# Determinants of Numbers on Antenatal Care Visits in Rural Ethiopia: A Multilevel Negative Binomial Regression Analysis

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**Research Article**

**Keywords:** Antenatal care, Women, Rural Ethiopia, Multilevel Negative Binomial count analysis

**Posted Date:** March 12th, 2021

**DOI:** https://doi.org/10.21203/rs.3.rs-283138/v1

1 **Determinants of numbers on Antenatal care visits in rural Ethiopia: A Multilevel negative**
2 **binomial regression analysis**

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Abstract

**Introduction**: Antenatal care (ANC) is an umbrella term used to describe medical care and procedures that are carried out for pregnant women. Data on the number of antenatal care visits can help policymakers to show the gap in service provision. So, the paper determines associated factors of the number of antenatal care visits among women who gave birth in the last five years in rural Ethiopia.

**Methods:** Total weighted sample of 6611 women who gave birth in the 5 years preceding the survey were included from the nationally representative 2016 Ethiopian Demographic and Health Survey. We used multi-level negative binomial regression analysis to consider the hierarchal nature of the data. In the multivariable analysis, variables with a p-value < 0.05 were considered to be significantly associated with the number of antenatal care visits.

**Results:** Overall, 27.3% (95% CI: 14.63, 15.76) of women had at least four antenatal care visits during their pregnancy in rural Ethiopia. Age group 25-29 years (adjusted incidence rate ratio (AIRR)=1.13,95% CI:1.02,1.26), household rich wealth status (AIRR=1.17, 95% CI:1.04,1.31), women's educational status (primary, AIRR=1.19,95% CI:1.08,1.32; Secondary, AIRR= 1.30,95% CI:1.08,1.55; above secondary, AIRR=1.35, 95%CI:1.07,1.71), partner educational status (primary, AIRR=1.16, 95%CI:1.05,1.28; secondary, AIRR=1.22,95% CI:1.08,1.38), and autonomy to decision to their care (AIRR=1.25,95%CI:1.10,1.42) were positively associated individual-level factors with number of antenatal care visits whereas having a birth order of five or more (AIRR=0.80,95% CI: 0.69,0.94) was a negatively associated factor with number of antenatal care visits. Among community-level variables; being in higher community level literacy (AIRR=1.35, 95% CI: 1.14, 1.59) and higher poverty level (AIRR=0.77, 95% CI: 0.64, 0.92) were significantly associated factors with the number of antenatal care visits.

**Conclusions and recommendations:** The level of antenatal care visits in rural areas was low. Age of women, wealth status, women's educational status, partner educational status, autonomy to decision making in health care, and birth order were the most important associated factors with the number of antenatal care visits. Furthermore, poverty and literacy are also important determinants at the community level. Addressing economic and educational interventions for rural women should be given the top priority.

**Keywords:** Antenatal care, Women, Rural Ethiopia, Multilevel Negative Binomial count analysis

## Introduction

Antenatal care (ANC) is an umbrella term that describes medical care and procedures that are carried out for pregnant women (1). It is the health care delivery that is given to pregnant women throughout their pregnancy. Services during ANC visit aimed at detecting the already existing problems and/or problems that might be developed during pregnancy, which may affect the pregnant woman and/or her unborn child (2). Screening tests, diagnostic procedures, and prophylactic treatments are the services provided to pregnant women based on identified problems and risk factors (3).

The World Health Organization (WHO) recommends all pregnant women and newborns get quality care. Recommended activities to assure the quality of care are; nutritional interventions, maternal and fetal assessment, preventive measures, interventions for common physiological conditions, and health systems interventions (4). By implementing timely and proper evidence-based practice, ANC can save lives. Remarkably, ANC also helps to communicate and help women, families, and communities in a dangerous situation in a woman's life (5).

Antenatal care services utilization is one of the most important health services in combating morbidity and mortality among pregnant mothers and the utilization of appropriate and recommended antenatal care services supports safe maternity and delivery which finally improved maternal and child health (6).

Many efforts have been done to assess the evolution in coverage of antenatal care in developing countries which focused on issues like the number of visits, the timing of visits, and the characteristics of users and non-users of antenatal care (7).

The number of antenatal care services is determined by socio-demographic characteristics and contextual causes. Regarding individual factors, higher educational status, older age, and higher-income were positively associated with the number of antenatal care visits. Fewer antenatal care visits were associated with parity, gestational age at delivery, time of initiation of ANC, and medical risks during the pregnancy. Concerning contextual factors; distance from a health facility, service waiting time, and client welcomed appreciation were associated with ANC services utilization. Besides, women's knowledge regarding ANC, the presence of electricity in households, and housing conditions were associated with ANC services utilization(8,9,18–27,10,28–32,11–17).

Even though antenatal care is crucial, the information in rural areas of Ethiopia is still very limited due to different factors. Little is known about factors affecting the number of antenatal care visits in rural Ethiopia. Thus, a detailed investigation of the factors affecting the number of ANC service utilization is crucial. That is why this study was conducted to analyze the number of ANC visits and determinants among women who gave birth in the last five years preceding the survey in rural Ethiopia. Besides, this study valuable information on count data models.

## Methods

### Study area and data source

The study was conducted in Ethiopia, which is located in the horn of Africa, lies between $3^0$ and $15^0$ North latitudes and $33^0$ and $48^0$ East longitudes. We used the EDHS 2016 dataset which was conducted by the Central Statistical Agency (33) in collaboration with the Federal Ministry of Health (FMoH) and the Ethiopian Public Health Institute (EPHI). The Ethiopian DHS is conducted every 5 years to assess population and health-related indicators of the country. Data were obtained from the DHS website (URL: www.dhsprogram.com) after contacting them via email through personal accounts and justifying the reason for requesting it.

### Population and sampling procedure

The study was conducted using nationally representative data from the 2016 Ethiopian Demographic and Health Survey. The current study used 443 EAs from 645 EDHS EAs or clusters as identified by the 2007 Ethiopia Population census. A stratified two-stage sampling procedure was employed to identify households from all eligible rural households within each cluster The source population were all women of reproductive age who gave birth within five years before the survey in rural Ethiopia. The study population included women of reproductive age who gave birth within five years before the survey in the households located in the primary sampling units (PSUs) that are in the 443 Enumeration areas sampled in the first stage.

### Variables

The outcome variable was the number of ANC visits each participant had in the last pregnancy. Individual (woman), household, community, and regional level variables have been considered as explanatory variables. The individual-level explanatory variables included education status of the

women and their husbands, age of the women, the autonomy of the women to healthcare issues, women's and husbands' occupational status, birth order of a child, and household wealth status whereas community-level variables were regional settings, community-level poverty, and literacy.

**Data processing and analysis**

The data were cleaned using STATA version 16.0 software. The analysis was conducted after sample weights were applied for complex sampling procedures. The characteristics of the study participants were described using frequencies and percentages.

Let $Y_{ij}$ represent the number of ANC visits of the $i^{th}$ women living in the $j^{th}$ cluster, and the vector $X_{ij}$ the corresponding values of the independent variables. Assuming independent women who are on ANC visits, Poisson regression and negative binomial regression models are specified as:

$$\log(\mu_{ij}) = \beta_0 + \beta X_{ij}$$

Where $\mu_{ij}$ is the expected number of ANC visits as a function of independent variables, $\beta_0$ the overall intercept, and $\beta$ the vector of regression coefficients. The assumed distribution of number of ANC visits are the difference between the Poisson regression (PR) and the negative binomial regression model (NBR). In PR, the outcome variable is assumed to follow a Poisson distribution with $E(y_{ij}) = \mu_{ij} = var(y_{ij})$, while in NBR, it is assumed to follow a negative binomial distribution with $E(y_{ij}) = \mu_{ij}$ and $var(y_{ij}) = \theta\mu_{ij}$, where θ is the shape parameter that controls the variance. When θ =1, the NBR model becomes PR model without over-dispersion.

When the assumptions of independence are violated in clustered data, using PR and NBR models could lead to biased estimates and misinterpretation of the results (34). The best way to consider the non-independence of observations is to use multilevel models. The use of a multilevel modeling strategy accommodates the clustered or hierarchical nature of the EDHS data and adjusts

standard errors of the estimated coefficients for ICC. A simple multilevel PR/NBR model is obtained by incorporating cluster-specific random effects in the standard PR/NBR model:

$$\log(\mu_{IJ}) = (\beta_0 + b_{0j)} + \beta X_{ij}$$

Where $b_{0j}$ denotes the random intercepts at cluster level and are assumed to follow a normal distribution with constant variance. Therefore, the multilevel PR and NBR models are preferred to model the data(35).

The random effects (variation of effects) were estimated by intracluster correlation coefficient (ICC) (variance partition coefficient) and the percentage change in variance (PCV). The ICC explains the cluster variability whereas PCV measures the total variation due to factors at the community and individual levels. The ICC and PCV were determined using the following formulas:

$$ICC = \text{ the variance of the null model}/(\text{variance of the null model} + 3.29)$$

$$PCV = \frac{(\text{variance of the initial model} - \text{variance of the model with more terms})}{\text{the variance of the initial model}} * 100$$

A multilevel model provides correct parameter estimates by adjusting the biases introduced from clustering to give correct SEs. Thus, it produces correct confidence interval and significance tests(36).

The goodness of fit statistics by Pearson Chi-square of Poisson regression analysis was conducted to show whether over-dispersion is present or not. If the observed value of the Pearson Chi-square statistic divided by the degrees of freedom is higher than one, the mentioned goodness of statistics represents over-dispersion in the data set.

142 **Operational definitions**

143 **Number of Antenatal care visit**: Is the number of health care visit of women who gave birth five
144 years preceding the survey, information was recorded for the last birth.

145 **Community women's literacy:** categorized into two as a higher proportion of women's literacy
146 within the cluster and a lower proportion of women's literacy based on the median value. The
147 aggregate of individual women's ability to read-only parts of a sentence, able to read the whole
148 sentence, and no card with required language can show the overall literacy status of women within
149 the cluster.

150 **Community-level poverty:** categorized into two as a higher proportion of poorest and poorer
151 households within the cluster and lower poorest and poorer households based on the median value.
152 The aggregate of individual women from the poorest and poorer households can show the overall
153 community-level poverty of women within the cluster.

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## Results

### Socio-demographic characteristics of respondents

The total number of women was 6611 with mean (±SD) ages of 29.7 (±7.4) years. About 3,219 (48.7%) mothers were in the age of 30-45 years. Approximately 70% of women and were non-educated with 224(3.4%) secondary and above the secondary school. Almost all (>94%) of women were married. About 2,916 (44.1%) of women were from the Oromia region and 2,596(39.3%) women were Muslim religion followers. Moreover, 3,681(55.7%) of the women had no work. Regarding wealth status, nearly half (49.1%) of the women were from poor or poorest households whereas, 1,803(27.2%) belonged to rich and richest households during the five years preceding the survey (Table 1).

### Community-level, maternal, and health service-related characteristics

Approximately 74.0% of women had autonomy for the decision of health care, 4,240 (64.1%) of them had big problems in distance to the health facility. Regarding birth order, 2,037 (30.8%) women had a child with above five birth order whereas, 1,099(16.6%) had first birth order child (Table 2).

### Number of ANC visits during pregnancy

The median and mode of the frequency of antenatal care visits were 2 and 0 among mothers who gave birth within the last five years respectively. Overall, 58.8% (95%CI: 57.6, 59.9) of women had at least one ANC visit during their pregnancy and only 27.3% (95% CI: 14.63, 15.76) of women had at least four times ANC visits during their pregnancy in rural Ethiopia (Fig1).

185 **Factors associated with Number of Antenatal care Visits**

186 About 10.7% of the number of antenatal care visits during pregnancy in clusters was explained in
187 the null model. The Percent change variation in the final model showed that about 74.9% of the
188 total variability in the number of antenatal care visits was explained (Table3).

189 The multilevel negative binomial regression model analysis of individual factors that had a
190 significant association with the number of antenatal care visits was age, educational status of
191 women, educational status of the husband, occupational status of the women, household wealth,
192 women's decision-making power on their healthcare issues, and birth order of child whereas,
193 community-level literacy, and poverty determine the number of antenatal care visits (Table 4).

194 Women with the age range of 25 to 29 years had 13% more antenatal visits compared with women
195 age 15-24 years (IRR: 1.13, 95% CI: 1.02–1.26). Women who were attending primary, secondary,
196 and above secondary education had more antenatal care visits compared with women who had no
197 educational status (primary education; IRR: 1.16, (95% CI: 1.05, 1.28), secondary IRR: 1.22, (95%
198 CI: 1.08, 1.38), and above IRR: 1.35, (95% CI: 1.07, 1.71)). Partner with primary education and
199 secondary had 16% and 22% more antenatal visits compared with a partner who had no educational
200 status (IRR: 1.16, (95% CI: 1.05, 1.28) and IRR: 1.22, (95% CI: 1.08, 1.38), respectively). Women
201 from richer households had 17% more antenatal care visits compared with women from poorer
202 households (IRR: 1.17, (95% CI: 1.04, 1.31). Women who had the decision-making power to their
203 health care were 25% more antenatal care visits (IRR: 1.25, (95% CI: 1.10, 1.42). On the other
204 hand, women who had a higher birth order child had lower antenatal care visits compared to
205 women who had first order child (IRR: 0.80, (95%CI: 0.69, 0.94).

206 Furthermore, community-level variables were significantly associated with the number of
207 antenatal care visits after controlling the possible confounding by multivariate analysis. Women

from higher literacy level communities had 35% higher antenatal care visits (IRR: 1.35, (95%CI: 1.14, 1.59) whereas women from the higher poverty level community had 23% lower antenatal care visits (IRR: 0.77 (95%CI: 0.64, 0.92) (Table3).

## Discussion

Antenatal care is an indicator to measure the efficiency of maternal care utilization. It helps in preventing adverse pregnancy outcomes when provided early in the pregnancy and continued through delivery. Identification of problems in pregnancy results in early referrals for women with complications; this is particularly true in Ethiopia, where three-quarters of the population live in rural areas. So as this study focused on determinants of the number of Antenatal care visits in rural Ethiopia using the multilevel negative binomial analysis to estimate individual, household, community-level factors.

The current study estimated that 27.3% of pregnant women in rural Ethiopia have been received at least four ANC during their pregnancy. It showed an improvement as compared to the 2011 data which was a 47% increase(37). This increment might be due to awareness creation activities, health promotion, and an increase in the number of health institutions and health care providers in rural areas(38).

In this study, individual-level and community-level factors were responsible for around 75% of the difference in the frequency of ANC visits during pregnancy in rural Ethiopia. After adjusting all factors, the frequency of ANC visits was higher among those pregnant mothers in the age range of 25 to 29 years, higher educational status of women and their partner, highest wealth quintile, women who had the autonomy to decide their health care, and community level literacy. However, women who had a higher birth order child and women from low socioeconomic status of the community had a lower frequency of ANC visits.

The current study showed that women who were in the age group of 25-29 years were 13 percentage points more likely to visit health institutions for ANC services compared with those who were in the age group of 15-24 years. This finding supports previous studies done in different

countries(6,39,40) that showed the positive association between ANC visits and increased age of women. This might be due to health conditions and birth complications are higher in older women who tend to demand more visits. But it is not in line with studies done in metropolitan countries(10).

The finding of the study also indicated that women who had primary, secondary, and above secondary educational attainment were 19, 30, and 35 percentage points more likely to use ANC services as compared with those who had no education respectively. This finding is consistent with the study conducted in Ghana(6,31). The statistical relationship between the utilization of maternal health services and education is also well documented in a systematic review of 74 studies and Bangladesh(22,34). This indicates that the educational attainment of the women increases awareness of the need to access health services by frequent antenatal care visits. The primary and secondary educational status of the husband was also more likely to have a high frequency of ANC visits as compared to the non-educated husband. This finding supports that the high educational attainment of the husband influenced the frequency of ANC visits in sub-Saharan countries(22,34). This implied that educated partners may be more concerned with their pregnant wives and associated pregnancy complications.

Furthermore, the multilevel negative binomial estimation indicates that the wealth status of the household had a positive and significant effect on the frequency of ANC visits. The result showed that pregnant women in the richer household were more likely to have frequent ANC visits relative to those in the poorest household. This finding agreed with a study conducted in different countries in the world(6,8,34). But, the positive association does not vary by urban-rural settings in these studies. Thus, the results suggested household wealth status could be an important variable for antenatal care utilization. This might be since having a low economic status would mean having

less money for transportation towards the health facility for utilization of ANC service. Another possible explanation could be women who belong to rich families usually have proper education, access to mass media than from poorer families.

Besides, the presence of women's autonomy in their health care was related to more antenatal care visits. This indicates the importance of women's empowerment, not only within the household but also in the community. Women empowerment leads to greater decision-making power concerning maternal health. Our findings are consistent with a previous research study conducted in Bangladesh(34), which revealed that women who decided about their medical care were more likely to receive professional antenatal care.

The current finding also showed that the birth order of the child influences the number of antenatal care visits. Having higher birth order child was negatively and significantly associated with the number of ANC visits. This finding agreed with a study done in Ghana(6). This implies that mothers with more previous birth experiences demand lesser visits, all other things being equal.

From community-level variables, literacy at the community level was a significant factor that determined the number of ANC visits. A high frequency of antenatal care visits was associated with literacy in a rural population. This result is in line with the study done in India(8).

**Strengths and limitations**

We used large population-based data with a large sample size, which is representative of all rural regions of Ethiopia. Furthermore, a count statistical analysis (multilevel Negative Binomial regression analysis) was applied for this study that allows the effects of each determinant on the frequency of ANC services efficiently. The novelty of this paper lies in the fact that we have modeled the determinants of the number of antenatal care services in rural Ethiopia using the most recent DHS. One significant point of departure of this study from previous studies on Ethiopia is

the inclusion of only rural place of residence. Even though, the cross-sectional nature of the EDHS data, reports of this finding explained by incidence rate ratio. The temporal relationship could not be established based on these study findings. Ethiopian demographic and health surveys were questionnaire-based surveys and depend on the memory of the respondents, and as such, recall bias in the results might be a limitation for this study.

## Conclusion and recommendations

The level of antenatal care visits among women who gave birth within the last five years before the survey was low in rural Ethiopia. Our results also indicate that wealth status, age, women and partner educational status, the decision-making power of women to their health care, community-level poverty, and literacy are significant factors affecting the number of antenatal care in rural Ethiopia. Besides, birth order is inversely and significantly associated with the frequency of ANC visits. The findings of this report help policymakers and programmers to focus their programs and plan in rural parts of the country to enhance maternally and child health. Priority should be given to women and their partners of low educational status to get appropriate maternal and child health care service promotions. However, ANC service is provided for free, interventions have to be in place to improve the household wealth status since household wealth status still plays a major role in the frequency of ANC follow-up.

## Abbreviations

WHO: World Health Organization; ANC: antenatal care services; IRR: incidence rate ratio; EDHS: Ethiopia Demographic and Health Survey; CI: confidence interval; NB: negative binomial; PR: Poisson regression

## Authors' contributions

MMA, ADG, FTD, DTA, and SAT made substantial contributions to the conception and design of the study, the formulation of the methodology, analyzed, interpreted the data, and reviewed the final version submitted for publication. HYD, GAY, BMB, MTE, and EAZ reviewed the final version submitted for publication. All authors read and approved the final manuscript.

## Acknowledgments

Our deepest gratitude goes to the Central statistical Agency for providing the data.

## Competing interests

The authors declare that they have no competing interests.

## Availability of data and materials

The datasets used and/or analyzed during the current study available from the corresponding author on reasonable request.

## Consent for publication

Not applicable as there are no image or other confidentiality-related issues.

## Ethics approval and consent to participate

It is not applicable, because the data was collected by the performance monitoring and accountability 2020 (PMA2020)/Ethiopia survey project.

## Funding

Not applicable

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# Figures

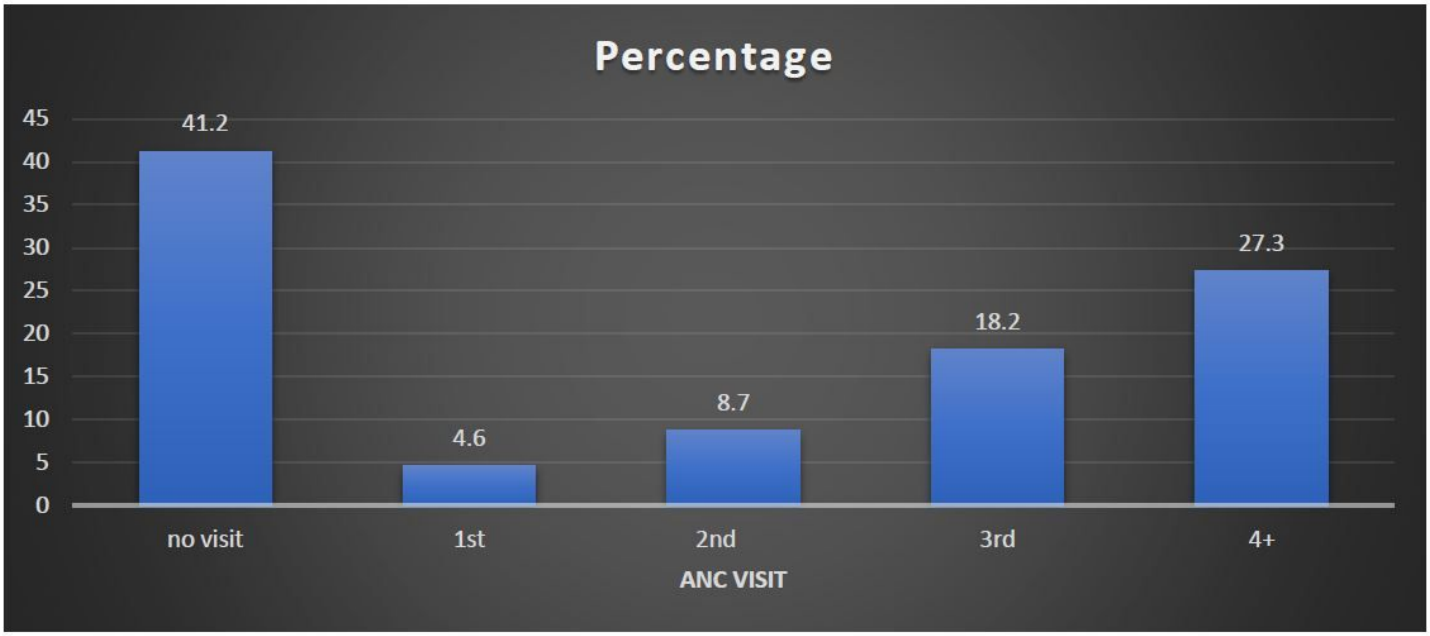


**Figure 1**

proportion of the number of antenatal care visits for women who gave birth within the last five years preceding the survey in rural Ethiopia, EDHS 2016, 2020(N=6611).