survey

**DF**Degrees of freedom

**HIV**Human Immunodeficiency Virus

**IRR**Incidence Rate Ratio

**MDG** Millennium Development Goal

**NB**Negative Binomial

**PMTCT**Prevention of Mother to Child Transmission

**PNC**Postnatal care

**PRM**Poisson Regression Model

**SDG**Sustainable Development Goal

**UNICEF**UnitedNations International Children's Emergency Fund

**WHO**World Health Organization

**ZIP** Zero –Inflated Poisson

**ZINB**)Zero –Inflated Negative Binomial

## Lists of tables and figures

# Table of Contents

# CHAPTER ONE

# INTRODUCTION

## 1.1 Background of the Study

Antenatal care (ANC) is a care provided by skilled health personnel to a pregnant woman throughout her pregnancy (WHO2016). The primary aim of ANC is to promote and protect the health of women and their unborn babies during pregnancy so as to achieve at the end of a pregnancy a healthy mother and a healthy baby. Currently, it is regarded as a basic component of maternal health care on which the life of mothers and babies depends(CSA 2011).

It is a key strategy for reducing maternal morbidity and mortality directly through detection and treatment of pregnancy-related illness or indirectly through detection of women at risk of complications of delivery and ensuring that they deliver in a suitably equipped facility (TrinT.,2007)

Developing countries have low ANC coverage and there is a wide gap of ANC between mothers in developed and developing countries. In developed countries, 97% of women make at least 1 ANC visit. In developing countries, coverage of at least 1 ANC visit is low, that is, 69% in sub-Saharan Africa (WHO,2018). Complications of pregnancy and childbirth are the leading causes of disability and death among mothers in the reproductive age (15-49) groups in developing countries (Making Pregnancy Safer, 2009) .Ethiopia is also one of the countries with the highest maternal mortality ratios in the world (CSA,2011).

In Ethiopia, an estimated 2.9 million women give birth every year. Of these, approximately 25, 000 women and girls die each year and more than 500,000 suffer from complications including obstetric fistula (Fekadu M., (2014)).

Health care services during pregnancy and after delivery are important for the survival and

wellbeing of both the mother and the infant. Skilled care during pregnancy, childbirth, and the postpartum period are important interventions in reducing maternal and neonatal morbidity and mortality. As highlighted in the 2015-16 Health Sector Transformation Plan (HSTP), maternal and newborn health are priorities for the Government of Ethiopia (MOH, 2015). The HSTP key components are delivery at a health facility, with skilled medical attention and hygienic conditions; reduction in complications and infections during labour and delivery; timely postnatal care that treats complications from delivery; and education of the mother on care for herself and her infant. The goal of the reproductive health program is to reduce the maternal mortality ratio to 199 maternal deaths per 100,000 live births and the neonatal mortality rate to 10 per 1,000 live births by 2020.).(CSA,2016)

The high number of maternal deaths in some areas of the world reflects inequities in access to health services and highlights the gap between rich and poor. Almost all maternal deaths (99%) occur in developing countries. More than half of these deaths occur in sub-Saharan Africa and almost one-third occur in South Asia. More than half of the maternal deaths occur in fragile and humanitarian settings. The maternal mortality ratio in developing countries in 2015 is 239 per 100, 000 live births versus 12 per 100, 000 live births in developed countries. There are large disparities between countries, but also within countries, and between those women living in rural versus urban areas(WHO,2015).

The quality of ANC is dependent on the qualifications of health providers and the number and frequency of ANC visits. Adverse pregnancy outcomes can be minimized or avoided altogether if ANC is received early in the pregnancy and continued through delivery. The World Health Organization (WHO) and United Nations Children's Fund recommend that a woman without complications should have at least 4 antenatal visits, the first of which should take place during the first trimester. Antenatal care represents a significant opportunity to reach a large number of pregnant women (Mrishoetal., 2009).

Reducing maternal health complication is directly or indirectly assured if and only if the child-bearing mother takes ANC service or visited doctor as well as health-care providers. Furthermore, the prevalence of ANC service utilization of child-bearing women is absolutely low in developing countries. Regular antenatal visits are necessary to establish confidence

between the woman and her health-care provider, to individualize health promotion messages, and to identify and manage any maternal complications or risk factors associated with child-bearing mothers((Abyot N.et.al (2019)).

## 1.2 Statement of the Problem

Maternal mortality is due to different causes and problems. These problems and causes are not specifically characterized. Thus to reduce the maternal mortality a wide range of interventions are required. The coverage and the quality of antenatal care play a significant role in maternal health. Antenatal care is crucial to managing preventive measures and identifying potential complications which will occur at birth.

There are many studies on the field of maternal care in which researchers often examined the effects of covariates on patients using logistic regression models, but this model cannot account for the number of ANC a mother visited. Hence, such data can be more explored using Poisson, negative binomial, zero inflated, and hurdle negative binomial models. Because of counting, common data analysis procedures can be adopted directly. With recognizing the underlying factors associated with the number of antenatal care visit utilization of child bearing mothers in Four disadvantaged regions (Somalia, Afar, Gambela and BenishangulGumuz) were attempted to study.This study focused on these regions because of the fact that there are competing realities of life in Ethiopia, where a family's circumstances can largely be determined by which region they live in, or whether they are in a rural or urban setting.In Somali , Afar ,Gambella and Benishangul regions, many families depend on the seasonal movement of livestock and are subject to recurrent droughts. Most children live more than an hour away from the nearest school, a trip to the market may take the better part of a day, and access to basic services is limited(Berhe M.et.al(2020).

In turn with the above veracity, the study attempted to turn up with possible clarification and commendation after having clear thought upon the state of affairs by giving own emphasis to answer the following research questions: What is the frequency and distribution of ANC visit

utilization of child-bearing mothers in study areas? What are the determinants significantly influencing ANC visits?

## 1.3 Significance of the Study

Promoting the antenatal care service definitely declines the number of maternal deaths. The evaluation of the interdependence of socioeconomic and demographic characteristics with utilizing any ANC is also measuring interrelationship among those characteristics and the maternal health. Therefore; making an assessment on the contemporary situations of the utilization of antenatal care and its symbiotic factors is vital and has a reflex action to measure possession of maternal health. This study will therefore, help the stakeholders to reduce maternal and infant mortality and clarifying the main determinant factors that significantly affect the number of ANC visit utilization of child-bearing mothers. In general, the results of this study will give information to concerned bodies in setting policies, strategies, and further investigation for ANC visit utilization

## 1.4 limitations of the study

The limitations of the current study were cost and time constraints to study on primary data sources. And thus, information on the distance to the nearby health facility that might have impact on the utilization of ANC was not included in the survey.

.

## 1.5 Objectives of the Study

### 1.5.1 General Objective

The general objective of the study is to examine the association of the socioeconomic and demographic characteristics on the frequency of antenatal care attendances in Somalia, Afar, Gambela and BenishangulGumuz of Ethiopia.

### 1.5.2 Specific Objectives

• To estimate the average coverage of ANC in Somalia, Afar, Gambela and BenishangulGumuz regions of Ethiopia.

# CHAPTER TWO

# LITRATURE RIVIEW

A cross-sectional study in Nepal conducted by Neupane et al. (2020) on Andersen's model on determining the factors associated with antenatal care services showed a strong association between both contextual and individual determinants and frequency of ANC visits. Contextual factors such as province, household wealth index, ethnicity, and individual level predisposing factors such as age along with enabling factors (partner's education level, exposure to multimedia) contributed to the recommended number of ANC visits. Thus, concluded that ANC attendance is vital for live birth, and intervention target at various levels is recommended. Effective National Safe Motherhood Policy meets SDGs' target by addressing healthy reproductive needs. To make National Safe Motherhood policy effective, the factors associated with 4+ ANC visit needs to be addressed appropriately with developing special health promotion program with a focus on the vulnerable and disadvantaged. Moreover, the flexible use of multimedia should be encouraged to improve maternal health literacy(Neupane et al. (2020)).

A study conducted byTeklesilasieandDeressa (2018) used logistic regression analyses with odds ratio and 95% confidence interval were computed to test homogeneity of the two groups' baseline characteristics and examined the association between husbands' involvement in antenatal care and women's use of skilled attendants during birth. The results of their study revealed that women who reported at least one antenatal care visit in which their husbands accompanied them were 6. 27 times (95% Confidence interval: 4.2, 9.3) more likely to use skilled birth attendants compared to women attended antenatal care alone(Teklesilasie W. andDeressa W. (2018))

According to the Ethiopian Demographic and Health Surveys report, the proportion of women age 15-49 who received any ANC from a skilled provider has increased from 27% in 2000, to 28% in 2005, 34% in 2011 and 62% in 2016. The proportion of women who received the recommended four or more ANC visit increased from 10%2000 in to 32% in2016 (CSA,2016).

A studyconductedbyTarekegn et al (2014) used logistic regression and the result of the study showed that 34% of women had ANC visit11.7% used skilled delivery attendance and 9.7% of

women had postnatal health checkup. Educationofwomen ethnicity, parity, place of residence women's autonomy and household wealth had significant association with the use of maternal health services. Women who completed higher education were more likely to use ANC(AOR=3.8, 95% CI:1.8,7.8); skilled delivery attendance (AOR=3.4, 95% CI:1.9,6.20) and PNC ( AOR=2.3, 95% CI: 2.0,5.2).Women from the urban areas use ANC (AOR = 2.3, 95% CI: 1.9-2.9),skilled delivery attendants (AOR = 4.9, % CI:3.8,6.3) and PNC service ( AOR = 2.6, 95% CL:2.0,3.4) more than women from rural areas. Women who have had ANC visits during the index pregnancy were more to subsequently use skilled delivery attendants (AOR=1.3,95% CI=1.1-1.7) and PNC( AOR=3.4, 95% CI:2.8-4.1).Utilization of ANC, delivery and PNC services is more among autonomous women than others . And therefore, maternal health in Ethiopia is very low.Socio-demographic and accessibility related factors are major determinants of service utilization. There is a high inequality in service utilization among women with difference in education, household wealth, autonomy and residence.ANC is an important entry point for subsequent use of delivery and PNC service(Tarekegn, et al (2014)).

A study conducted by Zegeye et.al (2018) used multivariablelogistic regression model to identify significant factors associated with prevention of mother to child transmission service utilization. Poisson and negative binomial regression models were applied, considering the number of ANC visits as a dependent variable. The explanatory variables were age; educational status; type of occupation; decision making power in the household; living in proximity to educated people; a neighborhood with good welfare services; location (urban high-HIV prevalence and rural low-HIV prevalence); transportation accessibility; walking distance (in minutes); and household income status. Significant results were reported at p-values of <0.05 and<0.001.And the result of the study showed that, long walking distance, low household income and living in a rural setting are the significant factors associated with low ANC service utilization. The primary strategies for a holistic policy to improve ANC/PMTCT utilization should thus include improving the geographical accessibility of ANC/PMTCT services, expanding household welfare and paying more attention to remote rural areas(Zegeye, et.al (2018)).

A study conducted by Birhan and Seretew (2020) used multivariate regression reanalysis to identify factors that contribute for the change in antenatal care visit, and found out that, among the reproductive age women the rate of an acceptable antenatal care visits was increased from 16% in 2005 to 35% in 2016 in Ethiopia. In the multivariate analysis, about 29% of the increase

in acceptable antenatal care visit was due to a difference in composition of women (endowments) across the surveys. Residence, religion, husband educational attainment, and wealth status was the main source of compositional change factors for the improvements of an acceptable antenatal care visit. Almost two-thirds of an overall change in acceptable antenatal care visit was due to the difference in coefficients/ change in behavior of the population. Religion, educational attainment (both women and husband), and residence are significantly contributed to the change in full antenatal care visit in Ethiopia over the last decades (Birhan and Seretew (2020)).

A study conducted by Yeneneh et al. (2018) used Bernoulli by applying Kulldorff methods using the SaTScan™ software to analyze the purely spatial clusters of ANC utilization and found out thatSpatial variation was found in ANC utilization at regional levels. Of a total of 7909 women interviewed, 3361 (42.5%) women utilized ANC by skilled health care providers. The highest utilization of ANC was spatially clustered in Addis Ababa. On the other hand, Somali Region was the lowest in ANC utilization. Of a total of 7304 women interviewed in 2005, 2016 (27.6%) utilized ANC. Of a total of 7967 women interviewed in 2011, 2127 (26.7%) utilized ANC. Out of these, the highest ANC utilization was in Addis Ababa, Dire Dawa, Hareri and Gambela sequentially, while Amhara and Somali Region showed the lowest ANC utilization. And also used multiple logistic regression analysis to identify predictors affecting ANC utilization and found out that, of the total respondents, in 2000, 7061 (88.6%), in 2005, 6673 (91.3%), and in 2011, 6720 (85%) were rural residents. The majority of women ages during birth were between 25 to 29 years old. Women who had 2 to 4 birth order were 3259 (43.8%) in 2000, 3026 (41.4%) in 2005, and 3464 (40.9%) in 2011. In 2000, 6539 (82.0%), in 2005, 5734 (78.5%), and in 2011, 5270 (66.6%) women were uneducated. Of the total women in 2005, 1520 (20.8%) and in 2011 1739 (22.0%) were in the lowest wealth quintile. Despite the low coverage of ANC utilization, all regions registered an increasing trend from 2000 to 2011(Yeneneh et al. (2018)).

A study in Kenya, conducted by Afulani et al.(20191) assuming the response to the individual items to generate ANC service provision and experience of care scores,used both linear and logistic regression to examine predictors and found out that ,the average service provision score was 10.9 (SD=2.4) out of a total of 16. Most women received some recommended services once, but not at the frequency recommended by the Kenyan Ministry of Health. About 90% had their blood pressure measured, and 78% had a urine test, but only 58 and 14% reported blood pressure monitoring and urine test, respectively, at every visit. Only 16% received an ultrasound at any

time during ANC. The average experience score is 27.3 (SD=8.2) out of a total score of 42, with key gaps demonstrated in communication. About half of women were not educated on pregnancy complications. Also, about one-third did not often understand the purposes of tests and medicines received and did not feel able to ask questions to the health care provider. In multivariate analysis, women who were literate, employed, and who received all their ANC in a health center had higher experiences scores than women who were illiterate (coefficient=1.52, CI:0.26,2.79), unemployed (coefficient=2.73, CI:1.46,4.00), and received some ANC from a hospital (coefficient=1.99, CI: 0.84, 3.14) respectively. The wealthiest women had two times higher odds of receiving an ultrasound than the poorest women (OR=2.00, CI: 1.20, 3.33) (Afulaniet al.2019).

# CHAPTER THREE
# DATA AND METHEODOLOGY

## 3.1 DATA SOURCE

The source of data for this study was the 2016 Ethiopian Demographic and Health Survey (EDHS), which is obtained from Central Statistical Agency (CSA). It is the fourth survey conducted in Ethiopia as part of the worldwide Demographic and Health Surveys project.

The 2016 Ethiopian Demographic and Health Survey, was designed to provide estimates for the health and demographic variables of interest for the following domains. Ethiopia as a whole; urban and rural areas (each as a separate domain); and 11 geographic administrative regions (9 regions and 2 city administrations), namely: Tigray, Affar, Amhara, Oromiya, Somali, Benishangul-Gumuz, Southern Nations, Nationalities and Peoples (SNNP), Gambela and Harari regional states and two city administrations, that is, Addis Ababa and Dire Dawa. The principal objective of the 2016 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. We used IBM SPSS Statistics 24 and Stata14 statistical software packages for data analysis.

## 3.2 Variables in the study

The response (dependant) andexplanatory variables included in the survey are defined as follows:

**Response variable**

The primary outcome variable of this study is the number of any ANC visits of pregnant women in the five years preceding EDHS 2016.

**Explanatory variables**

The explanatory variables that would be included are explained as follow. The choice of these variables is guided by different literatures as the determinant factors of antenatal care service. These categories of the independent variables were coded to make it appropriate for further analysis and interpretation using different statistical models.

### 3.2.1 Coding and Description of Variables

Tab 3.1 Coding and Descriptions of Variables

| No | Variable | Description | Type | Coding |
|---|---|---|---|---|
| 1 | Number of ANC visit | the number of any ANC visits of a pregnant women in the five years preceding EDHS 2016) | Count | |
| 2 | Age in 5 year group of respondent (Age) | This variable refers to age group of mother's at the time of the survey | Categorical | 1="15-19",2="20-24",3="25-29", 4="30-34",5="35-39",6="40-44" and 7="45-49" |
| 3 | Educational status of respondent | This variable refers to the highest educational level mother's attained | Categorical | 0 =" No Education", 1 =" Primary", 2 ="Secondary" & 3="Higher" |
| 4 | Educational level of husband or Partner | Similar to educational level of the mothers | Categorical | 0 =" No Education", 1 =" Primary", 2 ="Secondary"&3="Higher" |
| 5 | Mass Media Exposure | Refers that the frequency of listening to radio, watching TV & reading Newspaper | Categorical | 0 ="Not atall",1 =" less than once a week", 2 ="at least once a week" and 3="almost every day" |
| 6 | Work status | In the survey, this was defined as if mother's has been working in any field other than household work in the seven days before the survey | Categorical | 0 = "no", 1 ="yes" |
| 7 | Place of residence | This is a dichotomous variable (urban and rural) according to where the woman was living at the time of the survey | Categorical | 1= "Urban" and 2="rural" |
| 8 | Religion | This variable refers to Religion of mother's at the time of the survey | Categorical | 1="Orthodox",2="Catholic",3 ="Protestant", 4="Muslim",5="traditional" ,6="0thers" |
| 9 | Wealth index | Composite score of several indicators of household possession. This Measured by a | Categorical | 1=" Poorest",2="poorer",3 =" Middle" , 4=" Richer "and 5 =" richest" |

| | | | | |
|---|---|---|---|---|
| | | was based on the questions about whether the household has items and facilities as piped water, toilet, type of floor used, electricity, radio, television and bicycle. Then according to the answer, each asset was given weight. Each household then was assigned a score according to each asset and the scores were summed for each household | | |
| 10 | Sexof household | This is classified as male or female. Based on the answer from the usual residents of the households on who the head of the household is | Categorical | 0 =" Female "and 1=" Male" |
| 11 | Region | Refers to Region where the woman was living at the time of the survey | Categorical | 1 =" Afar",2 ="Somalia,3 =" BenishangulG,4 ="Gambela |
| 12 | Current marital status | Refers to the marital status of women at the time of the survey. | | |
| 13 | Literacy | Refers to the capability of the respondent to read at the time of the survey. | Categorical | 0 ="Cannot read at all" ,1 =" able to read only part of sentence", 2 =" able to read the whole sentence", 3=" no card with required language", 4=" Blind/visually impaired" |
| 14 | Person who decides on respondents health care | Refers to who usually is empowered to decide on respondents health care at the time of the survey | Categorical | 1="Respondent alone",2="Respondent and husband/partner",3="Respondent and other persons",4="Husband/partner alone",5="Someone else",6="Others" |

## 3.3 METHEODOLOGY OF ANALYSIS

### 3.3.1 Count regression Models

#### *3.3.1.1 Poisson Regression Model*

Poisson regression model is the usual starting point to analyze count data. This model provides a standard framework for the analysis of count data. It can be used to model the number of occurrences of an event of interest.

The Poisson regression assumes that the observed counts are generated from a Poisson distribution which is given by:

$$P(Y = y\,|\lambda) = \frac{e^{-\lambda}\lambda^{y}}{y!};\ y = 0,1,2,\ldots \quad (3.1)$$

where, Y is a random variable and the values y's are the possible outcomes or the realizations of the random variable Y. Within a specified time interval, the Poisson response variables defined in N = 0 ,1, 2... represents number of events occurred. The Poisson distribution is characterized with the property that the mean and the variance are assumed to be equal to λ. That is

$$E(Y) = Var(Y) = \lambda \quad (3.2)$$

The possible value of λ is clearly a positive number but not necessarily an integer. This characteristic of the distribution is described as"equi-dispersed.

The Poisson regression model is derived from the Poisson distribution by parameterizing the relation between the mean parameter$\lambda_i$ and covariates (regressors) x. And thus it follows that,

$$\lambda_i = \exp(X_i\beta) \quad (3.3)$$

$$= \exp(\beta_0 + \beta_1 X_1 + \ldots + \beta_p X_p)$$

Due to the canonical log-link functions property described above the Poisson regression models are also called Poisson log-link or simply log-linear models, Poisson distribution is belongs to the exponential classes of probability distribution functions. Thus the generalized linear model approach can be used to relate the Poisson response to the explanatory variables. Given p explanatory variables and taking the natural logarithms, we have the following:

$\ln\lambda_i = \beta_0 + \beta_1 X_1 + \beta_2 X_2 ... + \beta p Xp$(3.4)

Equality of the mean and variance is referred asequi-dispersion property of the Poisson. In real life situations this property is frequently violated. Thus there is an over dispersion or otherwise under dispersion in the data. Over dispersion is thus due to the variance exceed the mean of the response variable. Over-dispersion is closely related to the presence of unobserved inter-individual heterogeneity, but it can also arise from occurrence dependence between events. Zero event counts are often dominant, leading to a skewed distribution. Also, there may be a great deal of unobserved heterogeneity in the individual experiences of the event in question. Unobserved heterogeneity leads to over-dispersion; that is, the actual variance of the process exceeds the Poisson variance even after regresses are introduced .In these case alternative models such as Negative Binomial, Zero-inflated Poisson model and Zero-inflated Negative Binomial models could be used to solve over dispersion. In this study, all these possible models will be considered and the model with the best fit will finally be selected.

### *3.3.1.2 Negative Binomial Model*

Under the PRM the observed heterogeneity among the sample members is specified by the rate $\lambda_i$ as a function of the observed $X_i$'s. see Equation 3.3.above. In practice the PRM is inadequate to fit due to over dispersion. The PRM underestimates the amount of dispersions in the observed data. Hence the negative binomial regression model solves this failure by using the unobserved heterogeneity parameter α.

For count response variable the conditional negative binomial distribution is given by the following equation.

$$P(Y/X) = \frac{\Gamma(y+\propto^{-1})}{y!\Gamma(\propto^{-1})}\left(\frac{\propto^{-1}}{\propto^{-1}+\mu}\right)^{\alpha^{-1}}\left(\frac{\mu}{\propto^{-1}+\mu}\right)^{y} (3.5)$$

### *3.3.1.3 Zero-Inflated Models*

The main motivation for zero-inflated count models is that real-life data frequently display over dispersion and excess zeros than expected. Zero-inflated count models provide a way of modeling excess zeros in addition to allowing for over dispersion. For observation i, process 1 is chosen with probability $\omega$ and process 2 with probability 1- $\omega$, .Process 1 generates only zero counts, whereas process 2, g(y|x), generates counts from either a Poisson or an NB . In general:

$$Y = \begin{cases} 0, & \text{with probability } \omega \\ g(y|x), & \text{with probability } 1-\omega \end{cases} \qquad (3.6)$$

The probability distribution of a zero inflated Poisson random variable Y is given by

$$P(Y=y) = \begin{cases} \omega+(1-\omega)e^{-\mu} & \text{for } y=0 \\ (1-\omega)\frac{\mu^{y}e^{-\mu}}{y!} & \text{For } y=1,2,3\ldots \end{cases} \qquad (3.7)$$

## 3.3.2 Handling Over dispersions and Zero -Inflation

### *3.3.2.1 Zero Inflated Poisson Regression Model*

The zero-inflated Poisson (ZIP) regression model is a modfication of the standared Poisson regression model and it allows for an overabundance of zero counts in the data. The assumption of the Poisson distribution which is the equality of the mean and the variance is violated because data are often over dispersed when there are excess zeros than expected by the standard Poisson distribution .Thus the Poisson distribution underestimates the dispersion of the observed counts. The over dispersion occurs when the single parameter λ of Poisson distribution is unable to fully describe event counts. Hence this Poisson regression model in this regard is inadequate due to excess zeroes.Thus, Zero-inflated Poisson regression model can be taken for handling the occurrences of a higher proportion of zeroes than the parent Poisson distribution.Lambert (Lambert, D. (1992)).

The ZIP model assumes that some zeroes occur by a Poisson process and others were not even eligible to have the event occur. Some explanatory variable may have a significant effect to produce zero counts to the response variable. But it is not possible to identify which zero count is due to either of the processes. The essential idea is that the data come from two regimes. In the first process the outcome is always a zero count, while in the second the counts follow a standard Poisson process (David Giles(2010)). Thus, the two processes of the ZIP models for generating its count data can be described by the following probability distribution.

$$P(yi = r) = \begin{cases} \omega_i + (1 - \omega_i)e^{-\lambda_i}, & \text{where, } r = 0 \\ (1 - \omega_i)\frac{e^{-\lambda_i}\lambda_i{}^r}{r!}, & \text{where, } r = 1,2,3 \ldots. \end{cases} \quad (3.8)$$

The mean and the variance of the ZIP distribution are, respectively:

$$E_{ZIP}(y_i) = (1-\omega_i)\lambda_i$$

and

$$Var_{ZIP(Yi)} = (1-\omega_i) + \frac{\omega_i}{1+\omega_i}[(1-\omega_i)\lambda_i]^2. \quad (3.9)$$

The variance of the ZIP distribution from the above Equation 3.13 can be equivalently expressed as:

$$Var_{ZIP}(y_i) = (1-\omega_i)(\lambda_i + \omega_i\lambda_i{}^2). \quad (3.10)$$

Hence the variance of the ZIPM is the quadratic function of its mean (Minami et.al (2006)) because of the presence of overdispersion due to the excess zeros in the data yields;

$$Var_{ZIP}(y_i) = (1-\omega_i)(\lambda(i) + \omega i\lambda_i{}^2) > \lambda_i(1-\omega i) = E_{ZIP}(y_i). \quad (3.11)$$

ZIP model fits simultaneously two separate regression models. They are the count model and the logistic or probit model. These separate models have their own coefficient estimates using the same or different predictor variables. These coefficients/parameters are β and γ respectively. The parameter vector β is estimated due the measured explanatory variables, and vector γ is parameters for covariates due to the logit or the probit of the probability/proportion of the occurrences of zeroes counts $\omega_i$. The predictor variables have differentefects on the two separate processes. The nature of the two parameters β and λ can be explained in the following way. For the covariates B and Z, the Poisson mean $\lambda = (\lambda_1,\lambda_2,...,\lambda_k)$,

$$\log(\lambda) = B\beta, \quad (3.12)$$

and for the probability $\omega=(\omega_1,\omega_2,...,\omega_k)$

$$\log(\omega_i) = \log(\omega_i\,(1-\omega_i)) = Z\gamma; \quad (3.13)$$

where $0 \leq \omega_i \leq 1$. In the Equation 3.12 the $\log\lambda$ is the cononical link for a Poisson regression model, and in the Equation 3.13 $\log(\omega_i)$ is the canonical link for Bernoulli probabilities.

### *3.3.2.2 Zero-Inflated Negative Binomial Regression Model*

For count data that are skewed with highly right tail, the NB distribution is appropriate instead of the Poisson distribution. Furthermore the zero-inflated negative binomial (ZINB) regression appropriate to model over dispersed data with an excess of zeros (Minami et.al (2007)). By this model count outcome is generated by two models. First, a logit model wasgenerated for the " zero," to assess whether women would be in this group. Then, a NB model was generated for the counts for those women who did not have zero visits. Finally, the two models were combined.probability distribution function of the ZINB regression is given by

$$P(Y=y) = \begin{cases} \omega+(1-\omega)\left(\frac{\alpha^{-1}}{\alpha^{-1}+\mu}\right)^{\alpha^{-1}} & y = 0 \\ (1-\omega)\ \frac{\Gamma(\alpha^{-1}+y)\mu^{\frac{1}{\alpha}}}{\Gamma(\frac{1}{\alpha})^{y}}(1-\mu)^{y} & y>0 \end{cases} \qquad (3.14)$$

Where $\alpha$ is the overdispersion parameter.

## 3.4 Model selection

Basically the standard PRM is the starting model to fit for a count response variable. If the count data is characterized by over dispersions, the NB is the alternative model to be fitted. However; the count observations might have excess zeroes than expected in such situations the ZIPRM model could be the appropriate to analyze the dependent variable. If the data have over dispersions and excess zero counts, the ZINB regression model is an alternative for analysis.

### 3.4.1 Test of over dispersions

An indication of the magnitude of overdispersion for an event in count dataset is simply by comparing the sample mean and variance of the dependent count variable.

If the conditional variance of the response variable exceeds its mean then there is a possibility of overdispersion in the data (A. Colin Cameron and Pravin K. Trivedi (19981).

The Poisson is the special case of the negative binomial with α=0. If α is not equal to zero and actually greater than zero then there is overdispersion. Hence the hypothesis

$$H0 : \alpha = 0 \quad vs \quad Ha : \alpha > 0 \qquad (3.15)$$

is a test for overdispersion. The LR test uses -2 times the deference in the fitted log-likelihoods of the two models. Under the null hypothesis (no overdispersion), the PR is preferred to the NB. Alternatively a Wald test can by performed, using the reported t-statistic for the estimated α in the negative binomial model. Then the negative binomial MLE for α is zero, the negative binomial parameter estimates equal the Poisson estimates, and the LR test statistic takes a value of zero (A. Colin Cameron and Pravin K. Trivedi (19981).

Another useful diagnostic tool detecting overdispersion is the Pearson chi-square statistic. Pearson's chi-square statistic is defined as:

$$\chi^2 = \sum_i \frac{(y_i - \widehat{\mu_i})^2}{\widehat{\mu_i}} \qquad (3.16)$$

This statistic described in Equation 3.16 above has a limiting chi-square distribution, with degrees of freedom equal to the number of observations minus the number of parameters estimated. If a model is correctly specified and there is no over dispersion, the Pearson chi-square statistic divided by the degrees-of-freedom has an expected value of 1. A ZIP model can account for excess zero. However; if Pearson statistic indicates that there is evidence of model misspecification, with over dispersion being the most likely occurred, then fitting a zero-inflated negative binomial (ZINB) might be a solution.

Akaike Information Criterion (AIC) and Bayesian Information Criterion (BIC) are used as a model fit statistic. And a model with a minimum (AIC) or (BIC) is relatively considered as an appropriate model.

## 3.5 Model building and variable selection procedures

In order to select the important factors related to the response variable, the backward selection Procedure is used. This strategy is called backward because we are working backward from our

largest starting model that contains all variables to a smaller final model. In this case, theprocedure is used to remove covariates with non-significant p-values. This means that variables

that did not contribute to the model based on the highest p-value will be eliminated sequentially

and each time a new model, with the remaining covariates will be refitted, until we remainedwith covariates necessary for answering our research question. that are jointly significant.

# CHAPTER FOUR
# RESULTSANDDISCUSION

## 4.1 Introduction

In this chapter data were analyzed and interpretation of results was given. We start with descriptive statistics to show the distribution of the utilizations of any ANC for deferent major or fundamental variables.

To investigate the determinants of socioeconomic and demographic features on utilizations of ANC in disadvantaged region of Ethiopia, we compared four count models to choose the appropriate model for our data. That is two basic count models with their respective zero inflated models were compared so that an appropriate model or a better model in fitting the data was selected.. Finally we gave interpretations to our results

## 4.2 Summary of Descriptive Statistics

A total of 2386 child-bearing mothers who have a live birth in the last 5 years preceding the survey were interviewed from four regions (Afar, Somali, BenishangulandGambella), as shown in Table 1. About 1116 (46.8%) of the child-bearing mothers had not received ANC service during their pregnancyperiod, while 108 (4.5%), 186(7.8%) and 393(24.4%)of the child-bearing mothers had received one, two and three time ANC service respectively.. In total, 583 (24.4%) of childbearing mothers had received four and more times ANC service,. Table 4.1 reveals that among 2386 women who gave live births in the five years preceding EDHS-2016 in the disadvantaged regions 46.8% do not visited any ANC service. In addition it indicates that the variance of the response variable (27.42) is greater than its mean ( 2.08 )with the measure of the skewness 15.4. Besides, it is shown in figure 4.1 that the percentage of zero counts of the ANC visits is high i.e. almost half. From these we can hypothesize there is overdispersion in the distribution of any ANC visits in the data set.

In table 4.1 we can understand that the pattern of any ANC visits was skewed to the right with higher proportion of zeroes. Furthermore, we can see that the mean value of any ANC visits in the four disadvantageous regions was 2.08 which is less than the WHO recommendations (4+ times).

**Tab 4.1 The frequency distribution of number of ANC visit**

| | Frequency | Percent |
|---|---|---|
| **No ANC** | 1116 | 46.8 |
| **1** | 108 | 4.5 |
| **2** | 186 | 7.8 |
| **3** | 393 | 16.5 |
| **4 and above** | 583 | 24.4 |
| **Total** | 2386 | 100 |
| **Mean** | = 2.08 | |
| **Variance** | = 27.42 | |
| **Skeweness** | = 15.4 | |
| **Kurtosis** | = 281.81 | |

About two thousand five (83%) respondents were rural women attending ANC of 1.966 on average, whereas 381 (17%) were attending ANC of 3.433 on average. For this, most of the mothers who live in urban were more prevalent of receiving ANC than those who live in rural.

Table 4.2 revealed that as women got higher level of education, their number of ANC visits during pregnancy was increased considerably.About 1,698(71.2%) of women of child bearing age proceeding the survey were not educated and had 1.777 average number of ANC visits where as 128(5.4%) of women with primary education level had 3.813 average number of ANC visits followed by those women of higher education level with 3.063 average number of ANC visits.

The wealth index was also found to be another important indicator for utilizing ANC. Here we found that the change in the amount of income and expenditure of the households were seen with a consistent change in the frequency or the intensity of antenatal care utilization in the four disadvantageous regions during the five years preceding the survey. Women in lower index were loosely linked to ANC as compared to women who belong from the higher wealth indices. Table 4.2 indicate that 57.6 percent with average ANC of 2.298 and 13.9 percent with average ANC

of3.955 of the poorest and the richest pregnant women respectively were experienced ANC service.

One hundred fourteen (4.8%) child-bearing mothers were below the age of 20 years and ANC was 2.298 averagely. The pregnancy age of the most child-bearing mothers (675 [28.3%]) was between 25 and 29 years, with an average ANC of 2.669.

Table 4.2 indicates that the average ANC visit utilization of childbearing mothers in the 5 years preceding the surveyinAfar,Somali,BenishangulGumuz and Gambela region were 0.560 ,0.576, 1.019 and 1.059 respectively. Thus, on the average Gambelaregion child-bearing mothers had higher number of ANC visits thanAfar,Somali and BenishangulGumuz regions..
Table 4.2 indicates that Catholic (1%) ,Orthodox (10.5%) and Muslim (68.9%) women who gave live births in the five years preceding the survey had experienced average ANC visits of 3.2, 2.873 and 2.123 respectively.

Women from male headed HH in the study (73%) who gave birth in the five years preceding the survey had experienced 2.262 average number of ANC visits. Whereas those women fromfemale headed house hold (27%) who gave birth in the five years preceding the survey had 2.034 average number of ANC visits.

About26.8% of women who gave birth in the five years have work, and had average ANC visit of 2.635 and 73.2% of women without work were with the average ANC visit of 2.041 .

Table 4.2 indicate that among women who gave birth in the five years preceding the survey and who are autonomous on the decision of health care service(20.7%)% had 2.799 ANC visits on the average.

Tab 4.2 The frequency distribution of number of ANC visit

| **Back ground characteristics** | **Frequency(percent)** | **Mean** | **Std.Dev** |
|---|---|---|---|
| **Age in 5 years** | | | |
| 15-19 | 114(4.8%) | 2.298 | 2.194 |
| 20-24 | 562(23.6%) | 2.536 | 4.701 |
| 25-29 | 675(28.3%) | 2.669 | 8.521 |
| 30-34 | 474(19.9%) | 2.002 | 2.061 |
| 35-39 | 414(17.4%) | 1.681 | 5.088 |
| 40-44 | 117(4.9%) | 0.795 | 1.500 |
| 45-49 | 30(1.1%) | 0.767 | 1.223 |
| **Education Level** | | | |
| No education | 1,698(71.2%) | 1.777 | 6.031 |
| Primary | 504(21.1%) | 3.063 | 4.876 |
| Secondary | 128(5.4%) | 3.813 | 1.999 |
| Higher | 56(2.3%) | 3.571 | 1.906 |
| **Region** | | | |
| Afar | 582(24.4%) | 0.560 | 0.7250 |
| Somali | 754(31.6%) | 0.576 | 0.707 |
| Gambela | 481(20.2%) | 1.019 | 0.835 |
| Benishangul | 569(23.8%) | 1.059 | 0.872 |

| | | | |
|---|---|---|---|
| Place of residence | | | |
| Rural | 2,005(83%) | 1.966 | 6.028 |
| Urban | 381(17%) | 3.433 | 2.297 |
| **Religion** | | | |
| Orthodox | 251(10.5%) | 2.873 | 2.495 |
| Catholic | 25(1%) | 3.2 | 2.141 |
| Protestant | 427(17.9%) | 2.194 | 2.284 |
| Muslim | 1,645(68.9%) | 2.123 | 6.586 |
| Traditional | 25(1%) | 0.32 | 1.108 |
| Others | 13(0.7%) | 0.846 | 1.144 |
| **Frequency of reading news paper** | | | |
| Not at all | 2,318(97.2%) | 2.1665229 | 5.6995605 |
| Less than once a week | 39(1.6%) | 3.8461538 | 1.0396979 |
| At least once a week | 29(1.2%) | 2.6896552 | 1.8342661 |
| **Frequency of listening to radio** | | | |
| Not at all | 2,034(85.2%) | 1.982 | 5.611 |
| Less than once a week | 183(7.7%) | 3.683 | 7.238 |
| At least once a week | 169(7.1%) | 3.225 | 2.794 |
| **Frequency of watching television** | | | |
| Not at all | 2,069(86.7%) | 1.983 | 5.954 |
| Less than once a week | 129(5.4%) | 2.519 | 1.746 |

| | | | |
|---|---|---|---|
| At least once a week | 188(7.9%) | 4.378 | 2.079 |
| **Sex of HH** | | | |
| Male | 1,742(73%) | 2.262 | 5.595 |
| Female | 644(27%) | 2.034 | 5.715 |
| **Literacy** | | | |
| Cannot read at all | 1,887(79.1%) | 1.852 | 5.770 |
| Read only parts of sentence | 199(8.3%) | 3.809 | 2.402 |
| Read whole sentence | 186(7.8%) | 3.183 | 2.249 |
| No card with required language | 114(4.8%) | 3.561 | 9.174 |
| **Wealth index** | | | |
| Poorest | 1,374(57.6%) | 1.114 | 4.019 |
| Poorer | 271(11.4%) | 2.232 | 2.059 |
| Middle | 233(9.8%) | 5.069 | 12.453 |
| Richer | 175((7.3%) | 3.52 | 7.574 |
| Richest | 333(13.9%) | 3.955 | 2.029 |
| **Work status** | | | |
| **Yes** | 639(26.8%) | 2.635 | 6.870 |
| **No** | 1,747(73.2%) | 2.041 | 5.090 |
| **Husband/Partner education** | | | |
| No education | 1,395(58.5%) | 1.409 | 4.072 |
| Primary | 534(22.4%) | 3.358 | 8.601 |

| | | | |
|---|---|---|---|
| Secondary | 216(9.1%) | 3.505 | 6.775 |
| Higher | 241(10%) | 3.046 | 2.015 |
| **Person who usually decides on respondent's health** | | | |
| Respondent alone | 493(20.7%) | 2.799 | 9.865 |
| Respondent and husband/Partner | 1,314(55.1%) | 2.284 | 4.346 |
| Husband/partner alone | 579(24.2%) | 1.525 | 2.031 |

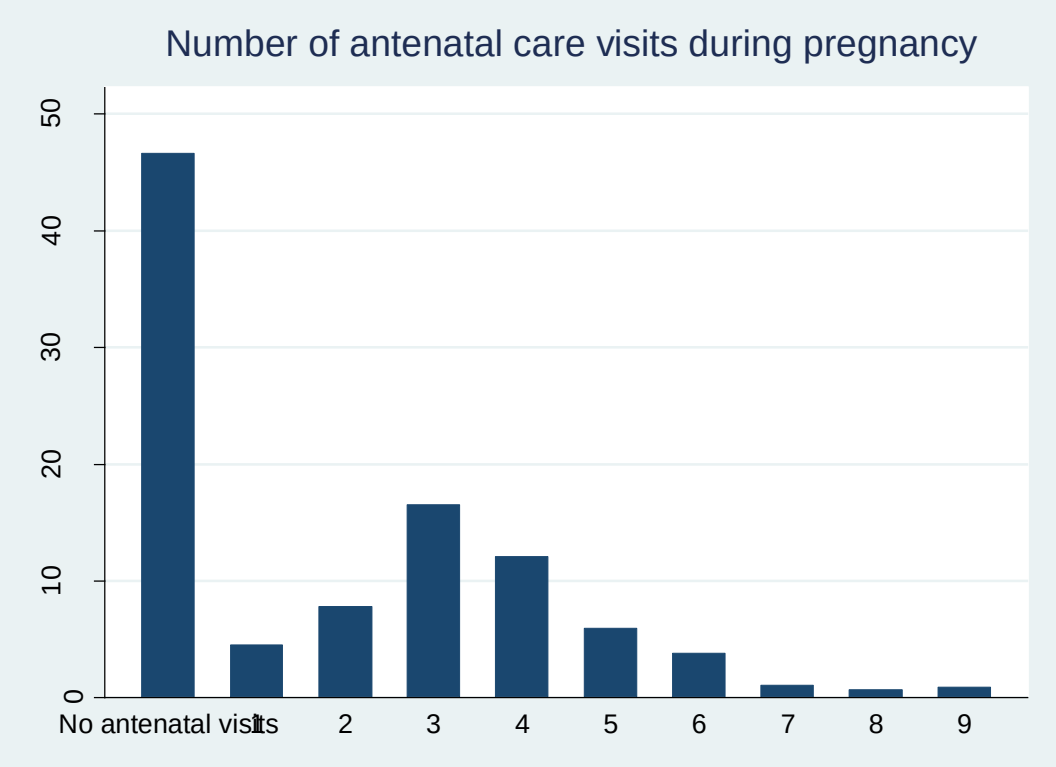


Figure 4.1 Number of antenatal care visits during pregnancy

## 4.3 Test for over dispersion

Test of overdispersion on standard Poisson regression were made using Deviance andPearson chi square Goodness of fit test.Thus, the tests confirmed that there is overdispersion in the data.

| Model | Deviance goodness of fit ( P-value) | df | Deviance Goodness of fit /df | Pearson chi square Goodness of fit | df | Pearson chi square Goodness of fit/df ( P-value) |
|---|---|---|---|---|---|---|
| Standard Poisson | 7390.92 ( <0.001) | 2324 | 3.2 | 20293 | 2324 | 8.73 ( <0.001) |

Voung test of ZIP vs Standard Poisson ( Z =33.45 ,P<0.001)

Voung test of ZINB vs standard Negative Binomial (Z=66.83,P<0.001)

## 4.4 Model Comparison

Count data models were compared using Akaike information criterion (AIC) and Bayesian. Information criterion (BIC). To incorporate all variables into the model building workflow for count data regression models, their model information would be used to complement standard techniques such as information criteria (AIC) and (BIC). Using a basic model for the number of ANC visit data ( Poisson vs. NB models) and/or extra zeros ( zero-inflation) are relevant issues in the data at hand. The models upon which the variables are based should use a reasonable first selection of regressor. (a standard specification from the literature or a model involving all potentially relevant variables). In much literature reviewed that the models with smallest AIC and (BIC) values is the better one .The value of voung statistics was 66.83 with P<0.001, indicating that over-dispersion due to many zeroobservations and unobserved heterogeneity.Moreover, both the AIC and BIC values also supported the conclusion that the ZINB model provided the best fit to the frequency of ANC care use data(Table 4.3)

***Table: 4.4 AIC and (BIC) values***

| No | Model | AIC | BIC |
|---|---|---|---|
| 1 | Poisson | 118458.78 | 12027.88 |
| 2 | Zero-inflated Poisson(ZIP) | 7309.16 | 7494.04 |
| 3 | Negative Binomial(NB) | 8640.15 | 8778.81 |
| 4 | Zero inflated Negative Binomial(ZINB) | 5817.76 | 6008.41 |

## 4.5 ZINB regression model analysis

### 4.5.1 NB part of ZINB Model

Table 4.5 shows the results from the NB part of the ZINBregression model. The model estimation applied Bootstrap to make the parameter estimation more precise and control for minor violations related to the underlying assumptions. The model was run to estimate the

incidence rate ratio (IRR), which measures the rate at which the event (ANC visits) occurs. Table 4.5 illustrates the IRRs estimated across the explanatory variables.

Age at birth was the major variable that had impact on the utilizations ANC in the last five years. Table 4.5 revealed that, the expected number of ANC visits for women of age group, 30-34, 35-39and 40-44 and 45-49were respectively equal to 0.754, 0.751,0.314 and 0.385 times the expected number of antenatal care visits for women of age group 15-19.

Women who were pregnant five years preceding the survey and were able to read whole sentence had 0.791times the expected number of ANC visits compared to woman who were not able to read at all.

Women's husband/partner education level showed a significant effect on the number of ANC visit during their pregnancy period. As shown in table 4.5 the expected number of antenatal care visits of women whose husband/partner education level were secondary, higher and primary education were 2.018, 1.438 and 1.431 times the expected number of antenatal care visitsby women whose husband/partner had no education.

Exposure to different Medias significantly affected the number of ANC visit. Women who listened radio and watched television in less than once a week had 2.23 and 0.601 times the expected number of antenatal care visitscompared to those women who did not at all respectively.

Table 4.5 revealed that the expected number of ANC visits of a woman in middle and richest indices were 4.121 and 3.017 times the expected number of antenatal care visitscompared to poorest womenrespectively.

Decision for healthcare being taken by the husbands was significantly associated with ANC visits showing0.689times of having the expected number of antenatal care visits compared to decision taken by women alone.

**Table 4.5 Parameter estimates of negative binomial part of the ZINB regression model across the explanatory variables**

| Variables | IRR | Coefficient | Std.error | Z-value | P-value | 95% CI |
|---|---|---|---|---|---|---|
| **Age in 5 years** | | | | | | |
| 15-19( Reference) | | | | | | |
| 20-24 | 0.849 | -0.164 | 0.136 | -1.20 | 0.228 | [-0.431 0.103] |
| 25-29 | 0.871 | 0.1386 | -0.138 | -1.01 | 0.310 | [-0.404 0.128] |
| 30-34 | 0.754 | -0.282 | -0.142 | -1.99 | 0.047 | [-0.561 -0.004] |
| 35-39 | 0.751 | -0.287 | 0.144 | -1.99 | 0.046 | [-0.568 -0.005] |
| 40-44 | 0.314 | -1.159 | .2027294 | -5.72 | 0.000 | [-1.557 -0.762] |
| 45-49 | 0.385 | -0.953 | 0.329 | -2.90 | 0.004 | [-1.598 -0.308] |
| **Literacy** | | | | | | |
| | | | | | | |
| Not at all**(**Reference) | | | | | | |
| Able to read only parts of sentence | 0.964 | -0.036 | 0.104 | -0.35 | 0.727 | [-0.241 0.168] |
| Able to read whole sentence | 0.791 | -0.234 | 0.112 | -2.09 | 0.037 | [-0.453 -0.014] |
| No card with required language | 1.577 | 0.455 | 0.134 | 3.40 | 0.001 | [0.193 0.718] |
| **Frequency of listening to radio** | | | | | | |
| Not at all**(**Reference) | | | | | | |
| Less than once a week | 2.237 | 0.805 | 0.103 | 7.85 | 0.000 | [0.604 1.006] |
| At least once a week | 1.426 | 0.355 | 0.106 | 3.36 | 0.001 | [0.148 0.562] |
| **Frequency of watching television** | | | | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| Not at all**(**Reference) | | | | | | |
| Less than once a week | 0.601 | -0.509 | 0.132 | -3.86 | 0.000 | [-0.767-0.251] |
| At least once a week | 1.044 | 0.043 | 0.126 | 0.35 | 0.728 | [-0.202 0.289] |
| **Wealth index** | | | | | | |
| Poorest**(**Reference) | | | | | | |
| Poorer | 1.928 | 0.656 | 0.088 | 7.49 | 0.000 | [0.485 0.828] |
| Middle | 4.121 | 1.416 | 0.091 | 15.53 | 0.000 | [1.237 1.594] |
| Richer | 2.559 | 0.939 | 0.107 | 8.77 | 0.000 | [0.729 1.149] |
| Richest | 3.017 | 1.104 | 0.111 | 9.94 | 0.000 | [0.886 1.322] |
| **Husband/ Partner's Education level** | | | | | | |
| No education**(**Ref.) | | | | | | |
| Primary | 1.431 | 0.358 | 0.073 | 4.93 | 0.000 | [0.216 0.500] |
| Secondary | 2.018 | 0.702 | 0.099 | 7.08 | 0.000 | [0.5080.897] |
| Higher | 1.438 | 0.363 | 0.107 | 3.40 | 0.001 | [0.154 0.573] |
| **Respondent work** | | | | | | |
| No**(**Reference) | | | | | | |
| Yes | 1.235 | 0.211 | 0.084 | 3.092 | 0.002 | [1.080 1.413] |
| | | | | | | |
| **Person who usually decides on respondent's health** | | | | | | |
| Respondent alone**(**Reference) | | | | | | |
| Respondent and husband/Partner | 0.753 | -0.284 | 0.069 | -4.08 | 0.000 | [-0.419 -0.147] |
| Husband/partner alone | 0.689 | -0.371 | 0.084 | -4.440 | 0.000 | [-0.535 -0.207] |
| _cons | 1.384 | 0.325 . | 0.139 | 2.321 | 0.020 | [0.051 0.599] |
| Alpha | 0.078 | 1.081 | 0.060 | | | [0.969 1.206] |

### 4.5.1 Zero-inflation part of ZINB Model

Table 4.6 revealed that, the probability of being in the excess Zero group for women of age group, 30-34 and 40-44 were decreased by19.7% and 29.5% respectively as compared to the reference group (i.e., pregnant women of age group 15-19).

The model also suggested that the probability of being in the excess zero group was 13.2%lowerfor women residing in Benishangul region compared to those in Afar region.

Women who were pregnant five years preceding the survey and with no card with required languagehad 21.9% inecrease in the probability of being in the excess Zero group compared to woman who were not able to read at all.

Women who read news paper at least once a week had 16.8% decrease in the probability of being in the excess zero group compared to those womenwho did not read at all.Simlarly women who listened radio and watched television in less than once a week had an increase in the probabilty of being in the excess Zero groupeby 26.1% and a decrease by 33% respectively ccompared to those women who did not listened and watched at all.

Table 4.6 revealed that the probability of being in the excess zero group of a woman in middle and richer indices wasincreased by 58.7%and 66.7% respectivelywhen compared topoorest women.

As shown in table 4.6probability of being in the excess zero group of a woman withprimary and secondary level of their husband/partner education were increased by 35.3% and 37.6% compared to husband/partner with no education respectively.

The probability that women were in the zero group decreased by 27.4% and 22.8% respectively whenthe women had decision on healthcareby the husband and both compared to women who haddecisionby her own.

***Table 4.6Zero-inflation part of ZINB model parameter estimation for ANC Visit for the Selected Variables***

| Variables | IRR | Coefficient | Std.error | z | P-value | 95% CI |
|---|---|---|---|---|---|---|
| **Age in 5 years** | | | | | | |
| 15-19( Reference) | | | | | | |
| 20-24 | 0.916 | -0.088 | 0.099 | -0.887 | 0.375 | [-0.282 0.106] |
| 25-29 | 1.117 | 0.111 | 0.099 | 1.117 | 0.264 | [-0.084 0.305] |
| 30-34 | 0.803 | -0.209 | 0.106 | -1.976 | 0.048 | [-0.416 -0.002] |
| 35-39 | 1.009 | 0.009 | 0.111 | 0.081 | 0.936 | [-0.208 0.226] |
| 40-44 | 0.705 | -0.350 | 0.170 | -2.061 | 0.003 | [-0.683 -0.017] |
| 45-49 | 0.594 | -0.521 | 0.288 | -1.810 | 0.070 | [0.367 0.873] |
| **Region** | | | | | | |
| Afa**r(**Reference**)** | | | | | | |
| Benishangul | 0.868 | -0.142 | 0.069 | -2.067 | 0.039 | [-0.276 -0.007] |
| **Literacy** | | | | | | |
| Not at all**(**Reference) | | | | | | |
| Able to read only parts of sentence | 0.940 | -0.061 | 0.064 | -0.904 | 0.366 | [-0.195 0.072] |
| Able to read whole sentence | 0.949 | -0.052 | 0.081 | -0.611 | 0.541 | [-0.221 0.116] |
| No card with required language | 1.219 | 0.198 | 0.090 | 2.193 | 0.028 | [0.021 0.375] |
| **Frequency of reading news paper** | | | | | | |
| Not at all**(**Reference) | | | | | | |
| Less than once a week | 0.887 | -0.120 | 0.134 | -0.890 | 0.374 | [-0.383 0.144] |
| At least once a week | 0.681 | -0.384 | 0.166 | -2.312 | 0.021 | [-0.710 -0.058] |
| **Frequency of listening to radio** | | | | | | |
| Not at all**(**Reference) | | | | | | |
| Less than once a week | 1.261 | 0.232 | 0.067 | 3.437 | 0.001 | [0.100 0.364] |
| At least once a week | 1.145 | 0.135 | 0.073 | 1.844 | 0.065 | [-0.009 0.279] |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Frequency of watching television** | | | | | | | |
| Not at all(Reference) | | | | | | | |
| Less than once a week | 0.670 | -0.401 | 0.093 | -4.316 | 0.000 | [-0.583 | -0.219] |
| At least once a week | 1.022 | 0.022 | 0.079 | 0.274 | 0.784 | [-0.134 | 0.177] |
| **Wealth index** | | | | | | | |
| Poorest(Reference) | | | | | | | |
| Poorer | 1.164 | 0.152 | 0.070 | 2.182 | 0.029 | [0.015 | 0.288] |
| Middle | 1.587 | 0.462 | 0.065 | 7.148 | 0.000 | [0.335 | 0.589] |
| Richer | 1.667 | 0.511 | 0.078 | 6.547 | 0.000 | [0.358 | 0.664] |
| Richest | 1.318 | 0.276 | 0.076 | 3.653 | 0.000 | [0.128 | 0.424] |
| **Husband/ Partner's Education level** | | | | | | | |
| No education(Reference) | | | | | | | |
| Primary | 1.353 | 0.303 | 0.054 | 5.632 | 0.000 | [0.197 | 0.408] |
| Secondary | 1.276 | 0.244 | 0.069 | 3.513 | 0.000 | [0.108 | 0.380] |
| Higher | 1.043 | 0.042 | 0.078 | 0.542 | 0.588 | [-0.111 | 0.196] |
| **Person who usually decides on respondent's health** | | | | | | | |
| Respondent alone(Reference) | | | | | | | |
| Respondent and husband/Partner | 0.772 | -0.259 | 0.052 | -4.980 | 0.000 | [-0.361 | -0.157] |
| Husband/partner alone | 0.726 | -0.320 | 0.064 | -5.014 | 0.000 | [-0.445-0.1 95] | |
| _cons | 3.769 | 1.327 | 0.103 | 12.866 | 0.000 | [1.125 | 1.529] |
| Alpha | 0.237 | 0.237 | 0.015 | | | [0.209 | 0.268] |

## 4.6. Discussion

In the current study, 2386 women who gave birth at least once within the last 5 years before the survey were interviewed from four regions (Afar, Somali, Benishangul and Gambela). Thechild-

bearing mothers who attend at least one ANC visits were 52.2% and 24.33% of women of chil bearing had at least 4 visits, but in the study done in Kaffa, Sheka, and Bench Maji Zones of Southwestern Ethiopia(Abiyot N.et.al(2019)),out of 1715interviewed women (91.9%) of them hadat least one ANC visit during their pregnancy. Majority of women, (66.6%), made at least 4 ANC visits during their pregnancy., which is much morethan the proportion for current study.

The current study showed that the age at pregnancy is significantly influencing the utilization of ANC.The study also showed that the attendance is higher for pregnant women whose age is in between 30 and 34 and get lower as age increases It is supported by a nationally representative sample survey in Ethiopia; receipt of maternity care was found to vary by age, and other sociodemographic factors (CSA, 2011)

Use of public media sources like listening radio and watching television increases the awareness of people on health and other matters. In this study, use of these public media sources significantly affected the use of ANCservices. Frequency of listening to radio has significant increasing effect than frequency of watching television.This may be due to the low proportion of households who have access to television and news paper in the regions. A study in Nigeria has shown that community media saturation was found to be a strong predictor of maternal health service utilization (Babalola,(2009)).

Decision making power of women can have a significant effect on the ability of womentoseek health services and/or contribute to delays in accessing and receiving medical care even in places where services are readily available(Ahmedetal.,2010)).In this study, women who have been able to decide on health care by themselves were more likely to have the expected number of ANC visits than women whose health care decision was controlled by other people. This may be because if resources are controlled by others women do not have the freedom to use services whenever they need care. This may be because if resources are controlled by others, women do not have the freedom to use services whenever they need care

This study has found that household wealth status is significantly associated with the utilization of ANC services. Women who are from household withmiddle and a higher wealth quintile are more likely to utilize ANC services than those who are from the poorest wealth households. This result is consistent with other similar studies (Arthur E. (2014)). This is expected since access to health services utilization in Ethiopia mainly depends on out of pocket payment (Ministry of

Health of Ethiopia(2010)). Though the services forANC are exempted, women are expected to pay for medications and additional transportation costs contribute to the high cost of seeking care and maydeter women from utilizing services. This has also been revealed in other similar studies (Ahmed etal.,2010).

This study has found thatofhusband/ partner's education levelhad a significant effect on the utilization of the ANC services.. These results have been consistently supported by many other studies which showed a positive influence of education on maternal health service utilization (Mengesha ZB etal.,2013)].. Educated husbands may have a better communication with their wives and willingness to discuss the use of maternal health services. They may also provide more autonomy to their wives (Ahmed etal.,2010)).

# CHAPTER FIVE

# CONCLUSIONS AND RECOMMENDATIONS

This study showed that in the four economically disadvantaged regions availing of at least one ANC visit was 53.2% and at least 4 visits was 24.40%, which is very low. Husband's education, literacy, decision maker for healthcare, and media exposure like listening radio, watching television Wealth index,, and age of women were the important factors which were significantly associated with the use of ANC visits. Thus, we conclude thatsocio economic and demographic factors determine the number of ANC, and intervention at various levels is recommended.

The average number of the frequency (2.08) of visiting for ANC in the four economically disadvantaged regions did not match to the recommended number (at least four) of ANC visit by the WHO..Benishangul region had relatively better proportion of women who had ANC visit(40.73%) followed by Gambella(35%) and Somali region had the least proportion of ANC visit(12.23%) almost similar with Afar region (16.37).Thus we concluded thatthere were differences observed among regions on the proportion of womenwho had utilizationof antenatal cares and we recommend that special needs in promoting ANC across regions should be prioritized and structured for better implementations in all respective regions.

## Acknowledgments

I highly appreciated the kindness of Central Statistical Agency of Ethiopia(CSA) for sponsoring my master degree education at the Addis Ababa University (AAU). I am also feeling highly thankfulness to the AAU for allowing me to study my MSc. degree in the department of Statistics. I am very grateful to my thesis advisor Dr.ShibruTemesgen for his invaluable comments and suggestions that he contributed to the successful realization of the study.

I am very much indebted to my sisters for they were tireless to encourage me and provide supports throughout my study. My especial deep thanks also goes to AtoAshenafiSeyoum and w/t AsresAbaynehfor whom they gave me untiring and persistent supports, assistances and encouragements throughout my study times.

Tilahun Abate

June,2021

Addis Ababa, Ethiopia.

## Reference


1) Abosse, Z., Woldie, M. and Ololo, S., 2010. Factors influencing antenatal care service utilization in hadiya zone. *Ethiopian Journal of Health Sciences*, *20*(2).
2) A. Colin Cameron and Pravin K. Trivedi (1998). Regression analysis of count data. Econometric Society Monographs No. 30. Cambridge University Press, United Kingdom. Published in the United States by Cambridge University Press, New York.
3) Afulani, P.A., Buback, L., Essandoh, F., Kinyua, J., Kirumbi, L. and Cohen, C.R., 2019. Quality of antenatal care and associated factors in a rural county in Kenya: an assessment of service provision and experience dimensions. *BMC health services research*, *19*(1), pp.1-16.
4) Anyait, A., Mukanga, D., Oundo, G.B. and Nuwaha, F., 2012. Predictors for health facility delivery in Busia district of Uganda: a cross sectional study. *BMC pregnancy and childbirth*, *12*(1), pp.1-9.
5) Ahmed, S., Creanga, A.A., Gillespie, D.G. and Tsui, A.O., 2010. Economic status, education and empowerment: implications for maternal health service utilization in developing countries. *PloS one*, *5*(6), p.e11190.
6) Arthur, E., 2012. Wealth and antenatal care use: implications for maternal health care utilisation in Ghana. *Health economics review*, *2*(1), pp.1-8.
7) Babalola, S. and Fatusi, A., 2009.Determinants of use of maternal health services in Nigeria-looking beyond individual and household factors. *BMC pregnancy and childbirth*, *9*(1), pp.1-13.
8) Berhe,M,Arden ,Fand Christina,W,2020.Faster Poverty Reduction in more urbanized regions
9) Birhan, T.Y. and Seretew, W.S., 2020. Trends and determinants of an acceptable antenatal care coverage in Ethiopia, evidence from 2005-2016 Ethiopian demographic and health survey; Multivariate decomposition analysis. *Archives of Public Health*, *78*(1), pp.1-12.
10) CSA [Ethiopia] and ICF International: Ethiopian Demographic andHealth Survey 2016.Addis Ababa Ethiopia and Cavil ton, Maryland, USA:Central Statistical Agency and ICF International;2017

11) Central Statistical Agency. Ethiopia Demographic and Health Survey 2011, Final Report: Addis Ababa, Ethiopia. Calverton, MD: CSA and ORC Macro; 2011.
12) David Giles (March, 2010). The Zero-Inflated Poisson Regression Model.Department of Economics, University of Victoria.
13) Fekadu, M. and Regassa, N., 2014. Skilled delivery care service utilization in Ethiopia: analysis of rural-urban differentials based on national demographic and health survey (DHS) data. *African health sciences*, *14*(4), pp.974-984.
14) Lambert, D., 1992.Zero-inflated Poisson regression, with an application to defects in manufacturing. *Technometrics*, *34*(1), pp.1-14.
15) Long, J.S. and Long, J.S., 1997. *Regression models for categorical and limited dependent variables* (Vol. 7). Sage.
16) Making Pregnancy Safer: A Health Sector Strategy for Reducing Maternal and Perinatal Morbidity and Mortality. Geneva, Switzerland; 20
17) Mengesha, Z.B., Biks, G.A., Ayele, T.A., Tessema, G.A. and Koye, D.N., 2013. Determinants of skilled attendance for delivery in Northwest Ethiopia: a community based nested case control study. *BMC public health*, *13*(1), pp.1-6.
18) Minami, M., Lennert-Cody, C.E., Gao, W. and Román-Verdesoto, M., 2007. Modeling shark bycatch: the zero-inflated negative binomial regression model with smoothing. *Fisheries Research*, *84*(2), pp.210-221.
19) Ministry of Health of Ethiopia: Ethiopia's Fourth National Health Accounts,2007/2008. Addis Ababa: Ministry of Health [Ethiopia]; 2010
20) Mrisho, M., Obrist, B., Schellenberg, J.A., Haws, R.A., Mushi, A.K., Mshinda, H., Tanner, M. and Schellenberg, D., 2009. The use of antenatal and postnatal care: perspectives and experiences of women and health care providers in rural southern Tanzania. *BMC pregnancy and childbirth*, *9*(1), pp.1-12.
21) Neupane, B., Rijal, S., Gc, S. and Basnet, T.B., 2020. Andersen's model on determining the factors associated with antenatal care services in Nepal: an evidence-based analysis of Nepal demographic and health survey 2016. *BMC Pregnancy and Childbirth*, *20*, pp.1-11.
22) Tarekegn, S.M., Lieberman, L.S. and Giedraitis, V., 2014. Determinants of maternal health service utilization in Ethiopia: analysis of the 2011 Ethiopian Demographic and Health Survey. *BMC pregnancy and childbirth*, *14*(1), pp.1-13.

23) Teklesilasie, W. and Deressa, W., 2018. Husbands' involvement in antenatal care and its association with women's utilization of skilled birth attendants in Sidama zone, Ethiopia: a prospective cohort study. *BMC pregnancy and childbirth*, *18*(1), pp.1-10.
24) Terefe, A.N. and Gelaw, A.B., 2019. Determinants of antenatal care visit utilization of child-bearing mothers in Kaffa, Sheka, and Bench Maji Zones of SNNPR, Southwestern Ethiopia. *Health Services Research and Managerial Epidemiology*, *6*, p.2333392819866620.
25) Anh, T.T., Isaranuruk, S. and Chompikul, J., 2007. Factors related to the Acceptance of the New Antenatal Care Protocol among the Health Personnel in SuphanBuri Province, Thailand.
26) Yeneneh, A., Alemu, K., Dadi, A.F. and Alamirrew, A., 2018. Spatial distribution of antenatal care utilization and associated factors in Ethiopia: evidence from Ethiopian demographic health surveys. *BMC pregnancy and childbirth*, *18*(1), pp.1-12.
27) World Health Organization, Antenatal care. In: Opportunities for Africa's Newborns, 2018
28) World Health Organization, Recommendations on Antenatal Care for a Positive Pregnancy Experience. Geneva, Switzerland: 2016
29) Zegeye, E.A., Mbonigaba, J. and Dimbuene, Z.T., 2018. Factors associated with the utilization of antenatal care and prevention of mother-to-child HIV transmission services in Ethiopia: applying a count regression model. *BMC women's health*, *18*(1), pp.1-11.

## Annex

## A1. Output for Poisson regression model

Poisson regression

| | |
|---|---|
| Number of obs | 2,386 |
| LR chi2(30) | 2773.37 |
| Prob > chi2 | 0.0000 |
| Log likelihood = -5893.3899 | Pseudo R2 = 0.1905 |

| Number_of_antenatal_care_visit | Coef. | Std. Err. | z | P>\|z\| | [95% Conf. | Interval] |
|---|---|---|---|---|---|---|
| Age_in_5_year_groups | | | | | | |
| 20-24 | -.0279343 | .06999 | -0.40 | 0.690 | -.1651123 | .1092436 |
| 25-29 | .1430294 | .0706097 | 2.03 | 0.043 | .0046369 | .2814219 |
| 30-34 | -.2614523 | .0762639 | -3.43 | 0.001 | -.4109268 | -.1119779 |
| 35-39 | -.2162246 | .0786645 | -2.75 | 0.006 | -.3704042 | -.062045 |
| 40-44 | -.8319788 | .1243276 | -6.69 | 0.000 | -1.075656 | -.5883012 |
| 45-49 | -1.005124 | .2204367 | -4.56 | 0.000 | -1.437172 | -.5730762 |
| Region | | | | | | |
| Somali | -.0530136 | .0445272 | -1.19 | 0.234 | -.1402853 | .0342581 |
| Benishangul | -.1765694 | .0488397 | -3.62 | 0.000 | -.2722933 | -.0808454 |
| Gambela | -.1225752 | .0506316 | -2.42 | 0.015 | -.2218114 | -.0233391 |
| Type_of_place_of_residence | | | | | | |
| Rural | .1062655 | .0463902 | 2.29 | 0.022 | .0153424 | .1971887 |
| Education_level | | | | | | |
| Primary | -.1751858 | .0510817 | -3.43 | 0.001 | -.275304 | -.0750675 |
| Secondary | -.1041738 | .0822769 | -1.27 | 0.205 | -.2654335 | .0570859 |
| Higher | -.2941888 | .103727 | -2.84 | 0.005 | -.4974899 | -.0908876 |
| Litracy | | | | | | |
| Able to read only parts of sentence | .0846052 | .0579177 | 1.46 | 0.144 | -.0289114 | .1981219 |
| Able to read whole sentence | -.1418324 | .0716186 | -1.98 | 0.048 | -.2822023 | -.0014625 |
| No card with required language | .2889311 | .0728428 | 3.97 | 0.000 | .1461618 | .4317003 |
| Frequency_of_watching_television | | | | | | |
| Less than once a week | -.2530752 | .0657993 | -3.85 | 0.000 | -.3820395 | -.1241109 |
| At least once a week | .1677401 | .0517799 | 3.24 | 0.001 | .0662534 | .2692269 |
| Wealth_index | | | | | | |
| Poorer | .6395203 | .0503613 | 12.70 | 0.000 | .5408139 | .7382266 |
| Middle | 1.416287 | .0436105 | 32.48 | 0.000 | 1.330812 | 1.501762 |
| Richer | 1.138323 | .0538304 | 21.15 | 0.000 | 1.032817 | 1.243828 |
| Richest | 1.137916 | .0620386 | 18.34 | 0.000 | 1.016322 | 1.259509 |
| Marital_status | | | | | | |
| Living with partner | .3669849 | .1221189 | 3.01 | 0.003 | .1276363 | .6063335 |
| Husband_partner_education | | | | | | |
| 1 | .4935304 | .0372702 | 13.24 | 0.000 | .420482 | .5665787 |
| 2 | .711917 | .0489749 | 14.54 | 0.000 | .6159279 | .807906 |
| 3 | .3715457 | .0573171 | 6.48 | 0.000 | .2592063 | .4838851 |
| Person_who_decide_on_heakth_care | | | | | | |
| Respondent and husband/partner | -.2873522 | .0354402 | -8.11 | 0.000 | -.3568137 | -.2178907 |
| Husband/partner alone | -.431777 | .0455176 | -9.49 | 0.000 | -.5209899 | -.3425641 |
| Someone else | -17.19776 | 2268.574 | -0.01 | 0.994 | -4463.522 | 4429.126 |
| Other | -16.48584 | 1212.604 | -0.01 | 0.989 | -2393.146 | 2360.174 |
| _cons | .2605525 | .0912315 | 2.86 | 0.004 | .0817421 | .4393629 |

.

## A1.2. Akaike's information criterion and Bayesian information criterion for Poisson regression model

Akaike's information criterion and Bayesian information criterion

| Model | Obs | ll(null) | ll(model) | df | AIC | BIC |
|---|---|---|---|---|---|---|
| . | 2,386 | -7280.076 | -5893.39 | 31 | 11848.78 | 12027.88 |

Note: N=Obs used in calculating BIC; see **[R] BIC note**.

# A2.Output for Zero inflated Poisson regression model

```
Zero-inflated Poisson regression              Number of obs     =      2,386
                                              Nonzero obs       =      1,277
                                              Zero obs          =      1,109

Inflation model = logit                       LR chi2(29)       =     751.39
Log likelihood  =  -3622.58                   Prob > chi2       =     0.0000
```

| Number_of_antenatal_care_visit | Coef. | Std. Err. | z | P>\|z\| | [95% Conf. | Interval] |
|---|---|---|---|---|---|---|
| Number_of_antenatal_care_visit | | | | | | |
| Age_in_5_year_groups | | | | | | |
| 20-24 | -.1116438 | .0710388 | -1.57 | 0.116 | -.2508773 | .0275897 |
| 25-29 | .1444443 | .0710288 | 2.03 | 0.042 | .0052304 | .2836582 |
| 30-34 | -.2969999 | .0770933 | -3.85 | 0.000 | -.4481001 | -.1458998 |
| 35-39 | -.0497284 | .0797853 | -0.62 | 0.533 | -.2061047 | .106648 |
| 40-44 | -.3974366 | .1262846 | -3.15 | 0.002 | -.64495 | -.1499233 |
| 45-49 | -.6865756 | .2230251 | -3.08 | 0.002 | -1.123697 | -.2494545 |
| Region | | | | | | |
| Somali | .1809214 | .0448475 | 4.03 | 0.000 | .0930219 | .2688209 |
| Benishangul | -.2029249 | .0498343 | -4.07 | 0.000 | -.3005983 | -.1052516 |
| Gambela | -.0922599 | .0503937 | -1.83 | 0.067 | -.1910296 | .0065099 |
| Type_of_place_of_residence | | | | | | |
| Rural | .0906433 | .0454952 | 1.99 | 0.046 | .0014743 | .1798123 |
| Education_level | | | | | | |
| Primary | -.1047387 | .0402888 | -2.60 | 0.009 | -.1837034 | -.0257741 |
| Secondary | .00618 | .0673321 | 0.09 | 0.927 | -.1257885 | .1381484 |
| Higher | -.3581268 | .0896522 | -3.99 | 0.000 | -.533842 | -.1824117 |
| Sex_of_HH_head | | | | | | |
| Female | -.1040097 | .0349938 | -2.97 | 0.003 | -.1725963 | -.035423 |
| Frequency_of_reading_news_paper | | | | | | |
| Less than once a week | -.0878405 | .0937939 | -0.94 | 0.349 | -.2716732 | .0959923 |
| At least once a week | -.4512545 | .1212409 | -3.72 | 0.000 | -.6888822 | -.2136267 |
| Frequency_of_watching_television | | | | | | |
| Less than once a week | -.3135012 | .066047 | -4.75 | 0.000 | -.4429509 | -.1840515 |
| At least once a week | .0627085 | .0515299 | 1.22 | 0.224 | -.0382882 | .1637053 |
| Wealth_index | | | | | | |
| Poorer | .1647464 | .0510987 | 3.22 | 0.001 | .0645948 | .2648979 |
| Middle | .5253245 | .0437733 | 12.00 | 0.000 | .4395303 | .6111186 |
| Richer | .6142715 | .0543934 | 11.29 | 0.000 | .5076625 | .7208805 |
| Richest | .2994706 | .060277 | 4.97 | 0.000 | .1813297 | .4176114 |
| Husband_partner_education | | | | | | |
| 1 | .3891898 | .0376855 | 10.33 | 0.000 | .3153275 | .4630521 |
| 2 | .2652745 | .0490423 | 5.41 | 0.000 | .1691532 | .3613957 |
| 3 | .1549897 | .0571417 | 2.71 | 0.007 | .0429939 | .2669855 |
| Person_who_decide_on_heakth_care | | | | | | |
| Respondent and husband/partner | -.3349096 | .0355461 | -9.42 | 0.000 | -.4045788 | -.2652405 |
| Husband/partner alone | -.4247991 | .0444831 | -9.55 | 0.000 | -.5119844 | -.3376138 |
| Someone else | -6.670358 | 1286769 | -0.00 | 1.000 | -2522027 | 2522013 |
| Other | -7.689499 | 1301318 | -0.00 | 1.000 | -2550544 | 2550529 |
| _cons | 1.362627 | .0895722 | 15.21 | 0.000 | 1.187068 | 1.538185 |
| inflate | | | | | | |
| Number_of_antenatal_care_visit | -45.85093 | 7519.823 | -0.01 | 0.995 | -14784.43 | 14692.73 |
| _cons | 23.7523 | 4462.442 | 0.01 | 0.996 | -8722.474 | 8769.979 |

.

## A2.1. Akaika's information criterion and Bayesian information criterion forzipm model

Akaike's information criterion and Bayesian information criterion

| Model | Obs | ll(null) | ll(model) | df | AIC | BIC |
|---|---|---|---|---|---|---|
| . | 2,386 | -3998.276 | -3622.58 | 32 | 7309.16 | 7494.036 |

Note: N=Obs used in calculating BIC; see **[R] BIC note**.

## A3. Output for Negative Binomial regression model

| Number_of_antenatal_care_visit | Coef. | Std. Err. | z | P>\|z\| | [95% Conf. | Interval] |
|---|---|---|---|---|---|---|
| Age_in_5_year_groups | | | | | | |
| 20-24 | -.1642513 | .1363319 | -1.20 | 0.228 | -.431457 | .1029543 |
| 25-29 | -.1377876 | .1358409 | -1.01 | 0.310 | -.4040309 | .1284556 |
| 30-34 | -.2825103 | .1421601 | -1.99 | 0.047 | -.561139 | -.0038817 |
| 35-39 | -.2866383 | .1437112 | -1.99 | 0.046 | -.568307 | -.0049696 |
| 40-44 | -1.159421 | .2027294 | -5.72 | 0.000 | -1.556763 | -.7620783 |
| 45-49 | -.9533475 | .3291063 | -2.90 | 0.004 | -1.598384 | -.308311 |
| Litracy | | | | | | |
| Able to read only parts of sentence | -.0364355 | .1043165 | -0.35 | 0.727 | -.2408921 | .1680211 |
| Able to read whole sentence | -.2339587 | .1119772 | -2.09 | 0.037 | -.45343 | -.0144873 |
| No card with required language | .4554086 | .133922 | 3.40 | 0.001 | .1929263 | .717891 |
| Frequency_of_listening_to_radio | | | | | | |
| Less than once a week | .8051719 | .1025455 | 7.85 | 0.000 | .6041864 | 1.006158 |
| At least once a week | .3550131 | .105683 | 3.36 | 0.001 | .1478783 | .562148 |
| Frequency_of_watching_television | | | | | | |
| Less than once a week | -.5087931 | .131683 | -3.86 | 0.000 | -.7668869 | -.2506992 |
| At least once a week | .0436414 | .125669 | 0.35 | 0.728 | -.2026653 | .289948 |
| Wealth_index | | | | | | |
| Poorer | .6562659 | .0875942 | 7.49 | 0.000 | .4845844 | .8279474 |
| Middle | 1.416121 | .0911813 | 15.53 | 0.000 | 1.237409 | 1.594833 |
| Richer | .9394973 | .1071475 | 8.77 | 0.000 | .729492 | 1.149503 |
| Richest | 1.104104 | .1110729 | 9.94 | 0.000 | .8864052 | 1.321803 |
| Husband_partner_education | | | | | | |
| 1 | .3584193 | .0727008 | 4.93 | 0.000 | .2159284 | .5009102 |
| 2 | .7022999 | .0992029 | 7.08 | 0.000 | .5078657 | .8967341 |
| 3 | .3634732 | .1069482 | 3.40 | 0.001 | .1538586 | .5730879 |
| Person_who_decide_on_heakth_care | | | | | | |
| Respondent and husband/partner | -.2838024 | .0694897 | -4.08 | 0.000 | -.4199998 | -.147605 |
| Husband/partner alone | -.3715474 | .0837256 | -4.44 | 0.000 | -.5356466 | -.2074481 |
| Someone else | -20.31075 | 11816.37 | -0.00 | 0.999 | -23179.97 | 23139.35 |
| Other | -19.60845 | 6316.117 | -0.00 | 0.998 | -12398.97 | 12359.75 |
| _cons | .3250711 | .139975 | 2.32 | 0.020 | .0507251 | .599417 |
| /lnalpha | .0782664 | .0556996 | | | -.0309029 | .1874356 |
| alpha | 1.081411 | .0602342 | | | .9695697 | 1.206153 |

LR test of alpha=0: chibar2(01) = 3099.22 Prob >= chibar2 = 0.000

.

.

]

## A3.1. Akaike's information criterion and Bayesian information criterion for Negative Binomial regression model

Akaike's information criterion and Bayesian information criterion

| Model | Obs | ll(null) | ll(model) | df | AIC | BIC |
|---|---|---|---|---|---|---|
| . | 2,386 | -4630.414 | -4296.074 | 24 | 8640.149 | 8778.806 |

Note: N=Obs used in calculating BIC; see **[R] BIC note**.

# A4. Output for Zero Inflated Negative Binomial regression model

Zero-inflated negative binomial regression — Number of obs = 2,386; Nonzero obs = 1,277; Zero obs = 1,109

Inflation model = logit — LR chi2(29) = 278.59; Log likelihood = -2875.877 — Prob > chi2 = 0.0000

| Number_of_antenatal_care_visit | Coef. | Std. Err. | z | P>\|z\| | [95% Conf. | Interval] |
|---|---|---|---|---|---|---|
| Number_of_antenatal_care_visit | | | | | | |
| Age_in_5_year_groups | | | | | | |
| 20-24 | -.0878008 | .0989361 | -0.89 | 0.375 | -.2817121 | .1061104 |
| 25-29 | .1107401 | .099149 | 1.12 | 0.264 | -.0835883 | .3050685 |
| 30-34 | -.2089502 | .105769 | -1.98 | 0.048 | -.4162537 | -.0016467 |
| 35-39 | .0089598 | .1107597 | 0.08 | 0.936 | -.2081252 | .2260448 |
| 40-44 | -.3501345 | .1699117 | -2.06 | 0.039 | -.6831552 | -.0171137 |
| 45-49 | -.5211771 | .2880093 | -1.81 | 0.070 | -1.085665 | .0433109 |
| Region | | | | | | |
| Somali | .0945218 | .0643532 | 1.47 | 0.142 | -.0316082 | .2206518 |
| Benishangul | -.1416134 | .0685169 | -2.07 | 0.039 | -.275904 | -.0073228 |
| Gambela | -.0868761 | .0708603 | -1.23 | 0.220 | -.2257597 | .0520074 |
| Litracy | | | | | | |
| Able to read only parts of sentence | -.0614628 | .0679683 | -0.90 | 0.366 | -.1946783 | .0717527 |
| Able to read whole sentence | -.0524121 | .0858307 | -0.61 | 0.541 | -.2206372 | .115813 |
| No card with required language | .1978006 | .0902024 | 2.19 | 0.028 | .0210071 | .374594 |
| Frequency_of_reading_news_paper | | | | | | |
| Less than once a week | -.1195816 | .1343881 | -0.89 | 0.374 | -.3829775 | .1438142 |
| At least once a week | -.3843149 | .1662357 | -2.31 | 0.021 | -.7101308 | -.0584989 |
| Frequency_of_listening_to_radio | | | | | | |
| Less than once a week | .2315111 | .0673522 | 3.44 | 0.001 | .0995033 | .363519 |
| At least once a week | .135018 | .073236 | 1.84 | 0.065 | -.008522 | .278558 |
| Frequency_of_watching_television | | | | | | |
| Less than once a week | -.4011897 | .0929474 | -4.32 | 0.000 | -.5833633 | -.219016 |
| At least once a week | .0216982 | .079192 | 0.27 | 0.784 | -.1335152 | .1769117 |
| Wealth_index | | | | | | |
| Poorer | .1517493 | .0695514 | 2.18 | 0.029 | .015431 | .2880676 |
| Middle | .461942 | .0646268 | 7.15 | 0.000 | .3352759 | .5886081 |
| Richer | .5112693 | .0780941 | 6.55 | 0.000 | .3582077 | .6643309 |
| Richest | .2758606 | .0755265 | 3.65 | 0.000 | .1278314 | .4238897 |
| Husband_partner_education | | | | | | |
| 1 | .3026412 | .053734 | 5.63 | 0.000 | .1973246 | .4079578 |
| 2 | .2440651 | .0694765 | 3.51 | 0.000 | .1078936 | .3802367 |
| 3 | .0423856 | .0781922 | 0.54 | 0.588 | -.1108683 | .1956394 |
| Person_who_decide_on_heakth_care | | | | | | |
| Respondent and husband/partner | -.2592335 | .0520527 | -4.98 | 0.000 | -.361255 | -.157212 |
| Husband/partner alone | -.320274 | .0638728 | -5.01 | 0.000 | -.4454623 | -.1950856 |
| Someone else | -14.88591 | 6.69e+07 | -0.00 | 1.000 | -1.31e+08 | 1.31e+08 |
| Other | -15.91589 | 6.76e+07 | -0.00 | 1.000 | -1.32e+08 | 1.32e+08 |
| _cons | 1.326776 | .1031242 | 12.87 | 0.000 | 1.124656 | 1.528895 |
| inflate | | | | | | |
| Number_of_antenatal_care_visit | -45.07272 | 6278.031 | -0.01 | 0.994 | -12349.79 | 12259.64 |
| _cons | 23.32686 | 3697.209 | 0.01 | 0.995 | -7223.071 | 7269.724 |
| /lnalpha | -1.440842 | .0631176 | -22.83 | 0.000 | -1.56455 | -1.317134 |
| alpha | .2367283 | .0149417 | | | .209182 | .267902 |

.

## A4.1. Akaike's information criterion and Bayesian information criterion for ZIBN model

Akaike's information criterion and Bayesian information criterion

| Model | Obs | ll(null) | ll(model) | df | AIC | BIC |
|---|---|---|---|---|---|---|
| . | 2,386 | -3015.17 | -2875.877 | 33 | 5817.753 | 6008.407 |

Note: N=Obs used in calculating BIC; see **[R] BIC note**.