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## Determinant of Antenatal Care Service uptake among Pregnant Women: analysis of the 2016 Ethiopia demographic and health survey

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3 **Determinant of Antenatal Care Service uptake among Pregnant Women: analysis of the**  
4 **2016 Ethiopia demographic and health survey**  
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6 Setegn Muche Fenta\*<sup>1</sup> and Girum Meseret Ayenew<sup>2</sup>  
7

8 <sup>1</sup>Department of Statistics, Debre Tabor University, P.O.Box272 Debre Tabor, Ethiopia.  
9

10 <sup>2</sup>Research and Technology Transfer Directorate, Amhara Public Health Institute, P.O. Box 477  
11 Bahir Dar, Ethiopia; [girum.m21@gmail.com](mailto:girum.m21@gmail.com)  
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15 **\*Corresponding:** [setegn14@gmail.com](mailto:setegn14@gmail.com)  
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## Abstract

**Objective:** Antenatal and postnatal cares are crucial for the survival and well being of both the mother and the child. World Health Organization recommends a minimum of four antenatal care visits during a pregnancy. In Ethiopia, only 38% of women in the reproductive age received a minimum of first antenatal care visits. This value is far more below the typical rates of least developed countries. This study aimed to identify the determinant factors of antenatal care service utilization among pregnant women in Ethiopia.

**Design:** Cross-sectional study design

**Setting:** Ethiopian.

**Participants:** A total of 7913 pregnant women were included in the study.

**Primary outcome measures:** Antenatal Care Service uptake among Pregnant

**Result:** Only 35.5% of the pregnant mothers have utilized antenatal care services at least four times and 64.5% of the pregnant mothers have utilized less than three times during their periods of pregnancy. The study showed that rich women (IRR 1.077, 95% CI: 1.029,1.127), having access to mass media (IRR=1.086, 95% CI: 1.045, 1.128), having pregnancy complications (IRR=1.203, 95% CI: 1.165, 1.242), secondary school and above-educated women (IRR=1.112, 95% CI:1.052, 1.176), husbands' having secondary school and above level of education (IRR=1.085, 95% CI: 1.031, 1.142), being married (IRR = 1.187; 95% CI: 1.087,1.296), rural women (IRR=0.884, 95% CI: 0.846, 0.924) and women age >30 years (IRR=1.067, 95% CI: 1.024, 1.111) were significantly associated with the antenatal care service uptake.

**Conclusion:** Efforts have to be done to increase the socioeconomic status, and to promote the decision making role of women. Besides, this study indicates a need for improving community awareness on maternal health and for motivating women to utilize maternal care services.

**Keywords:** Antenatal Care services uptake, Ethiopia, Zero Inflated Poisson Regression Model

### Strengths and limitation

- Used EDHS data with a large sample size and high-quality data which reduced the risk of sampling bias and measurement bias in this study.
- The result of this study also enable for policy maker and health sectors to reducing levels of maternal and infant mortality and morbidity depends on increasing the use of reproductive and maternal health services.
- The study offers flawless information to other researcher how to use to use over dispersed, excess zero and zero-inflated Poisson regression model.
- It is difficult to measure the causal effects, and it is not possible to know whether the data are time-dependent or not.

## Introduction

Each day, 830 women die of preventable reasons associated with pregnancy and childbirth. Most maternal deaths arise in developing countries like Ethiopia. Sub-Saharan Africa and Southern Asia accounted for approximately 85% of the estimated global maternal deaths of which two-third from sub-Saharan Africa. The maternal mortality ratio in developing countries in the year 2015 is 239 per 100 000 live births and 12 per 100,000 live births in developed countries<sup>1 2</sup>. In Ethiopia, the maternal mortality ratio is 412 deaths per 100,000 live births. This indicates a female lifetime hazard of maternal death is 1 in 243 Ethiopia<sup>2 3</sup>.

Regular Antenatal care service utilization assists the fitness care company to perceive capability fitness problems early and take steps to control them, to protect the fitness of the mother and therefore the developing fetus. Antenatal Care (ANC) may be described because of the care supplied by the use of skilled health-care providers to pregnant women to ensure the health situations for each mother and child during pregnancy<sup>4 5</sup>. The reason for this is to possess a healthy mother and child<sup>4-7</sup>. ANC also will help to understand the Sustainable Development Goals (SDG) of drop child mortality as low as 25 in line with 100,000 live births and maternal mortality to as low as 70 per 100,000 live births by the end of 2030<sup>1</sup>. In recent times, the World Health Organization (WHO) has changed the ANC version increasing the amount of ANC visits with a fitness issuer from 4 to 8<sup>6</sup>.

In Ethiopia, sixty-two percent of women didn't attend a minimum of 4 ANC visits throughout their pregnancy<sup>3</sup>. Health Sector Transformation Plan of the Ethiopian Federal Ministry of Health addresses troubles associated with having targeted ANC with a minimal of 4 visits consistent with pregnancy as mainstream in the least provider delivery levels with a target to grow the proportion from 68% to ninety-five % at the highest by 2020<sup>8</sup>. But, according to the Ethiopia Demography and Health Survey (EDHS) 2016, the ANC service utilization with a minimum of four visits is merely 32%<sup>3</sup>. This indicated that ANC going to in Ethiopia immobile underneath any suitable standard.

Previous research in Ethiopia has been covered in small geographical regions and there is no sufficient study at nationwide to the best knowledge of the authors<sup>9-14</sup>. These studies also

investigated the determinant factor of antenatal care service utilization through binary logistic. While, binary logistic regression undercounts the total number of antenatal care visit since multiple service utilization are collapsed into a single unit to fulfill the requirements of binary logistic regression, provides sufficient information for studying the pattern of multiple service utilization. In this study, the Zero-Inflated Poisson regression model is the preferred model of analysis since Zero-Inflated Poisson regression model provide a way of modeling the excessive proportion of zero values by allowing over dispersion. When number of zeros is large, provides a good fit than Poisson or negative binomial model<sup>15</sup>. Therefore, this study aimed to identify the determinant factors of ANC service uptake for the country at large.

## Method

### Patient and public involvement

This study used a publicly available data set (EDHS 2016); therefore, there were no patients or members of the public involved.

### Data source

The data used for this study were taken from the 2016 EDHS. This survey is the fourth compressive survey designed to provide estimates for the health and demographic variables of interest for the whole urban and rural areas of Ethiopia as a domain. Women who had 9 months of pregnancy during the survey interview were included in the analysis. The study includes 7193 of the reproductive age group within the country.

### Sampling Design

The EDHS 2016 employed a stratified two-stage cluster sampling procedure designed to provide a representative sample for multiple health and population indicators at national and sub-national levels (nine regions and two city administrations). Initially, 645 Enumeration Areas (EAs) (202 in urban areas and 443 in rural areas) were drawn using Probability Proportional to Size (PPS) sampling approach from a whole list of 84,915 EAs defined within the recent 2007 population census. Then in every selected EA, an exhaustive listing of households was made and 28 households were selected using a systematic sampling approach. Within the chosen households, enumeration of the entire members was made and information about the ANC service utilization among all household members was collected primarily from the women<sup>16</sup>.

### Variable of the study



### Dependent variables

The dependant variable was count variable: the quantity (number) of ANC visits.

### Independent variables

The independent variables of this study were selected by reviewing related work of literature<sup>9-14 17-22</sup>. Women's educational level, husband's occupation, wealth index, marital status, women's occupation, women's age, husband's educational level, planned pregnancy, access to mass media, pregnancy complications, the desire of pregnancy and residence, were considered to be a possible independent variable within the study.

### Data analysis

The cleaned and recoded data were analyzed using R software version 3.5.3. Frequencies and percentages were used to describe the categorical variables. Data was presented using tables. Zero Inflated Poisson Regression (ZIPR) model were conducted to identify factors associated with antenatal care service utilization among pregnant. In recent years, the ZIPR model has gained popularity for modeling count data with excess zeroes<sup>15</sup>. The ZIP models can be viewed as a finite mixture model with a degenerate distribution whose mass is concentrated at zero. Excess zeroes arise when the event of interest is not experienced by many of the subjects<sup>23</sup>. In this study, the ZIPR model was employed to identify the determinant factors of ANC service uptake among pregnant women. Suppose  $Y_i$  is the number of ANC service uptake among pregnant then, the probability mass function of ZIPR is given by<sup>15 24 25</sup>

$$p(Y_i = y_i) = \begin{cases} \pi_i + (1 - \pi_i) \exp(-\mu_i), & \text{if } y_i = 0 \\ (1 - \pi_i) \frac{\exp(-\mu_i) \mu_i^{y_i}}{y_i!}, & \text{if } y_i = 1, 2, \dots \end{cases} \quad 0 \leq \pi_i \leq 1$$

The parameter  $\mu_i$  and  $\pi_i$  depends on the covariates  $x_i$  and  $z_i$ , respectively. The mean and the variance of ZIP regression model, respectively, are:

$E(y_i) = (1 - \pi_i) \mu_i$  and  $Var(y_i) = \mu_i (1 - \pi_i) (1 + \pi_i \mu_i)$ . To apply the ZIPR model in practical modeling situations,<sup>15 24 25</sup> suggested the following joint models for  $\mu$  and  $\pi$

$$\ln(\mu) = X^T \beta \quad \text{and} \quad \ln\left(\frac{\pi}{1 - \pi}\right) = Z^T \gamma \quad \text{where } X \text{ and } Z \text{ are covariate matrices and } \beta, \gamma \text{ are}$$

$(p + 1) \times 1$  and  $(q + 1) \times 1$  vectors of unknown parameters respectively. The two sets of covariates

may or may not coincide. Finally, the adjusted odds ratio (AOR) and incidence rate ratio (IR) with 95% confidence interval (CI) were used to assess the strength of associations between the outcome and the independent variables. P-values of  $\leq 0.05$  were considered for statistical significant.

### Ethical Issues

Publicly available EDHS 2016 data were used for this study. Informed consent was taken from each participant, and all identifiers were removed

### Results

From a total of 7913 pregnant women, 2545(35.4%) didn't receive any ANC service and 35.5% visited four and more than four times. The mean and variance of observation are 2.53 and 5.614, respectively. The variance to mean ratio is 2.22, which indicates some over-dispersion (Table 1).

**Table 1:** The number of women that experienced ANC visits

Number of visits	Count	Percent
0	2545	35.4
1	342	4.8
2	563	7.8
3	1187	16.5
4	1136	15.8
5	621	8.6
6	402	5.6
7	187	2.6
8+	108	2.9
Total	7193	100.0
Mean	2.53	
Variance	5.614	

### Socio-demographic characteristics of study participants

The majority of the study respondents were from rural residences (79%). Most of the respondents were housewives (70%) and 30% of the respondents were employed. About 60.6% of mothers didn't attend primary school and only 12.4% of mothers attended secondary and above education. The majority (69.4%) of the respondents had no pregnancy complications and 64.4% had not an access to mass media. About 91.5 percent of women were married, 3.2 percent of women were living alone women while 5.3% were divorced and widowed. The majorities (79.8%) of pregnancies were planned and 9% pregnancies were terminated. Regarding husband

education, 31.7% of the husband had no formal education while 30% of husbands attend primary education. About half (50.7%) of had poor wealth index, 35.0% were rich wealth while others were middle wealth index (14.3%). Regarding the mother age, the majorities (46.2%) of mothers were under the age group of 30 years plus, then followed 25-29 years (Table 2).

**Table 2:** Socio demographic characteristics of pregnant women in Ethiopia.

Categories	Frequency (n)	Percentage (%)
<b>Residence</b>		
Urban	1512	21
Rural	5681	79
<b>Occupation of mothers</b>		
Housewife	5033	70
Others	2160	30
<b>Planned pregnancy</b>		
No	1452	20.2
Yes	5741	79.8
<b>Terminated pregnancy</b>		
No	6556	91.1
Yes	637	8.9
<b>Wealth index</b>		
Low	3607	50.7
Medium	1028	14.3
Rich	2558	35.0
<b>Marital status</b>		
Never married	230	3.2
Married	6579	91.5
Divorced/widowed	384	5.3
<b>Age of women in a year</b>		
15-24	1852	25.7
25-29	2015	28.1
30 and above	3326	46.2
<b>Husband education</b>		
No education	3719	51.7
Primary	2160	30.0
Secondary and above	1314	18.3
<b>Woman education</b>		
No education	4359	60.6
Primary	1942	27
Secondary and above	892	12.4
<b>Access to mass media</b>		
No	4646	64.6
Yes	2547	35.4
<b>Pregnancy complications</b>		

No	5015	69.7
Yes	2178	30.3
<b>Husband's occupation</b>		
Not working	1285	17.9
Working	5908	82.1

### Determinant Factor of ANC service uptake

As shown in the below table (Table 3), the Poisson component shows that the incidence rate of ANC visits (IR). The finding of this study revealed that women's and husbands' levels of education have a significant factor for ANC service uptake. The ANC service uptake for women with primary education was 1.06 (IRR =1.06; 95%CI: 1.02, 1.10) times higher compared to women with no education. The ANC service uptake for women with secondary and above education was 1.11 (IRR =1.11; 95% CI: 1.05, 1.18) times compared with women having no formal education. Likewise, ANC service uptake for husbands with primary education increased by 5% (IRR =1.05; 95% CI: 1.01, 1.10) compared with husbands having no formal education. Similarly, ANC service uptake for husbands with secondary and above education increased by 9% (IRR =1.09; 95%CI: 1.03, 1.14) compared with husbands having no formal education. The ANC service uptake of the rural women was decreased by 12% (IRR =0.88; 95%CI: 1.85, 1.92) compared to the urban residents.

The study also indicated that the husbands' wealth index and marital status were a significant factor in the ANC service uptake. The ANC service uptake for rich wealth index would be 1.08 (IRR =1.08; 95% CI: 1.03, 1.13) times higher compared to their poor wealth index. ANC service uptake for married women was 1.19 (IRR =1.19; 95% CI: 1.09, 1.30) times higher compared to living alone women.

Moreover, ANC service uptake for women who had seen signs of pregnancy complications was 1.20 (IRR =1.20; 95% CI: 1.17, 1.24) times higher compared to those women who had no signs of pregnancy complication. The ANC service uptake for women being the use of mass media was 1.09 (IRR =1.09; 95% CI: 1.05, 1.13) times higher compared to those don't use of mass media. The ANC service uptake for mothers age 25-29 was 1.06 (IRR =1.06; 95% CI: 1.02, 1.10) times higher compared to whose age is 15-24. The ANC service uptake for mothers age 30 and above was 1.07 (IRR =1.07; 95% CI: 1.02, 1.11) times higher compared to whose age is 15-24 (Table 3).

**Table 3:** Zero Inflated Poisson regression model result (IRR and AOR)

Parameter	Poisson part	Bernoulli part
	IR(95% CI of IR)	AOR(95%CI of AOR)
Intercept	3.051( 2.777,3.352)*	0.542(0.399, 0.738)*
<b>Residence</b>		
Urban	1	1
Rural	0.884(0.846, 0.924)*	2.254(1.780, 2.855)*
<b>Access to mass media</b>		
No	1	1
Yes	1.086(1.045, 1.128)*	0.612(0.525,0.713)*
<b>Planned pregnancy</b>		
No	1	1
Yes	1.028( 0.989, 1.069)	0.794(0.685, 0.920)*
<b>Husbands occupation</b>		
not working	1	1
Working	1.017(0.959, 1.077)	0.761(0.655,0.884)*
<b>Wealth index</b>		
Low	1	1
Medium	1.039(0.989, 1.093)	0.594(0.501, 0.704)*
Rich	1.077( 1.029, 1.127)*	0.568(0.479, 0.672)*
<b>Women's education</b>		
No education	1	1
Primary	1.057(1.015, 1.101)*	0.454(0.388, 0.531)*
Secondary and above	1.112(1.052, 1.176)*	0.389(0.286, 0.530)*
<b>Husband education</b>		
No education	1	1
Primary	1.052(1.010, 1.096)*	0.625(0.542, 0.721)*
Secondary and above	1.085(1.031, 1.142)*	0.666(0.532, 0.836)*
<b>Age of mother (year)</b>		
15-24	1	1
25-29	1.060(1.016, 1.104)*	1
30 and above	1.067(1.024, 1.111)*	1
<b>Marital status</b>		
living alone	1	1
Married	1.187(1.087, 1.296)*	1
Divorced/widowed	1.083(0.990, 1.184)	1
<b>Pregnancy complications</b>		
No	1	1
Yes	1.203(1.165, 1.242)*	1
<b>Occupation of mother</b>		
Housewife	1	1
Working	0.982(0.950, 1.016)	1
<b>Terminated pregnancy</b>		

No	1
Yes	1.039(0.986,1.094)

**Note:** 1 = reference category of the categorical variable.

\* Significant at 5% level of significance

The Bernoulli or logit part used to show the likelihood of ANC service uptake (AOR) on the household level. Compared to urban women, being a rural resident (OR = 2.25; 95%CI: 1.78, 2.86) increases the odds of ANC non-utilization by about 2.25 times. Women who had primary (OR = 0.45; 95%CI: 0.39, 0.53) and secondary and higher (OR = 0.39; 95%CI: 0.29, 0.53) education had decreased odds of not attending ANC compared with those of no education category. Again, women in the middle (OR = 0.59; 95%CI: 0.50, 0.70) and rich (OR = 0.57; 95%CI: 0.48, 0.67) wealth quintiles respectively had a 41%, and 43 % reduction in the odds of not attending ANC compared with those in the poor class. On the other hand, being employed (OR = 0.76; 95%CI: 0.66, 0.88) reduced the odds of ANC non-utilization by 24% compared to unemployed husbands/partners. Similarly, women whose husband/partner's had primary (OR = 0.63; 95%CI: 0.54, 0.72), secondary and above (OR = 0.67; 95% CI: 0.53, 0.84) education respectively had a 37.0% and 33.0% reduction in the odds of not utilizing ANC compared to those whose husbands/partners had no education. Women who have used mass media (AOR = 0.61; 95%CI: 0.53, 0.71) had a 39.0% reduction in the odds of not utilizing ANC compared to those not to use of mass media (Table 3).

## Discussion

Antenatal care during pregnancy is important for the health of the mother and the development of the unborn baby. Therefore, this study aimed at assessing the determinant factors of ANC service uptake among pregnant women in Ethiopia. The results of this study showed that about 64.6 % of the pregnant women have utilized the service and 35.4% haven't received ANC services during their pregnancy which is less than that reported from 2016 EDHS urban Ethiopia<sup>16</sup>. It's also less than reported from the studies conducted in Hadiya and Jimma<sup>9 26</sup>.

The findings of this study revealed that education had a positive relationship with ANC service uptake, that is, the amount of ANC service uptake increase with the rise in woman's and husband's education level. The study shows an identical result with other studies<sup>12 17 22 27-31</sup> which revealed that non-educated women were less ANC attendants than those that have educated women.

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2  
3 This study also showed that marital status was found to be a significant determinant factor for  
4 ANC service uptake. The ANC service uptake among married women was higher compared to  
5 live alone women. This finding is in favor of study conducted in Tigray, of Ethiopia, Kenya and  
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8 Rwanda<sup>12 28 31 32</sup>

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10 Wealth index and husbands' occupation was positively related to ANC service uptake. The study  
11 showed that poor women were less ANC service uptake than those of middle and rich women.  
12 Studies elsewhere have also documented a positive relationship between economic status and  
13 ANC service uptake<sup>14 18 19 27 31 33</sup>. The results of this study indicated that residence and access to  
14 mass media are significantly associated with ANC service uptake. The ANC service uptake of  
15 rural women was lower than the urban woman. This is consistent with the study done in Amhara  
16 and Oromia, Ethiopia<sup>13 14 29 34</sup>. This may be because urban women were more informed than  
17 rural women about the importance of ANC service uptake. Women who were exposed to media  
18 were more ANC service uptake than women weren't exposed to media. It's also supported by<sup>14</sup>  
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30 Besides, women who had seen signs of pregnancy complications were better in ANC  
31 service uptake than women who had no signs of pregnancy complications. This finding is in line  
32 with studies done in Amhara, Ethiopia and Northern Jordan<sup>13 21 22 33</sup>.

31 Moreover, the will for the pregnancy and age of girls was also significantly associated with ANC  
32 service uptake. Women who had planned pregnancy had a better number of ANC service uptake  
33 than an unplanned pregnancy. This finding is supported by<sup>19-21 28</sup>. Similarly, women within the age  
34 of 30years and above are more likely to use ANC service e than women within the age group of  
35 15–19. Several studies supported that women's age plays a big role in the utilization of maternal  
36 health care<sup>9 17</sup>.

### 37 38 39 40 41 **Conclusion**

42 Only 35.5 percent of women have received a minimum of four ANC visits during their  
43 pregnancy. ANC service uptake in Ethiopia is extremely low and below average as compared to  
44 the minimum requirement of ANC service uptake recommended by WHO. This study was  
45 revealed that rural women, poor women, lower maternal and paternal education, mothers not  
46 having access to mass media, Living alone women, mothers have not complicated pregnancy  
47 was significantly associated with less number of ANC service utilization. Therefore, efforts have  
48 to be done to increase the socioeconomic status and to promote the decision making role of  
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women. Besides, there is a need for improving community awareness on maternal health and for motivating women to ANC service uptake.

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**Contributors:** SM drafted the proposal, did the analysis, wrote the results and prepared the manuscript. GM revised and critically reviewed the manuscript. Both authors read and approved the final manuscript.

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**Competing interests:** None declared.

**Patient consent for publication:** Not required.

**Data sharing statement:** The survey datasets used in this study was based on a publicly available dataset that is freely available online with no participant's identity from <http://www.dhsprogram.com/data/available-datasets.cfm>.

**Ethics approval and consent to participate:** The study used available secondary data accessed under the National Data Sharing and Accessibility Policy (NDSAP) of the Government of Ethiopia. The data set had no identifiable information on the survey participants; therefore, no ethical approval is required for this work.

**Provenance and peer review:** Not commissioned; externally peer reviewed.

**Abbreviations:** ANC: Antenatal Care; AOR: Adjusted Odd Ratio; EDHS: Ethiopian Demographic and Health Survey; HSTP: Health Sector Transformation Plan; IR: Incidence Rate; SDG: Sustainable development Goal; WHO: World Health Organization; ZIP: Zero Inflated Regression Poisson

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# BMJ Open

## Magnitude of Antenatal Care Service uptake and associated factors among Pregnant Women: analysis of the 2016 Ethiopia demographic and health survey

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3 **Magnitude of Antenatal Care Service uptake and associated factors among Pregnant**  
4 **Women: analysis of the 2016 Ethiopia demographic and health survey**  
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6 Setegn Muche Fenta\*<sup>1</sup> and Girum Meseret Ayenew<sup>2</sup>  
7

8 <sup>1</sup>Department of Statistics, Debre Tabor University, P.O.Box272 Debre Tabor, Ethiopia.  
9

10 <sup>2</sup>Research and Technology Transfer Directorate, Amhara Public Health Institute, P.O. Box 477  
11 Bahir Dar, Ethiopia; [girum.m21@gmail.com](mailto:girum.m21@gmail.com)  
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15 **\*Corresponding:** [setegn14@gmail.com](mailto:setegn14@gmail.com)  
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## Abstract

**Objective:** Antenatal and postnatal cares are crucial for the survival and well being of both the mother and the child. World Health Organization recommends a minimum of four antenatal care visits during a pregnancy. In Ethiopia, only 38% of women in the reproductive age received a minimum of first antenatal care visits. This value is far more below the typical rates of least developed countries. This study aimed to calculate the magnitude and identify associated factors of antenatal care service utilization among pregnant women in Ethiopia.

**Design:** Cross-sectional study design

**Setting:** Ethiopian.

**Participants:** A total of 7913 pregnant women were included in the study.

**Primary outcome measures:** Antenatal Care Service uptake among Pregnant

**Result:** Only 35.5% of the pregnant mothers have utilized antenatal care services at least four times and 64.5% of the pregnant mothers have utilized less than three times during their periods of pregnancy. The study showed that rich women (IRR 1.077, 95% CI: 1.029,1.127), having access to mass media (IRR=1.086, 95% CI: 1.045, 1.128), having pregnancy complications (IRR=1.203, 95% CI: 1.165, 1.242), secondary school and above-educated women (IRR=1.112, 95% CI:1.052, 1.176), husbands' having secondary school and above level of education (IRR=1.085, 95% CI: 1.031, 1.142), being married (IRR = 1.187; 95% CI: 1.087,1.296), rural women (IRR=0.884, 95% CI: 0.846, 0.924) and women age >30 years (IRR=1.067, 95% CI: 1.024, 1.111) were significantly associated with the antenatal care service uptake.

**Conclusion:** Efforts have to be done to increase the socioeconomic status, and to promote the decision making the role of women. Besides, this study indicates a need for improving community awareness on maternal health and for motivating women to utilize maternal care services.

**Keywords:** Antenatal Care services uptake, Ethiopia, Zero Inflated Poisson Regression Model

### Strengths and limitation

- Using a large sample size and high-quality data reduced the risk of sampling bias and measurement bias.
- Providing timely evidence for policy makers and health sectors to reducing levels of maternal and infant mortality.
- Ability to provide other researchers with flawless information about how to use over dispersed and excesses zero data.
- It is difficult to measure the causal effects, and impossible to know whether the data are time-dependent or not.

## Introduction

Maternal mortality is one of the most significant health problems in low and middle income country<sup>1 2</sup>. For preventable reasons associated with pregnancy and childbirth, 830 maternal deaths, 225000 newborns and 227000 stillbirths occur worldwide every day. Around 99% of these deaths have occurred in developing countries including Ethiopia. About 85% of the total global maternal deaths occurred in Sub-Saharan Africa and Southern Asia, of which two-thirds were from sub-Saharan Africa<sup>3-5</sup>. The maternal mortality rate in developing countries in the year 2015 is 239 per 100 000 live births and 12 per 100,000 live births in developed countries<sup>6 7</sup>. In Ethiopia, the maternal mortality rate is 412 deaths per 100,000 live births. This indicates a female lifetime hazard of maternal death is 1 in 243 Ethiopia<sup>7 8</sup>.

Antenatal and postnatal cares are crucial for the survival and well-being of both the mother and the child. Antenatal care (ANC) helps women to prepare for childbirth and consider the warning signs during pregnancy and birth<sup>9</sup>. The World Health Organization (WHO) suggested encouraging the positive experience of ANC pregnancy and increasing the recommended number of ANC visits from four to eight by 2018. However, it revealed that only 64 percent of women worldwide had  $\geq$  four ANC visit<sup>9 10</sup>. In Ethiopia, about sixty-two percent of women didn't attend a minimum of four ANC visits throughout their pregnancy<sup>8</sup>. Health Sector Transformation Plan of the Ethiopian Federal Ministry of Health addresses troubles associated with having targeted ANC with a minimal of four visits consistent with pregnancy as mainstream in the least provider delivery levels with a target to grow the proportion from 68% to 95 % at the highest by 2020<sup>11</sup>. But, according to the Ethiopia Demography and Health Survey (EDHS) 2016, the ANC service utilization with a minimum of four visits is merely 32%<sup>8</sup>. This indicated that ANC going to in Ethiopia immobile underneath any suitable standard.

Previous research in Ethiopia has been covered in small geographical regions and there is no sufficient study nationwide to the best knowledge of the authors<sup>12-17</sup>. These studies also investigated the associated factor of antenatal care service utilization through binary logistic. While binary logistic regression undercounts the total number of antenatal care visit since multiple service utilization is collapsed into a single unit to fulfill the requirements of binary



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3 logistic regression, provides sufficient information for studying the pattern of multiple service  
4 utilization. In this study, the Zero-Inflated Poisson regression model is the preferred model of  
5 analysis since the Zero-Inflated Poisson regression model provides a way of modeling the  
6 excessive proportion of zero values by allowing over dispersion. When the number of zeros is  
7 large, provides a good fit than Poisson or negative binomial model<sup>18</sup>. Therefore, this study  
8 aimed to calculate the magnitude and identify associated factors of ANC service uptake for the  
9 country at large.

## 15 **Method**

### 16 **Patient and public involvement**

17 This study used a publicly available data set (EDHS 2016); therefore, there were no patients or  
18 members of the public involved.

### 19 **Data source**

20 The data used for this study were taken from the 2016 EDHS. This survey is the fourth  
21 compressive survey designed to provide estimates for the health and demographic variables of  
22 interest for the whole urban and rural areas of Ethiopia as a domain. Women who had 9 months  
23 of pregnancy during the survey interview were included in the analysis. The study includes 7193  
24 of the reproductive age group within the country.

### 25 **Sampling Design**

26 The EDHS 2016 employed a stratified two-stage cluster sampling procedure designed to provide  
27 a representative sample for multiple health and population indicators at national and sub-national  
28 levels (nine regions and two city administrations). Initially, 645 Enumeration Areas (EAs) (202  
29 in urban areas and 443 in rural areas) were drawn using Probability Proportional to Size (PPS)  
30 sampling approach from a whole list of 84,915 EAs defined within the recent 2007 population  
31 census. Then in every selected EA, an exhaustive listing of households was made and 28  
32 households were selected using a systematic sampling approach. Within the chosen households,  
33 enumeration of the entire members was made and information about the ANC service utilization  
34 among all household members was collected primarily from the women<sup>19</sup>.

### 35 **Study variables**

36 The outcome variable of interest in this study was a count response of the number of ANC visits  
37 during their last pregnancy. The independent variables of this study were selected by reviewing  
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related work of literature<sup>12-17</sup>. Women educational level (no education, primary, secondary and higher), husband's occupation (not working, working), wealth index (poor, middle, rich), marital status (living alone, married, Divorced/widowed), women occupation (housewife, employed), age of women (15–24, 25–29 and  $\geq 30$  years), husbands educational level (no education, primary, secondary and higher), planned pregnancy (yes, no), access to mass media (yes, no), pregnancy complications (yes, no), the desire of pregnancy (yes, no), history of terminated pregnancy ever in her life (yes, no) and residence (urban, rural) were considered to be a possible independent variable within the study.

### Data analysis

The cleaned and recoded data were analyzed using R software version 3.5.3. Frequencies and percentages were used to describe the categorical variables. Data were presented using tables. Zero Inflated Poisson Regression (ZIPR) model was conducted to identify factors associated with antenatal care service utilization among pregnant. In recent years, the ZIPR model has gained popularity for modeling count data with excess zeroes<sup>18</sup>. The ZIP models can be viewed as a finite mixture model with a degenerate distribution whose mass is concentrated at zero. Excess zeroes arise when the event of interest is not experienced by many of the subjects<sup>26</sup>. In this study, the ZIPR model was employed to identify the determinant factors of ANC service uptake among pregnant women. Suppose  $Y_i$  is the number of ANC service uptake among pregnant then, the probability mass function of ZIPR is given by<sup>18 27 28</sup>

$$p(Y_i = y_i) = \begin{cases} \pi_i + (1 - \pi_i)\exp(-\mu_i), & \text{if } y_i = 0 \\ (1 - \pi_i)\frac{\exp(-\mu_i)\mu_i^{y_i}}{y_i!}, & \text{if } y_i = 1, 2, 3, \dots \end{cases} \quad 0 \leq \pi_i \leq 1$$

The parameter  $\mu_i$  and  $\pi_i$  depends on the covariates  $x_i$  and  $z_i$ , respectively. The mean and the variance of ZIP regression model, respectively, are:

$E(y_i) = (1 - \pi_i)\mu_i$  and  $Var(y_i) = \mu_i(1 - \pi_i)(1 + \pi_i\mu_i)$ . To apply the ZIPR model in practical modeling situations,<sup>18 27 28</sup> suggested the following joint models for  $\mu$  and  $\pi$

$\ln(\mu) = X^T\beta$  and  $\ln\left(\frac{\pi}{1-\pi}\right) = Z^T\gamma$  where  $X$  and  $Z$  are covariate matrices and  $\beta, \gamma$  are  $(p + 1) \times 1$  and  $(q + 1) \times 1$  vectors of unknown parameters respectively. The two sets of covariates may or may not coincide. Finally, the odds ratio (OR) and incidence rate (IR) with a 95% confidence

interval (CI) were used to assess the strength of associations between the outcome and the independent variables. P-values of  $\leq 0.05$  were considered for statistical significant.

### Ethical Issues

Publicly available EDHS 2016 data were used for this study. Informed consent was taken from each participant, and all identifiers were removed

### Results

From a total of 7913 pregnant women, 64.6 % of the pregnant women have utilized the service, 35.4% of the pregnant women didn't receive any ANC service and 35.5% of the pregnant women have received at least four ANC visits. The mean and variance of observation are 2.53 and 5.614, respectively. The variance to mean ratio is 2.22, which indicates some over-dispersion (Table 1).

**Table 1:** The number of women that experienced ANC visits

Number of visits	Count	Percent
0	2545	35.4
1	342	4.8
2	563	7.8
3	1187	16.5
4	1136	15.8
5	621	8.6
6	402	5.6
7	187	2.6
8+	108	2.9
Total	7193	100.0
Mean	2.53	
Variance	5.614	

### Test of over dispersion

The Pearson residual  $\chi^2$ -statistic for Poisson and ZIP model was summarized in Table 2. The Pearson dispersion value of the Poisson model is 1.829 ( $p < 0.001$ ), which clearly shows the existence of over-dispersion in the data and the Poisson model is over-dispersed. It follows that the options for modeling and analyzing such over dispersed and excess zero ANC count response data should be considered. Then fit ZIP and 1.001 is the Pearson dispersion value. This indicates that the ZIP has modeled and captured the over-dispersion in the data set very well; because the dispersion value is very close to 1. For this reason, ZIP model used for the analysis in order to identify the associated factors of ANC service uptake (Table 2).

**Table 2:** Test of over-dispersion based on Pearson residual  $\chi^2$ -statistic

Model	Dispersion Test (Ratio Statistic & p-value)
Poisson	1.829(0.001)
ZIP	1.001 ( 0.004)

### Socio-demographic characteristics of study participants

The majority of the study respondents were from rural residences (79%). Most of the respondents were housewives (70%) and 30% of the respondents were employed. About 60.6% of mothers didn't attend primary school and only 12.4% of mothers attended secondary and above education. The majority (69.4%) of the respondents had no pregnancy complications and 64.4% had no access to mass media. About 91.5 percent of women were married, 3.2 percent of women were living alone women while 5.3% were divorced and widowed. The majorities (79.8%) of pregnancies were planned and 9% of pregnancies were terminated. Regarding husband education, 31.7% of the husband had no formal education while 30% of husbands attend primary education. About half (50.7%) of had poor wealth index, 35.0% were rich wealth while others were middle wealth index (14.3%). Regarding the mother age, the majorities (46.2%) of mothers were under the age group of 30 years plus, then followed 25-29 years (Table 3).

**Table 3:** Socio demographic characteristics of pregnant women in Ethiopia

Variable	Frequency (n)	Percentage (%)
Residence		
Urban	1512	21
Rural	5681	79
Occupation of women		
Housewife	5033	70
Employed	2160	30
Planned pregnancy		
No	1452	20.2
Yes	5741	79.8
Terminated pregnancy		
No	6556	91.1
Yes	637	8.9
Wealth index		
Low	3607	50.7
Medium	1028	14.3
Rich	2558	35.0
Marital status		
Never married	230	3.2
Married	6579	91.5
Divorced/widowed	384	5.3

Age of women in a year		
15-24	1852	25.7
25-29	2015	28.1
30 and above	3326	46.2
Husband education		
No education	3719	51.7
Primary	2160	30.0
Secondary and above	1314	18.3
Woman education		
No education	4359	60.6
Primary	1942	27
Secondary and above	892	12.4
Access to mass media		
No	4646	64.6
Yes	2547	35.4
Pregnancy complications		
No	5015	69.7
Yes	2178	30.3
Husband's occupation		
Not working	1285	17.9
Working	5908	82.1

### Associated factors of ANC service uptake

As shown in the below table (Table 4), the Poisson component shows that the incidence rate (IR) of ANC visits. The finding of this study revealed that women's and husbands' levels of education have a significant factor for ANC service uptake. The expected number of ANC service uptake for women with primary education was 1.06 (IRR =1.06; 95%CI: 1.02, 1.10) times higher compared to women with no formal education. The expected number of ANC service uptake for women with secondary and above education was 1.11 (IRR =1.11; 95% CI: 1.05, 1.18) times higher compared to women with no formal education. The expected number of ANC service uptake for husbands with primary education was 1.05 (IRR =1.05; 95% CI: 1.01, 1.10) times higher compared to husbands with no formal education. Similarly, ANC service uptake for husbands with secondary and above education increased by 9% (IRR =1.09; 95%CI: 1.03, 1.14) times higher compared to husbands with no formal education. The expected number of ANC service uptake of the rural women was 0.88 (IRR =0.88; 95%CI: 1.85, 1.92) times lower compared to urban women. The incidence rate of ANC service uptake for the rich wealth index would be 1.08 (IRR =1.08; 95% CI: 1.03, 1.13) times higher compared to their poor wealth

index. The incidence rate of ANC service uptake for married women was 1.19 (IRR =1.19; 95% CI: 1.09, 1.30) times higher compared to living alone women. The incidence rate of ANC service uptake for women who had seen signs of pregnancy complications was 1.20 (IRR =1.20; 95% CI: 1.17, 1.24) times higher compared to those women who had no signs of pregnancy complication. The incidence rate of ANC service uptake for women being the use of mass media was 1.09 (IRR =1.09; 95% CI: 1.05, 1.13) times higher compared to those who don't use mass media. The incidence rate of ANC service uptake for mothers age 25-29 was 1.06 (IRR =1.06; 95% CI: 1.02, 1.10) times higher compared to those whose aged is 15-24. The incidence rate of ANC service uptake for mothers age 30 and above was 1.07 (IRR =1.07; 95% CI: 1.02, 1.11) times higher compared to those whose aged is 15-24 (Table 4).

**Table 4:** Zero Inflated Poisson regression model result (IRR and AOR)

Variable	Poisson part	Bernoulli part
	IR(95% CI of IR)	AOR(95%CI of AOR)
Residence		
Urban	1	1
Rural	0.884(0.846, 0.924)*	2.254(1.780, 2.855)*
Access to mass media		
No	1	1
Yes	1.086(1.045, 1.128)*	0.612(0.525,0.713)*
Planned pregnancy		
No	1	1
Yes	1.028( 0.989, 1.069)	0.794(0.685, 0.920)*
Husbands occupation		
Not working	1	1
Working	1.017(0.959, 1.077)	0.761(0.655,0.884)*
Wealth index		
Low	1	1
Medium	1.039(0.989, 1.093)	0.594(0.501, 0.704)*
Rich	1.077( 1.029, 1.127)*	0.568(0.479, 0.672)*
Women's education		
No education	1	1
Primary	1.057(1.015, 1.101)*	0.454(0.388, 0.531)*
Secondary and above	1.112(1.052, 1.176)*	0.389(0.286, 0.530)*
Husband education		
No education	1	1
Primary	1.052(1.010, 1.096)*	0.625(0.542, 0.721)*
Secondary and above	1.085(1.031, 1.142)*	0.666(0.532, 0.836)*
Age of women (year)		
15-24	1	1
25-29	1.060(1.016, 1.104)*	0.991(0.830, 1.184)
30 and above	1.067(1.024, 1.111)*	0.827(0.656,1.042)
Marital status		
living alone	1	1

Married	1.187(1.087, 1.296)*	0.865(0.576, 1.301)
Divorced/widowed	1.083(0.990, 1.184)	0.639(0.460, 0.888)*
Pregnancy complications		
No	1	1
Yes	1.203(1.165, 1.242)*	0.859(0.569, 1.297)
Occupation of women		
Housewife	1	1
Working	0.982(0.950, 1.016)	0.937(0.809, 1.085)
Terminated pregnancy		
No	1	1
Yes	1.039(0.986, 1.094)	0.817(0.649, 1.027)

**Note:** 1 = reference category of the categorical variable.

\* Significant at 5% level of significance

The Bernoulli part also indicated that the estimated odds that the number of ANC service uptake becomes zero with who is living in the rural area was 2.25 (OR = 2.25; 95%CI: 1.78, 2.86) times that of urban women. The estimated odds the number of ANC service uptake becomes zero with women who attend primary education was 0.45 (OR = 0.45; 95%CI: 0.39, 0.53) times that of the non-educated women. Similarly, the estimated odds the number of ANC service uptake becomes zero with husbands who have primary education was 0.63 (OR = 0.63; 95%CI: 0.54, 0.72) times that of the non-educated husbands. The estimated odds the number of ANC service uptake becomes zero with rich women was 0.57 (OR = 0.57; 95%CI: 0.48, 0.67) times that of the poor wealth index. The odds of the number of ANC service uptake becomes zero with husbands who work is 0.76 (OR = 0.76; 95%CI: 0.66, 0.88) times that of husbands without work. The estimated odds the number of ANC service uptake becomes zero with women who have used mass media was 0.61 (AOR = 0.61; 95%CI: 0.53, 0.71) times that of women who did not use any mass media (Table 4).

## Discussion

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3 Antenatal care during pregnancy is important for the health of the mother and the development  
4 of the unborn baby. Therefore, this study aimed at determining the magnitude and associated  
5 factors of ANC service uptake among pregnant women in Ethiopia. The results of this study  
6 showed that about 64.6 % of the pregnant women have utilized the service and 35.4% haven't  
7 received ANC services during their pregnancy which is less than that reported from 2016 EDHS  
8 urban Ethiopia<sup>19</sup>. It's also less than reported from the studies conducted in different parts of  
9 Ethiopia<sup>12 29 30</sup>.

10 The findings of this study revealed that education had a positive relationship with ANC service  
11 uptake, that is, the amount of ANC service uptake increase with the rise in woman's and  
12 husband's education level. The study shows an identical result with other studies<sup>15 20 25 31-35</sup>,  
13 which revealed that non-educated women and husbands were less ANC attendants than those  
14 that have educated women. The possible justification behind this could be that educated women  
15 have taken more ANC because they have more awareness of the benefits of regular ANC uptake,  
16 such as reducing risks of pregnancy and ensuring safe childbirth. Educated husbands may have  
17 better communication with their wives and may be able to explore the importance of ANC  
18 uptake and other maternal health services<sup>36</sup>. This could also provide their wives with more  
19 freedom as well<sup>37</sup>.

20 The uptake of ANC services among married women was higher compared to women living  
21 alone. This finding is consistent with the studies conducted in Ethiopia<sup>15</sup>, Kenya<sup>32</sup>, Rwanda<sup>38</sup>  
22 and Bangladesh<sup>35</sup>. This may be attributed to the psychological and economic support obtained  
23 from their husbands, planning/desirability of their pregnancy and the societal acceptability and  
24 support of their pregnant state when compared with their unmarried women.

25 Wealth index has been negatively correlated with the use of ANC services. Relative to the richest  
26 wealth quintile, women belonging to the lowest wealth quintiles were less likely to uptake ANC  
27 service. Studies elsewhere have also documented a positive relationship between economic status  
28 and ANC service uptake<sup>17 21 22 31 35 39</sup>. The possible justification of this finding might be that rich  
29 women may obtain more ANC information from mass media and may have greater access to  
30 health care. In addition, this may be attributed to the indirect cost of antenatal care, such as  
31 transport cost, while traveling to distant health facility<sup>40</sup>.

32 Compared to rural women, women living in urban areas were more likely to utilize ANC service.  
33 This finding is supported by the studies conducted in<sup>16 17 33 41</sup>. The potential reason may be that



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3 urban women had a better education, access to health services and more informed about the  
4 importance of ANC service uptake. The exposure of mass media was positively associated with  
5 ANC services. Women who were exposed to media were more ANC service uptake than women  
6 who weren't exposed to media. This finding is in line with reports of other previous studies<sup>17 23 33</sup>  
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35. Compared to housewife women, the number of ANC uptake among employed women was higher. This finding is similar to the study done in Kenya<sup>42</sup> and 31 sub-Saharan Africa countries<sup>43</sup> which showed that the odds of antenatal care utilization were higher among working women than non-working<sup>43</sup>. This may be due to the fact that employed women, especially those in the formal sector, have the ability to benefit from a pregnancy care health insurance system. The finding indicated that women who did develop pregnancy complications were more likely to uptake ANC service than those who did not develop pregnancy complications. This finding is in line with studies done in Ethiopia<sup>44</sup>, Northern Jordan<sup>24</sup> and Tanzanian<sup>25</sup> and Pakistan<sup>25</sup>.

Relative to unplanned/unwanted pregnancies, women whose pregnancies were planned and desired were more likely to use ANC services. These findings were consistent with previous studies<sup>22-24 32</sup>. Results also showed that the number of ANC visit increased significantly as the age of women increased. Previous studies supported that women's age plays a big role in the utilization of maternal health care<sup>12 20</sup>.

### **Strengths and limitation**

This study used EDHS data with large sample size and high-quality data which reduced the risk of sampling bias and measurement bias. The result of this study also providing timely evidence for policymakers and health sectors to reducing levels of maternal and infant mortality depends on increasing the use of reproductive and maternal health services. The study is also able to provide other researchers with flawless information about how to use over dispersed excesses zero and zero-inflated Poisson regression model. Due to cross sectional study design, It is difficult to measure the causal effects, and impossible to know whether the data are time-dependent or not.

### **Conclusion**

About 64.6 percent of the pregnant women have utilized the service and only 35.5 percent of the pregnant women have received at least four ANC visits. ANC service uptake in Ethiopia is extremely low and below average as compared to the minimum requirement of ANC service uptake recommended by WHO. This study was revealed that rural women, poor women, lower

maternal and paternal education, mothers not having access to mass media, living alone women, mothers who have not complicated pregnancy was significantly associated with less number of ANC service utilization. Therefore, efforts have to be done to increase the socioeconomic status and to promote the decision making the role of women. Besides, there is a need for improving community awareness on maternal health and for motivating women to ANC service uptake.

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**Contributors:** SM drafted the proposal, did the analysis, wrote the results and prepared the manuscript. GM revised and critically reviewed the manuscript. Both authors read and approved the final manuscript.

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**Ethics approval and consent to participate:** The study used available secondary data accessed under the National Data Sharing and Accessibility Policy (NDSAP) of the Government of Ethiopia. The data set had no identifiable information on the survey participants; therefore, no ethical approval is required for this work.

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**Abbreviations:** ANC: Antenatal Care; AOR: Adjusted Odd Ratio; EDHS: Ethiopian Demographic and Health Survey; HSTP: Health Sector Transformation Plan; IR: Incidence Rate; SDG: Sustainable development Goal; WHO: World Health Organization; ZIP: Zero Inflated Regression Poisson

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# BMJ Open

## Magnitude of Antenatal Care Service uptake and associated factors among Pregnant Women: analysis of the 2016 Ethiopia demographic and health survey

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3 **Magnitude of Antenatal Care Service uptake and associated factors among Pregnant**  
4 **Women; analysis of the 2016 Ethiopia demographic and health survey**  
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8 Setegn Muche Fenta\*<sup>1</sup>and Girum Meseret Ayenew<sup>2</sup>  
9

10 <sup>1</sup>Department of Statistics, Debre Tabor University,P.O. Box272 Debre Tabor, Ethiopia.  
11

12 <sup>2</sup>Research and Technology Transfer Directorate, Amhara Public Health Institute, P.O. Box 477  
13 Bahir Dar, Ethiopia;[girum.m21@gmail.com](mailto:girum.m21@gmail.com)  
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17 **\*Corresponding:**[setegn14@gmail.com](mailto:setegn14@gmail.com)  
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## Abstract

**Objective:** Antenatal and postnatal cares are crucial for the survival and well-being of both the mother and the child. World Health Organization recommends a minimum of four antenatal care visits during a pregnancy. In Ethiopia, only 38% of women in the reproductive age received a minimum of first antenatal care visits. This value is far more below the typical rates of least developed countries. This study aimed to calculate the magnitude and identify associated factors of antenatal care service utilization among pregnant women in Ethiopia.

**Design:** Cross-sectional study design

**Setting:** Ethiopian.

**Participants:** A total of 7913 pregnant women were included in the study.

**Primary outcome measures:** Antenatal Care Service uptake among Pregnant

**Result:** Only 35.5% of the pregnant mothers have utilized antenatal care services at least four times and 64.5% of the pregnant mothers have utilized less than three times during their periods of pregnancy. The study showed that rich women (PR=1.077, 95% CI: 1.029,1.127), having access to mass media (PR=1.086, 95% CI: 1.045, 1.128), having pregnancy complications (PR=1.203, 95% CI: 1.165, 1.242), secondary school and above-educated women (PR=1.112, 95% CI:1.052, 1.176), husbands' having secondary school and above level of education (PR=1.085, 95% CI: 1.031, 1.142), being married (PR = 1.187; 95% CI: 1.087,1.296), rural women (PR=0.884, 95% CI: 0.846, 0.924) and women age >30 years (PR=1.067, 95% CI: 1.024, 1.111) were significantly associated with the antenatal care service uptake.

**Conclusion:** The magnitude of ANC service uptake was low. This low magnitude of ANC service utilization calls for a need for improving community awareness on maternal health. More importantly, intensive health education is required for pregnant women to have better ANC service uptake and follow-up adherence.

**Keywords:** Antenatal Care services uptake, Ethiopia, Zero Inflated Poisson Regression Model

### Strengths and limitation

- Large sample size and high-quality data reduced the risk of sampling and measurement bias.
- Timely evidence for policymakers and health sectors to reduce maternal and infant mortality.
- Gives flawless information to the scientific community about how to use over dispersed and excesses zero data.
- Unable to measure the causal effects, and impossible to know whether the data are time-dependent or not.

## Introduction

Maternal mortality is one of the most significant health problems in low and middle income country<sup>1 2</sup>. Worldwide; about 295, 000 maternal deaths, 2.4 million newborn and 2 million stillbirths occur each year and most causes of these death were found to be preventable which are associated with pregnancy and childbirth. Around 99% of these deaths have occurred in developing countries including Ethiopia. About 85% of the total global maternal deaths occurred in Sub-Saharan Africa and Southern Asia, of which two-thirds were from sub-Saharan Africa<sup>3-5</sup>. The maternal mortality rate in developing countries in the year 2015 is 239 per 100 000 live births and 12 per 100,000 live births in developed countries<sup>6 7</sup>. In Ethiopia, the maternal mortality rate is 412 deaths per 100,000 live births. This indicates a female lifetime hazard of maternal death is 1 in 243 Ethiopia<sup>7 8</sup>.

Antenatal and postnatal cares are crucial for the survival and well-being of both the mother and the child. Antenatal care (ANC) helps women to prepare for childbirth and consider the warning signs during pregnancy and birth<sup>9</sup>. The World Health Organization (WHO) suggested encouraging the positive experience of ANC pregnancy and increasing the recommended number of ANC visits from four to eight by 2018. However, it revealed that only 64 percent of women worldwide had  $\geq$  four ANC visit<sup>9 10</sup>. In Ethiopia, about sixty-two percent of women didn't attend a minimum of four ANC visits throughout their pregnancy<sup>8</sup>. Health Sector Transformation Plan of the Ethiopian Federal Ministry of Health addresses troubles associated with having targeted ANC with a minimal of four visits consistent with pregnancy as mainstream in the least provider delivery levels with a target to grow the proportion from 68% to 95 % at the highest by 2020<sup>11</sup>. But, according to the Ethiopia Demography and Health Survey (EDHS) 2016, the ANC service utilization with a minimum of four visits is merely 32%<sup>8</sup>. This indicated that ANC going to in Ethiopia immobile underneath any suitable standard.

Previous research in Ethiopia has been covered in small geographical regions and there is no sufficient study nationwide to the best knowledge of the authors<sup>12-17</sup>. These studies also investigated the associated factor of antenatal care service utilization through binary logistic. While binary logistic regression undercounts the total number of antenatal care visit since multiple service utilization is collapsed into a single unit to fulfill the requirements of binary

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3 logistic regression, provides sufficient information for studying the pattern of multiple service  
4 utilization. In this study, the Zero-Inflated Poisson regression model is the preferred model of  
5 analysis since the Zero-Inflated Poisson regression model provides a way of modeling the  
6 excessive proportion of zero values by allowing over dispersion. When the number of zeros is  
7 large, provides a good fit than Poisson or negative binomial model<sup>18</sup>. Therefore, this study aimed  
8 to calculate the magnitude and identify associated factors of ANC service uptake for the country  
9 at large.

## 15 **Method**

### 16 **Patient and public involvement**

17 This study used a publicly available data set (EDHS 2016); therefore, there were no patients or  
18 members of the public involved.

### 19 **Data source**

20 The data used for this study were taken from the 2016 EDHS. This survey is the fourth  
21 compressive survey designed to provide estimates for the health and demographic variables of  
22 interest for the whole urban and rural areas of Ethiopia as a domain. Women who had 9 months  
23 of pregnancy during the survey interview were included in the analysis. The study includes 7193  
24 of the reproductive age group within the country.

### 25 **Sampling Design**

26 The EDHS 2016 employed a stratified two-stage cluster sampling procedure designed to provide  
27 a representative sample for multiple health and population indicators at national and sub-national  
28 levels (nine regions and two city administrations). Initially, 645 Enumeration Areas (EAs) (202  
29 in urban areas and 443 in rural areas) were drawn using Probability Proportional to Size (PPS)  
30 sampling approach from a whole list of 84,915 EAs defined within the recent 2007 population  
31 census. Then in every selected EA, an exhaustive listing of households was made and 28  
32 households were selected using a systematic sampling approach. Within the chosen households,  
33 enumeration of the entire members was made and information about the ANC service utilization  
34 among all household members was collected primarily from the women<sup>19</sup>.

### 35 **Study variables**

36 The outcome variable of interest in this study was a count response of the number of ANC visits  
37 during their last pregnancy. The independent variables of this study were selected by reviewing  
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related work of literature<sup>12-17 20-25</sup>. Women educational level (no education, primary, secondary and higher), husband's occupation (not working, working), wealth index (poor, middle, rich), marital status (living alone, married, Divorced/widowed), women occupation (housewife, employed), age of women (15–24, 25–29 and  $\geq 30$  years), husbands educational level (no education, primary, secondary and higher), planned pregnancy (yes, no), access to mass media (yes, no), pregnancy complications (yes, no), the desire of pregnancy (yes, no), history of terminated pregnancy ever in her life (yes, no) and residence (urban, rural) were considered to be a possible independent variable within the study.

### Data analysis

The cleaned and recoded data were analyzed using R software version 3.5.3. Frequencies and percentages were used to describe the categorical variables. Data were presented using tables. Zero Inflated Poisson Regression (ZIPR) model was conducted to identify factors associated with antenatal care service utilization among pregnant. In recent years, the ZIPR model has gained popularity for modeling count data with excess zeroes<sup>18</sup>. The ZIP models can be viewed as a finite mixture model with a degenerate distribution whose mass is concentrated at zero. Excess zeroes arise when the event of interest is not experienced by many of the subjects<sup>26</sup>. In this study, the ZIPR model was employed to identify the determinant factors of ANC service uptake among pregnant women. Suppose  $Y_i$  is the number of ANC service uptake among pregnant then, the probability mass function of ZIPR is given by<sup>18 27 28</sup>

$$p(Y_i = y_i) = \begin{cases} \pi_i + (1 - \pi_i)\exp(-\mu_i), & \text{if } y_i = 0 \\ (1 - \pi_i)\frac{\exp(-\mu_i)\mu_i^{y_i}}{y_i!}, & \text{if } y_i = 1, 2, 3, \dots \end{cases} \quad 0 \leq \pi_i \leq 1$$

The parameter  $\mu_i$  and  $\pi_i$  depends on the covariates  $x_i$  and  $z_i$ , respectively. The mean and the variance of ZIP regression model, respectively, are:

$E(y_i) = (1 - \pi_i)\mu_i$  and  $Var(y_i) = \mu_i(1 - \pi_i)(1 + \pi_i\mu_i)$ . To apply the ZIPR model in practical modeling situations, <sup>18 27 28</sup> suggested the following joint models for  $\mu$  and  $\pi$

$\ln(\mu) = X^T\beta$  and  $\ln\left(\frac{\pi}{1-\pi}\right) = Z^T\gamma$  where  $X$  and  $Z$  are covariate matrices and  $\beta, \gamma$  are  $(p + 1) \times 1$  and  $(q + 1) \times 1$  vectors of unknown parameters respectively. The two sets of covariates may or may not coincide. Finally, the odds ratio (OR) and prevalence ratios (PR) with a 95% confidence interval (CI) were used to assess the strength of associations between the outcome and the

independent variables using Poisson and Bernoulli regression models' assumptions. P-values of  $\leq 0.05$  were considered for statistically significant.

### Ethical Issues

Publicly available EDHS 2016 data were used for this study. Informed consent was taken from each participant, and all identifiers were removed

### Results

From a total of 7913 pregnant women, 64.6 % of the pregnant women have utilized the service, 35.4% of the pregnant women didn't receive any ANC service and 35.5% of the pregnant women have received at least four ANC visits. The mean and variance of observation are 2.53 and 5.614, respectively. The variance to mean ratio is 2.22, which indicates some over-dispersion (Table 1).

**Table 1: The number of women that experienced ANC visits**

Number of visits	Count	Percent
0	2545	35.4
1	342	4.8
2	563	7.8
3	1187	16.5
4	1136	15.8
5	621	8.6
6	402	5.6
7	187	2.6
8+	108	2.9
Total	7193	100.0
Mean	2.53	
Variance	5.614	

### Test of over dispersion

The Pearson residual  $\chi^2$ -statistic for Poisson and ZIP model was summarized in Table 2. The Pearson dispersion value of the Poisson model is 1.829 ( $p < 0.001$ ), which clearly shows the existence of over-dispersion in the data and the Poisson model is over-dispersed. It follows that the options for modeling and analyzing such over dispersed and excess zero ANC count response data should be considered. Then fit ZIP and 1.001 is the Pearson dispersion value. This indicates that the ZIP has modeled and captured the over-dispersion in the data set very well; because the dispersion value is very close to 1. For this reason, ZIP model used for the analysis in order to identify the associated factors of ANC service uptake (Table 2).

**Table 2: Test of over-dispersion based on Pearson residual  $\chi^2$ -statistic**

Model	Dispersion Test (Ratio Statistic & P-value)
Poisson	1.829(0.001)
ZIP	1.001 ( 0.004)

### Socio-demographic characteristics of study participants

The majority of the study respondents were from rural residences (79%). Most of the respondents were housewives (70%) and 30% of the respondents were employed. About 60.6% of mothers didn't attend primary school and only 12.4% of mothers attended secondary and above education. The majority (69.4%) of the respondents had no pregnancy complications and 64.4% had no access to mass media. About 91.5 percent of women were married, 3.2 percent of women were living alone women while 5.3% were divorced and widowed. The majorities (79.8%) of the pregnancies were planned and 9% of the pregnancies were terminated. Regarding husband education, 31.7% of the husband had no formal education while 30% of husbands attend primary education. About half (50.7%) of women had poor wealth index, 35.0% were rich wealth while others were middle wealth index (14.3%). Regarding the mother age, the majorities (46.2%) of mothers were under the age group of 30 years plus, then followed 25-29 years (Table 3).

### Magnitude of ANC services uptake by socio-demographic characteristics of study participants

The mean and median numbers of ANC visits by socio-demographic characteristics of study participants are shown in Table 3. The mean numbers of ANC visits for urban women (4.26)

were higher than for rural women (2.07). Among poor women, the lowest mean numbers of ANC visits were recorded (1.71). The lowest mean numbers of ANC visits were observed for uneducated husbands (1.93), while the highest mean numbers of ANC visits were observed for husbands with secondary education and above (3.83). Women exposed to the media had the highest mean numbers of ANC visits (3.65), while the mean numbers of ANC visits for women not exposed to the media were low (1.92). The lowest mean numbers of ANC visits occur in uneducated women (1.88), while the highest mean numbers of ANC visits have been recorded for women with secondary education and above (4.36). Compared with women who had no symptoms of pregnancy problems (1.78), women who had seen signs of pregnancy complications had a higher mean number of ANC visits (4.28). Furthermore; residency, occupation of women, planned pregnancy, wealth index, marital status, age of women, husbands' education status, women education level, access to mass media, pregnancy complication and occupation of husbands were significantly correlated with the median number of ANC visits (Table 3).

Table 3: Magnitude of ANC services uptake by socio-demographic characteristics of study participants and the associated Chi-Square ( $\chi^2$ ) test for equality of the medians

Characteristics		Frequency (%)	Mean	Median	X <sup>2</sup> value (p-value)
Residence	Urban	1512(21.0)	4.26	4	184.60 (<0.001)
	Rural	5681(79.0)	2.07	2	
Occupation of women	Housewife	5033(70.0)	2.37	2	93.14 (<0.001)
	Employed	2160(30.0)	2.92	3	
Planned pregnancy	No	1452(20.2)	2.53	3	28.81 (<0.001)
	Yes	5741(79.8)	2.54	3	
Terminated pregnancy	No	6556(91.1)	2.51	3	4.97(0.893)
	Yes	637(8.9)	2.79	3	
Wealth index	Low	3607(50.7)	1.71	1	237.13 (<0.001)
	Medium	1028(14.3)	2.47	3	
	Rich	2558(35.0)	3.71	4	
Marital status	Never married	230(3.2)	2.52	3	59.19 (<0.001)
	Married	6579(91.5)	3.26	4	



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3		Divorced/widowed	384(5.3)	2.56	3	
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5	Age of	15-24	1852(25.1)	2.60	3	
6	women in a	25-29	2015(28.1)	2.73	3	75.50 (<0.001)
7	year	30 and above	3326(46.2)	2.38	3	
8						
9	Husband	No education	3719(51.7)	1.93	1	
10	education	Primary	2160(30.0)	2.79	3	742.45 (<0.001)
11		Secondary and above	1314(18.3)	3.83	4	
12	Woman	No education	4359(60.6)	1.88	1	
13	education	Primary	1942(27.0)	3.15	3	205.01 (<0.001)
14		Secondary and above	892(12.4)	4.36	4	
15	Access to	No	4646(64.6)	1.92	1	188.39 (<0.001)
16	mass media	Yes	2547(35.4)	3.65	4	
17	Pregnancy	No	5015(69.7)	1.78	1	848.99 (<0.001)
18	complications	Yes	2178(30.3)	4.28	4	
19	Husband's	Not working	1285(17.9)	2.19	2	56.98 (<0.001)
20	occupation	Working	5908(82.1)	2.61	3	
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## Factors associated with ANC service uptake, application of Zero Inflated Poisson regression models

As shown in the below table (Table 4), the Poisson component shows that the prevalence ratios (PR) of ANC visits. The finding of this study revealed that women's and husbands' levels of education have had a significant factor in ANC service uptake. The expected number of ANC service uptake for women with primary education was 1.06 (PR =1.06; 95%CI: 1.02, 1.10) times higher compared to women with no formal education. The expected number of ANC service uptake for women with secondary and above education was 1.11 (PR =1.11; 95% CI: 1.05, 1.18) times higher compared to women with no formal education. The expected number of ANC service uptake for husbands with primary education was 1.05 (PR =1.05; 95% CI: 1.01, 1.10) times higher compared to husbands with no formal education. Similarly, ANC service uptake for husbands with secondary and above education increased by 9% (IRR =1.09; 95%CI: 1.03, 1.14) times higher compared to husbands with no formal education. The expected number of ANC service uptake of the rural women was 0.88 (PR =0.88; 95%CI: 1.85, 1.92) times lower compared to urban women. The expected number of ANC service uptake for the rich wealth index was 1.08 (PR =1.08; 95% CI: 1.03, 1.13) times higher compared to their poor wealth index. The expected number of ANC service uptake for married women was 1.19 (PR =1.19; 95% CI: 1.09, 1.30) times higher compared to living alone women. The expected number of ANC service uptake for women who had seen signs of pregnancy complications was 1.20 (PR =1.20; 95% CI: 1.17, 1.24) times higher compared to those women who had no signs of pregnancy complication. The expected number of ANC service uptake for women using mass media was 1.09 (PR =1.09; 95% CI: 1.05, 1.13) times higher compared to those who don't use mass media. The expected number of ANC service uptake for mothers in the age group of 25-29 was 1.06 (PR =1.06; 95% CI: 1.02, 1.10) times higher compared with the age group of 15-24 years. The expected number of ANC service uptake for mothers age 30 and above was 1.07 (PR =1.07; 95% CI: 1.02, 1.11) times higher compared with the age group of 15-24 years (Table 4).

Table 4: Factors associated with ANC service uptake, application of application of Zero Inflated Poisson regression models

Characteristics		Poisson part PR (95% CI of PR)	Bernoulli part AOR (95%CI of AOR)
Residence	Urban	1	1
	Rural	0.884(0.846, 0.924) *	2.254(1.780, 2.855)*
Access to mass media	No	1	1
	Yes	1.086(1.045, 1.128) *	0.612(0.525,0.713)*
Planned pregnancy	No	1	1
	Yes	1.028( 0.989, 1.069)	0.794(0.685, 0.920)*
Husbands occupation	Not working	1	1
	Working	1.017(0.959, 1.077)	0.761(0.655,0.884)*
Wealth index	Low	1	1
	Medium	1.039(0.989, 1.093)	0.594(0.501, 0.704)*
	Rich	1.077( 1.029, 1.127)*	0.568(0.479, 0.672)*
Women's education	No education	1	1
	Primary	1.057(1.015, 1.101)*	0.454(0.388, 0.531)*
	Secondary and above	1.112(1.052, 1.176)*	0.389(0.286, 0.530)*
Husband education	No education	1	1
	Primary	1.052(1.010, 1.096)*	0.625(0.542, 0.721)*
	Secondary and above	1.085(1.031, 1.142)*	0.666(0.532, 0.836)*
Age of women (year)	15-24	1	1
	25-29	1.060(1.016, 1.104)*	0.991(0.830, 1.184)
	30 and above	1.067(1.024, 1.111)*	0.827(0.656,1.042)
Marital status	living alone	1	1
	Married	1.187(1.087, 1.296)*	0.865(0.576, 1.301)
	Divorced/widowed	1.083(0.990, 1.184)	0.639(0.460, 0.888)*
Pregnancy complications	No	1	1
	Yes	1.203(1.165, 1.242)*	0.859(0.569,1.297)
Occupation of women	Housewife	1	1
	Working	0.982(0.950, 1.016)	0.937(0.809, 1.085)
Terminated pregnancy	No	1	1
	Yes	1.039(0.986,1.094)	0.817(0.649, 1.027)

**Note:** 1 = reference category of the categorical variable.

\* Significant at 5% level of significance

The Bernoulli part also indicated that the estimated odds that the number of ANC service uptake becomes zero with who is living in the rural area was 2.25 (OR = 2.25; 95%CI: 1.78, 2.86) times that of urban women. The estimated odds the number of ANC service uptake becomes zero with women who attend primary education was 0.45 (OR =0.45; 95%CI: 0.39, 0.53) times that of the non-educated women. Similarly, the estimated odds the number of ANC service uptake becomes zero with husbands who have primary education was 0.63 (OR = 0.63; 95%CI: 0.54, 0.72) times that of the non-educated husbands. The estimated odds the number of ANC service uptake

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3 becomes zero with rich women was 0.57 (OR = 0.57; 95%CI: 0.48, 0.67) times that of the poor  
4 wealth index. The odds of the number of ANC service uptake becomes zero with husbands who  
5 work is 0.76 (OR = 0.76; 95%CI: 0.66, 0.88) times that of husbands without work. The estimated  
6 odds the number of ANC service uptake becomes zero with women who have used mass media  
7 was 0.61 (AOR = 0.61; 95%CI: 0.53, 0.71) times that of women who did not use any mass media  
8 (Table 4).  
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## 14 Discussion

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16 Antenatal care during pregnancy is important for the health of the mother and the development  
17 of the fetus. Therefore, this study aimed at determining the magnitude and associated factors of  
18 ANC service uptake among pregnant women in Ethiopia. The results of this study showed that  
19 about 64.6 % of the pregnant women have utilized the service and 35.4% haven't received ANC  
20 services during their pregnancy which is less than that reported from 2016 EDHS urban  
21 Ethiopia<sup>19</sup>. It's also less than reported from the studies conducted in different parts of Ethiopia<sup>12</sup>  
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28 The findings of this study revealed that education had a positive relationship with ANC service  
29 uptake, that is; the amount of ANC service uptake increase with the rise in woman's and  
30 husband's education level. The study shows an identical result with other studies<sup>15 20 25 31-35</sup>,  
31 which revealed that non-educated women and husbands were fewer ANC attendants than those  
32 that have educated women. The possible justification behind this could be that educated women  
33 have taken more ANC because they have more awareness of the benefits of regular ANC uptake,  
34 such as reducing risks of pregnancy and ensuring safe childbirth. Educated husbands may have  
35 better communication with their wives and may be able to explore the importance of ANC  
36 uptake and other maternal health services<sup>36</sup>. This could also provide their wives with more  
37 freedom as well<sup>37</sup>.  
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39 The uptake of ANC services among married women was higher compared to women living  
40 alone. This finding is consistent with the studies conducted in Ethiopia<sup>15</sup>, Kenya<sup>32</sup>, Rwanda<sup>38</sup>  
41 and Bangladesh<sup>35</sup>. This may be attributed to the psychological and economic support obtained  
42 from their husbands, planning/desirability of their pregnancy and the societal acceptability and  
43 support of their pregnant state when compared with their unmarried women.  
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45 Wealth index has been negatively correlated with the use of ANC services. Relative to the richest  
46 wealth quintile, women belonging to the lowest wealth quintiles were less likely to uptake ANC  
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3 service. Studies elsewhere have also documented a positive relationship between economic status  
4 and ANC service uptake<sup>17 21 22 31 35 39</sup>. The possible justification of this finding might be that rich  
5 women may obtain more ANC information from mass media and may have greater access to  
6 health care. In addition, this may be attributed to the indirect cost of antenatal care, such as  
7 transport cost, while traveling to distant health facility<sup>40</sup>.  
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12 Compared to rural women, women living in urban areas were more likely to utilize ANC service.  
13 This finding is supported by the studies conducted in<sup>16 17 33 41</sup>. The potential reason may be that  
14 urban women had a better education, access to health services and more informed about the  
15 importance of ANC service uptake. The exposure of mass media was positively associated with  
16 ANC services. Women who were exposed to media were more ANC service uptake than women  
17 who weren't exposed to media. This finding is in line with reports of other previous studies<sup>17 23 33</sup>  
18 <sup>35</sup>. Compared to housewife women, the number of ANC uptake among employed women was  
19 higher. This finding is similar to the study done in Kenya<sup>42</sup> and 31 sub-Saharan Africa countries  
20 <sup>43</sup> which showed that the odds of antenatal care utilization were higher among working women  
21 than non-working<sup>43</sup>. This may be due to the fact that employed women, especially those in the  
22 formal sector, have the ability to benefit from a pregnancy care health insurance system. The  
23 finding indicated that women who did develop pregnancy complications were more likely to  
24 uptake ANC service than those who did not develop pregnancy complications. This finding is in  
25 line with studies done in Ethiopia<sup>44</sup>, Northern Jordan<sup>24</sup> and Tanzanian<sup>25</sup> and Pakistan<sup>25</sup>.  
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38 Relative to unplanned/unwanted pregnancies, women whose pregnancies were planned and  
39 desired were more likely to use ANC services. These findings were consistent with previous  
40 studies<sup>22-24 32</sup>. Results also showed that the number of ANC visit increased significantly as the  
41 age of women increased. Previous studies supported that women's age plays a big role in the  
42 utilization of maternal health care<sup>12 20</sup>.  
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### 46 **Strengths and limitation**

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48 This study used EDHS data with a large sample size and high-quality data which reduced the risk  
49 of sampling bias and measurement bias. The result of this study also providing timely evidence  
50 for policymakers and health sectors to reducing levels of maternal and infant mortality depends  
51 on increasing the use of reproductive and maternal health services. The study is also able to  
52 provide other researchers with flawless information about how to use over dispersed excesses  
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3 zero and zero-inflated Poisson regression model. Due to the cross-sectional study design, It is  
4 difficult to measure the causal effects and impossible to know whether the data are time-  
5 dependent or not.  
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## 8 **Conclusion**

9  
10 About 64.6 percent of the pregnant women have utilized the service and only 35.5 percent of the  
11 pregnant women have received at least four ANC visits. ANC service uptake in Ethiopia is  
12 extremely low and below average as compared to the minimum requirement of ANC service  
13 uptake recommended by WHO. This study was revealed that rural women, poor women, lower  
14 maternal and paternal education, mothers not having access to mass media, living alone women,  
15 mothers who have not complicated pregnancy was significantly associated with less number of  
16 ANC service utilization. This low magnitude of ANC service utilization calls for a need for  
17 improving community awareness on maternal health. More importantly, intensive health  
18 education is required for pregnant women to have better ANC service uptake and follow-up  
19 adherence.  
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35

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38

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40

41 **Patient consent for publication:** Not required.  
42

43 **Data sharing statement:** The survey datasets used in this study was based on a publicly  
44 available dataset that is freely available online with no participant's identity  
45 from <http://www.dhsprogram.com/data/available-datasets.cfm>.  
46

47 **Ethics approval and consent to participate:** The study used available secondary data accessed  
48 under the National Data Sharing and Accessibility Policy (NDSAP) of the Government of  
49 Ethiopia. The data set had no identifiable information on the survey participants; therefore, no  
50 ethical approval is required for this work.  
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54 **Provenance and peer review:** Not commissioned; externally peer reviewed.  
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**Abbreviations:** ANC: Antenatal Care; AOR: Adjusted Odd Ratio; EDHS: Ethiopian Demographic and Health Survey; HSTP: Health Sector Transformation Plan; IR: Incidence Rate; SDG: Sustainable development Goal; WHO: World Health Organization; ZIP: Zero Inflated Regression Poisson

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## Magnitude of Antenatal Care Service uptake and associated factors among Pregnant Women: analysis of the 2016 Ethiopia demographic and health survey

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3 **Magnitude of Antenatal Care Service uptake and associated factors among Pregnant**  
4 **Women; analysis of the 2016 Ethiopia demographic and health survey**  
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8 Setegn Muche Fenta\*<sup>1</sup>and Girum Meseret Ayenew<sup>2</sup>  
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10 <sup>1</sup>Department of Statistics, Debre Tabor University. Box272 Debre Tabor, Ethiopia.  
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12 <sup>2</sup>Research and Technology Transfer Directorate, Amhara Public Health Institute, P.O. Box 477  
13 Bahir Dar, Ethiopia; [girum.m21@gmail.com](mailto:girum.m21@gmail.com)  
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17 **\*Corresponding:** [setegn14@gmail.com](mailto:setegn14@gmail.com)  
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## Abstract

**Objective:** Antenatal and postnatal cares are crucial for the survival and well-being of both the mother and the child. World Health Organization recommends a minimum of four antenatal care visits during a pregnancy. In Ethiopia, only 38% of women in the reproductive age received a minimum of first antenatal care visits. This value is far more below the typical rates of least developed countries. This study aimed to calculate the magnitude and identify associated factors of antenatal care service utilization among pregnant women in Ethiopia.

**Design:** Cross-sectional study design

**Setting:** Ethiopian.

**Participants:** A total of 7913 pregnant women were included in the study.

**Primary outcome measures:** Antenatal Care Service uptake among Pregnant

**Result:** Only 35.5% of the pregnant mothers have utilized antenatal care services at least four times and 64.5% of the pregnant mothers have utilized less than three times during their periods of pregnancy. The study showed that rich women (PR=1.077, 95% CI: 1.029,1.127), having access to mass media (PR=1.086, 95% CI: 1.045, 1.128), having pregnancy complications (PR=1.203, 95% CI: 1.165, 1.242), secondary school and above-educated women (PR=1.112, 95% CI:1.052, 1.176), husbands' having secondary school and above level of education (PR=1.085, 95% CI: 1.031, 1.142), being married (PR = 1.187; 95% CI: 1.087,1.296), rural women (PR=0.884, 95% CI: 0.846, 0.924) and women age >30 years (PR=1.067, 95% CI: 1.024, 1.111) were significantly associated with the antenatal care service uptake.

**Conclusion:** The magnitude of ANC service uptake was low. This low magnitude of ANC service utilization calls for a need for improving community awareness on maternal health. More importantly, intensive health education is required for pregnant women to have better ANC service uptake and follow-up adherence.

**Keywords:** Antenatal Care services uptake, Ethiopia, Zero Inflated Poisson Regression Model

### Strengths and limitation

- Large sample size and high-quality data reduced the risk of sampling and measurement bias.
- Timely evidence for policymakers to reduce maternal and infant mortality.
- Gives flawless information to the scientific community about how to use over dispersed and excesses zero data.
- Unable to measure the causal effects, and impossible to know whether the data are time-dependent or not.
- DHS did not include information on distance to a health facility and the quality of healthcare that could affect the uptake of ANC service.

## Introduction

Maternal mortality is one of the most significant health problems in low and middle income country<sup>1 2</sup>. Worldwide; about 295, 000 maternal deaths, 2.4 million newborn and 2 million stillbirths occur each year and most causes of these death were found to be preventable which are associated with pregnancy and childbirth. Around 99% of these deaths have occurred in developing countries including Ethiopia. About 85% of the total global maternal deaths occurred in Sub-Saharan Africa and Southern Asia, of which two-thirds were from sub-Saharan Africa<sup>3-5</sup>. The maternal mortality rate in developing countries in the year 2015 is 239 per 100 000 live births and 12 per 100,000 live births in developed countries<sup>6 7</sup>. In Ethiopia, the maternal mortality rate is 412 deaths per 100,000 live births. This indicates a female lifetime hazard of maternal death is 1 in 243 Ethiopia<sup>7 8</sup>.

Antenatal and postnatal cares are crucial for the survival and well-being of both the mother and the child. Antenatal care (ANC) helps women to prepare for childbirth and consider the warning signs during pregnancy and birth<sup>9</sup>. The World Health Organization (WHO) suggested encouraging the positive experience of ANC pregnancy and increasing the recommended number of ANC visits from four to eight by 2018. However, it revealed that only 64 percent of women worldwide had  $\geq$  four ANC visit<sup>9 10</sup>. In Ethiopia, about sixty-two percent of women didn't attend a minimum of four ANC visits throughout their pregnancy<sup>8</sup>. Health Sector Transformation Plan of the Ethiopian Federal Ministry of Health addresses troubles associated with having targeted ANC with a minimal of four visits consistent with pregnancy as mainstream in the least provider delivery levels with a target to grow the proportion from 68% to 95 % at the highest by 2020<sup>11</sup>. But, according to the Ethiopia Demography and Health Survey (EDHS) 2016, the ANC service utilization with a minimum of four visits is merely 32%<sup>8</sup>. This indicated that ANC going to in Ethiopia immobile underneath any suitable standard.

Previous research in Ethiopia has been covered in small geographical regions and there is no sufficient study nationwide to the best knowledge of the authors<sup>12-17</sup>. These studies also investigated the associated factor of antenatal care service utilization through binary logistic. While binary logistic regression undercounts the total number of antenatal care visit since multiple service utilization is collapsed into a single unit to fulfill the requirements of binary logistic regression, provides sufficient information for studying the pattern of multiple service

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3 utilization. In this study, the Zero-Inflated Poisson regression model is the preferred model of  
4 analysis since the Zero-Inflated Poisson regression model provides a way of modeling the  
5 excessive proportion of zero values by allowing over dispersion. When the number of zeros is  
6 large, provides a good fit than Poisson or negative binomial model<sup>18</sup>. Therefore, this study aimed  
7 to calculate the magnitude and identify associated factors of ANC service uptake for the country  
8 at large.  
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## 14 **Method**

### 16 **Patient and public involvement**

18 This study used a publicly available data set (EDHS 2016); therefore, there were no patients or  
19 members of the public involved.  
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### 22 **Data source**

24 The data used for this study were taken from the 2016 EDHS. This survey is the fourth  
25 compressive survey designed to provide estimates for the health and demographic variables of  
26 interest for the whole urban and rural areas of Ethiopia as a domain. Women who had 9 months  
27 of pregnancy during the survey interview were included in the analysis. The study includes 7193  
28 of the reproductive age group within the country.  
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### 32 **Sampling Design**

34 The EDHS 2016 employed a stratified two-stage cluster sampling procedure designed to provide  
35 a representative sample for multiple health and population indicators at national and sub-national  
36 levels (nine regions and two city administrations). Initially, 645 Enumeration Areas (EAs) (202  
37 in urban areas and 443 in rural areas) were drawn using Probability Proportional to Size (PPS)  
38 sampling approach from a whole list of 84,915 EAs defined within the recent 2007 population  
39 census. Then in every selected EA, an exhaustive listing of households was made and 28  
40 households were selected using a systematic sampling approach. Within the chosen households,  
41 enumeration of the entire members was made and information about the ANC service utilization  
42 among all household members was collected primarily from the women<sup>19</sup>.  
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### 51 **Study variables**

52 The outcome variable of interest in this study was a count response of the number of ANC visits  
53 during their last pregnancy. The independent variables of this study were selected by reviewing  
54 related work of literature<sup>12-17 20-25</sup>. Women educational level (no education, primary, secondary  
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and higher), husband's occupation (not working, working), wealth index (poor, middle, rich), marital status (living alone, married, Divorced/widowed), women occupation (housewife, employed), age of women (15–24, 25–29 and  $\geq 30$  years), husbands educational level (no education, primary, secondary and higher), planned pregnancy (yes, no), access to mass media (yes, no), pregnancy complications (yes, no), the desire of pregnancy (yes, no), history of terminated pregnancy ever in her life (yes, no) and residence (urban, rural) were considered to be a possible independent variable within the study.

### Data management and analysis

The cleaned and recoded data were analyzed using R software version 3.5.3. Frequencies and percentages were used to describe the categorical variables. Data were presented using tables. Zero Inflated Poisson Regression (ZIPR) model was conducted to identify factors associated with antenatal care service utilization among pregnant. In recent years, the ZIPR model has gained popularity for modeling count data with excess zeroes<sup>18</sup>. The ZIP models can be viewed as a finite mixture model with a degenerate distribution whose mass is concentrated at zero. Excess zeroes arise when the event of interest is not experienced by many of the subjects<sup>26</sup>. In this study, the ZIPR model was employed to identify the determinant factors of ANC service uptake among pregnant women. Suppose  $Y_i$  is the number of ANC service uptake among pregnant then, the probability mass function of ZIPR is given by<sup>18 27 28</sup>

$$p(Y_i = y_i) = \begin{cases} \pi_i + (1 - \pi_i) \exp(-\mu_i), & \text{if } y_i = 0 \\ (1 - \pi_i) \frac{\exp(-\mu_i) \mu_i^{y_i}}{y_i!}, & \text{if } y_i = 1, 2, 3, \dots \end{cases} \quad 0 \leq \pi_i \leq 1$$

The parameter  $\mu_i$  and  $\pi_i$  depends on the covariates  $x_i$  and  $z_i$ , respectively. The mean and the variance of ZIP regression model, respectively, are:

$E(y_i) = (1 - \pi_i)\mu_i$  and  $Var(y_i) = \mu_i(1 - \pi_i)(1 + \pi_i\mu_i)$ . To apply the ZIPR model in practical modeling situations,<sup>18 27 28</sup> suggested the following joint models for  $\mu$  and  $\pi$

$\ln(\mu) = X^T\beta$  and  $\ln\left(\frac{\pi}{1-\pi}\right) = Z^T\gamma$  where  $X$  and  $Z$  are covariate matrices and  $\beta, \gamma$  are  $(p + 1) \times 1$  and  $(q + 1) \times 1$  vectors of unknown parameters respectively. The two sets of covariates may or may not coincide. Finally, the odds ratio (OR) and prevalence ratios (PR) with a 95% confidence interval (CI) were used to assess the strength of associations between the outcome and the

independent variables using Poisson and Bernoulli regression models' assumptions. P-values of  $\leq 0.05$  were considered for statistically significant.

### Ethical Issues

Publicly available EDHS 2016 data were used for this study. Informed consent was taken from each participant, and all identifiers were removed

### Results

From a total of 7913 pregnant women, 64.6 % of the pregnant women have utilized the service, 35.4% of the pregnant women didn't receive any ANC service and 35.5% of the pregnant women have received at least four ANC visits. The mean and variance of observation are 2.53 and 5.614, respectively. The variance to mean ratio is 2.22, which indicates some over-dispersion (Table 1).

**Table 1: The number of women that experienced ANC visits**

Number of visits	Count	Percent
0	2545	35.4
1	342	4.8
2	563	7.8
3	1187	16.5
4	1136	15.8
5	621	8.6
6	402	5.6
7	187	2.6
8+	108	2.9
Total	7193	100.0
Mean	2.53	
Variance	5.614	

### Test of over dispersion

The Pearson residual  $\chi^2$ -statistic for Poisson and ZIP model was summarized in Table 2. The Pearson dispersion value of the Poisson model is 1.829 ( $p < 0.001$ ), which clearly shows the existence of over-dispersion in the data and the Poisson model is over-dispersed. It follows that the options for modeling and analyzing such over dispersed and excess zero ANC count response data should be considered. Then fit ZIP and 1.001 is the Pearson dispersion value. This indicates that the ZIP has modeled and captured the over-dispersion in the data set very well; because the dispersion value is very close to 1. For this reason, ZIP model used for the analysis in order to identify the associated factors of ANC service uptake (Table 2).

**Table 2: Test of over-dispersion based on Pearson residual  $\chi^2$ -statistic**

Model	Dispersion Test (Ratio Statistic & P-value)
Poisson	1.829(0.001)
ZIP	1.001 ( 0.004)

### Socio-demographic characteristics of study participants

The majority of the study respondents were from rural residences (79%). Most of the respondents were housewives (70%) and 30% of the respondents were employed. About 60.6% of mothers didn't attend primary school and only 12.4% of mothers attended secondary and above education. The majority (69.4%) of the respondents had no pregnancy complications and 64.4% had no access to mass media. About 91.5 percent of women were married, 3.2 percent of women were living alone women while 5.3% were divorced and widowed. The majorities (79.8%) of the pregnancies were planned and 9% of the pregnancies were terminated. Regarding husband education, 31.7% of the husband had no formal education while 30% of husbands attend primary education. About half (50.7%) of women had poor wealth index, 35.0% were rich wealth while others were middle wealth index (14.3%). Regarding the mother age, the majorities (46.2%) of mothers were under the age group of 30 years plus, then followed 25-29 years (Table 3).

### Magnitude of ANC services uptake by socio-demographic characteristics of study participants

The mean and median numbers of ANC visits by socio-demographic characteristics of study participants are shown in Table 3. The mean numbers of ANC visits for urban women (4.26)

were higher than for rural women (2.07). Among poor women, the lowest mean numbers of ANC visits were recorded (1.71). The lowest mean numbers of ANC visits were observed for uneducated husbands (1.93), while the highest mean numbers of ANC visits were observed for husbands with secondary education and above (3.83). Women exposed to the media had the highest mean numbers of ANC visits (3.65), while the mean numbers of ANC visits for women not exposed to the media were low (1.92). The lowest mean numbers of ANC visits occur in uneducated women (1.88), while the highest mean numbers of ANC visits have been recorded for women with secondary education and above (4.36). Compared with women who had no symptoms of pregnancy problems (1.78), women who had seen signs of pregnancy complications had a higher mean number of ANC visits (4.28) (Table 3).

Table 3: Magnitude of ANC services uptake by socio-demographic characteristics of study participants and the associated Chi-Square ( $\chi^2$ ) test for equality of the medians

Characteristics		Frequency (%)	Mean	Median
Residence	Urban	1512(21.0)	4.26	4
	Rural	5681(79.0)	2.07	2
Occupation of women	Housewife	5033(70.0)	2.37	2
	Employed	2160(30.0)	2.92	3
Planned pregnancy	No	1452(20.2)	2.53	3
	Yes	5741(79.8)	2.54	3
Terminated pregnancy	No	6556(91.1)	2.51	3
	Yes	637(8.9)	2.79	3
Wealth index	Low	3607(50.7)	1.71	1
	Medium	1028(14.3)	2.47	3
	Rich	2558(35.0)	3.71	4
Marital status	Never married	230(3.2)	2.52	3
	Married	6579(91.5)	3.26	4
	Divorced/widowed	384(5.3)	2.56	3
Age of women in a year	15-24	1852(25.1)	2.60	3
	25-29	2015(28.1)	2.73	3

	30 and above	3326(46.2)	2.38	3
Husband education	No education	3719(51.7)	1.93	1
	Primary	2160(30.0)	2.79	3
	Secondary and above	1314(18.3)	3.83	4
Woman education	No education	4359(60.6)	1.88	1
	Primary	1942(27.0)	3.15	3
	Secondary and above	892(12.4)	4.36	4
Access to mass media	No	4646(64.6)	1.92	1
	Yes	2547(35.4)	3.65	4
Pregnancy complications	No	5015(69.7)	1.78	1
	Yes	2178(30.3)	4.28	4
Husband's occupation	Not working	1285(17.9)	2.19	2
	Working	5908(82.1)	2.61	3

### Factors associated with ANC service uptake, application of Zero Inflated Poisson regression models

As shown in the below table (Table 4), the Poisson component shows that the prevalence ratios (PR) of ANC visits. The finding of this study revealed that women's and husbands' levels of education have had a significant factor in ANC service uptake. The expected number of ANC service uptake for women with primary education was 1.06 (PR =1.06; 95%CI: 1.02, 1.10) times higher compared to women with no formal education. The expected number of ANC service uptake for women with secondary and above education was 1.11 (PR =1.11; 95% CI: 1.05, 1.18) times higher compared to women with no formal education. The expected number of ANC service uptake for husbands with primary education was 1.05 (PR =1.05; 95% CI: 1.01, 1.10) times higher compared to husbands with no formal education. Similarly, ANC service uptake for husbands with secondary and above education increased by 9% (PR =1.09; 95%CI: 1.03, 1.14) times higher compared to husbands with no formal education. The expected number of ANC service uptake of the rural women was 0.88 (PR =0.88; 95%CI: 1.85, 1.92) times lower compared to urban women. The expected number of ANC service uptake for the rich wealth

index was 1.08 (PR =1.08; 95% CI: 1.03, 1.13) times higher compared to their poor wealth index. The expected number of ANC service uptake for married women was 1.19 (PR =1.19; 95% CI: 1.09, 1.30) times higher compared to living alone women. The expected number of ANC service uptake for women who had seen signs of pregnancy complications was 1.20 (PR =1.20; 95% CI: 1.17, 1.24) times higher compared to those women who had no signs of pregnancy complication. The expected number of ANC service uptake for women using mass media was 1.09 (PR =1.09; 95% CI: 1.05, 1.13) times higher compared to those who don't use mass media. The expected number of ANC service uptake for mothers in the age group of 25-29 was 1.06 (PR =1.06; 95% CI: 1.02, 1.10) times higher compared with the age group of 15-24 years. The expected number of ANC service uptake for mothers age 30 and above was 1.07 (PR =1.07; 95% CI: 1.02, 1.11) times higher compared with the age group of 15-24 years (Table 4).

Table 4: Factors associated with ANC service uptake, application of application of Zero Inflated Poisson regression models

Characteristics		Poisson part PR (95% CI of PR)	Bernoulli part AOR (95%CI of AOR)
Residence	Urban	1	1
	Rural	0.884(0.846, 0.924) *	2.254(1.780, 2.855)*
Access to mass media	No	1	1
	Yes	1.086(1.045, 1.128) *	0.612(0.525,0.713)*
Planned pregnancy	No	1	1
	Yes	1.028( 0.989, 1.069)	0.794(0.685, 0.920*
Husbands occupation	Not working	1	1
	Working	1.017(0.959, 1.077)	0.761(0.655,0.884)*
Wealth index	Low	1	1
	Medium	1.039(0.989, 1.093)	0.594(0.501, 0.704)*
	Rich	1.077( 1.029, 1.127)*	0.568(0.479, 0.672)*
Women's education	No education	1	1
	Primary	1.057(1.015, 1.101)*	0.454(0.388, 0.531)*
	Secondary and above	1.112(1.052, 1.176)*	0.389(0.286, 0.530)*
Husband education	No education	1	1
	Primary	1.052(1.010, 1.096)*	0.625(0.542, 0.721)*
	Secondary and above	1.085(1.031, 1.142)*	0.666(0.532, 0.836)*
Age of women (year)	15-24	1	1
	25-29	1.060(1.016, 1.104)*	0.991(0.830, 1.184)
	30 and above	1.067(1.024, 1.111)*	0.827(0.656,1.042)
Marital status	living alone	1	1

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	Married	1.187(1.087, 1.296)*	0.865(0.576, 1.301)
	Divorced/widowed	1.083(0.990, 1.184)	0.639(0.460, 0.888)*
Pregnancy complications	No	1	1
	Yes	1.203(1.165, 1.242)*	0.859(0.569, 1.297)
Occupation of women	Housewife	1	1
	Working	0.982(0.950, 1.016)	0.937(0.809, 1.085)
Terminated pregnancy	No	1	1
	Yes	1.039(0.986, 1.094)	0.817(0.649, 1.027)

**Note:** 1 = reference category of the categorical variable.

\* Significant at 5% level of significance

The Bernoulli part also indicated that the estimated odds that the number of ANC service uptake becomes zero with who is living in the rural area was 2.25 (OR = 2.25; 95%CI: 1.78, 2.86) times that of urban women. The estimated odds the number of ANC service uptake becomes zero with women who attend primary education was 0.45 (OR = 0.45; 95%CI: 0.39, 0.53) times that of the non-educated women. Similarly, the estimated odds the number of ANC service uptake becomes zero with husbands who have primary education was 0.63 (OR = 0.63; 95%CI: 0.54, 0.72) times that of the non-educated husbands. The estimated odds the number of ANC service uptake becomes zero with rich women was 0.57 (OR = 0.57; 95%CI: 0.48, 0.67) times that of the poor wealth index. The odds of the number of ANC service uptake becomes zero with husbands who work is 0.76 (OR = 0.76; 95%CI: 0.66, 0.88) times that of husbands without work. The estimated odds the number of ANC service uptake becomes zero with women who have used mass media was 0.61 (AOR = 0.61; 95%CI: 0.53, 0.71) times that of women who did not use any mass media (Table 4).

## Discussion

Antenatal care during pregnancy is important for the health of the mother and the development of the fetus. Therefore, this study aimed at determining the magnitude and associated factors of ANC service uptake among pregnant women in Ethiopia. The results of this study showed that about 64.6 % of the pregnant women have utilized the service and 35.4% haven't received ANC services during their pregnancy which is less than that reported from 2016 EDHS urban Ethiopia<sup>19</sup>. It's also less than reported from the studies conducted in different parts of Ethiopia<sup>12</sup>  
29 30.

The findings of this study revealed that education had a positive relationship with ANC service uptake, that is; the amount of ANC service uptake increase with the rise in woman's and

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3 husband's education level. The study shows an identical result with other studies<sup>15 20 25 31-35</sup>,  
4 which revealed that non-educated women and husbands were fewer ANC attendants than those  
5 that have educated women. The possible justification behind this could be that educated women  
6 have taken more ANC because they have more awareness of the benefits of regular ANC uptake,  
7 such as reducing risks of pregnancy and ensuring safe childbirth. Educated husbands may have  
8 better communication with their wives and may be able to explore the importance of ANC  
9 uptake and other maternal health services<sup>36</sup>. This could also provide their wives with more  
10 freedom as well<sup>37</sup>.

11 The uptake of ANC services among married women was higher compared to women living  
12 alone. This finding is consistent with the studies conducted in Ethiopia<sup>15</sup>, Kenya<sup>32</sup>, Rwanda<sup>38</sup>  
13 and Bangladesh<sup>35</sup>. This may be attributed to the psychological and economic support obtained  
14 from their husbands, planning/desirability of their pregnancy and the societal acceptability and  
15 support of their pregnant state when compared with their unmarried women.

16 Wealth index has been negatively correlated with the use of ANC services. Relative to the richest  
17 wealth quintile, women belonging to the lowest wealth quintiles were less likely to uptake ANC  
18 service. Studies elsewhere have also documented a positive relationship between economic status  
19 and ANC service uptake<sup>17 21 22 31 35 39</sup>. The possible justification of this finding might be that rich  
20 women may obtain more ANC information from mass media and may have greater access to  
21 health care. In addition, this may be attributed to the indirect cost of antenatal care, such as  
22 transport cost, while traveling to distant health facility<sup>40</sup>.

23 Compared to rural women, women living in urban areas were more likely to utilize ANC service.  
24 This finding is supported by the studies conducted in <sup>16 17 33 41</sup>. The potential reason may be that  
25 urban women had a better education, access to health services and more informed about the  
26 importance of ANC service uptake. The exposure of mass media was positively associated with  
27 ANC services. Women who were exposed to media were more ANC service uptake than women  
28 who weren't exposed to media. This finding is in line with reports of other previous studies<sup>17 23 33</sup>  
29 <sup>35</sup>. Compared to housewife women, the number of ANC uptake among employed women was  
30 higher. This finding is similar to the study done in Kenya<sup>42</sup> and 31 sub-Saharan Africa countries  
31 <sup>43</sup> which showed that the odds of antenatal care utilization were higher among working women  
32 than non-working <sup>43</sup>. This may be due to the fact that employed women, especially those in the  
33 formal sector, have the ability to benefit from a pregnancy care health insurance system. The  
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3 finding indicated that women who did develop pregnancy complications were more likely to  
4 uptake ANC service than those who did not develop pregnancy complications. This finding is in  
5 line with studies done in Ethiopia<sup>44</sup>, Northern Jordan <sup>24</sup> and Tanzanian<sup>25</sup> and Pakistan<sup>25</sup>.  
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9 Relative to unplanned/unwanted pregnancies, women whose pregnancies were planned and  
10 desired were more likely to use ANC services. These findings were consistent with previous  
11 studies<sup>22-24 32</sup>. Results also showed that the number of ANC visit increased significantly as the  
12 age of women increased. Previous studies supported that women's age plays a big role in the  
13 utilization of maternal health care<sup>12 20</sup>.  
14  
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### 16 17 18 **Strengths and limitation**

19 This study used EDHS data with a large sample size and high-quality data which reduced the risk  
20 of sampling bias and measurement bias. The result of this study also providing timely evidence  
21 for policymakers and health sectors to reducing levels of maternal and infant mortality depends  
22 on increasing the use of reproductive and maternal health services. The study is also able to  
23 provide other researchers with flawless information about how to use over dispersed excesses  
24 zero and zero-inflated Poisson regression model. Due to the cross-sectional study design, It is  
25 difficult to measure the causal effects and impossible to know whether the data are time-  
26 dependent or not. The other limitation was that DHS did not include information on distance to a  
27 health facility and the quality of healthcare that could affect the uptake of ANC service.  
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### 30 31 32 **Conclusion**

33 About 64.6 percent of the pregnant women have utilized the service and only 35.5 percent of the  
34 pregnant women have received at least four ANC visits. ANC service uptake in Ethiopia is  
35 extremely low and below average as compared to the minimum requirement of ANC service  
36 uptake recommended by WHO. This study was revealed that rural women, poor women, lower  
37 maternal and paternal education, mothers not having access to mass media, living alone women,  
38 mothers who have not complicated pregnancy was significantly associated with less number of  
39 ANC service utilization. This low magnitude of ANC service utilization calls for a need for  
40 improving community awareness on maternal health. More importantly, intensive health  
41 education is required for pregnant women to have better ANC service uptake and follow-up  
42 adherence.  
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**Competing interests:** None declared.

**Patient consent for publication:** Not required.

**Data sharing statement:** The survey datasets used in this study was based on a publicly available dataset that is freely available online with no participant's identity from <http://www.dhsprogram.com/data/available-datasets.cfm>.

**Ethics approval and consent to participate:** The study used available secondary data accessed under the National Data Sharing and Accessibility Policy (NDSAP) of the Government of Ethiopia. The data set had no identifiable information on the survey participants; therefore, no ethical approval is required for this work.

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**Abbreviations:** ANC: Antenatal Care; AOR: Adjusted Odd Ratio; EDHS: Ethiopian Demographic and Health Survey; HSTP: Health Sector Transformation Plan; IR: Incidence Rate; SDG: Sustainable development Goal; WHO: World Health Organization; ZIP: Zero Inflated Regression Poisson

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STROBE Statement—Checklist of items that should be included in reports of *cross-sectional studies*

bmjopen-2020-043904.R2 - "Magnitude of Antenatal Care Service uptake and associated factors among Pregnant Women: analysis of the 2016 Ethiopia demographic and health survey"

	Item No.	Recommendation	Page No.	Relevant text from manuscript
<b>Title and abstract</b>	1	(a) Indicate the study's design with a commonly used term in the title or the abstract	2	"Abstract Study's design, Paragraph 2, line 37"
		(b) Provide in the abstract an informative and balanced summary of what was done and what was found	2	"Abstract, objective section Paragraph 1 and Result section Paragraph 6"
<b>Introduction</b>				
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4	"Introduction, paragraph 1, paragraph 2 and paragraph 3"
Objectives	3	State specific objectives, including any prespecified hypotheses	5	"Introduction, paragraph 3, line 128 and 129"
<b>Methods</b>				
Study design	4	Present key elements of study design early in the paper	5	"Methods, paragraph 3, Sampling Design, line 142 and 143"
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	5	"Methods, paragraph 2/data source, line 136-140"
Participants	6	Give the eligibility criteria, and the sources and methods of selection of participants	5	"Methods, paragraph 2/data source line 138 -140 and Paragraph 3/Sampling Design line 142-150"
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	6	"Methods, paragraph 3/ Study variables, line 152-161"
Data sources/measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	6	"Methods, paragraph 3/ Study variables, line 152-161"
Bias	9	Describe any efforts to address potential sources of bias	5	"Methods, Paragraph 3/Sampling Design line 142-150"
Study size	10	Explain how the study size was arrived at	5	"Methods, paragraph 2/data source, line 138-140"

Continued on next page

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2	Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	6	“Methods, paragraph 5/Data management and analysis, line 163&164”
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6	Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding	6	“Methods, paragraph 5/Data management and analysis, line 165 -183”
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10			(b) Describe any methods used to examine subgroups and interactions	6	“Methods, paragraph 5/Data analysis”
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13			(c) Explain how missing data were addressed	6	“Methods, paragraph 5/Data analysis line 180-183”
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16			(d) If applicable, describe analytical methods taking account of sampling strategy		“N/A”
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19			(e) Describe any sensitivity analyses		“N/A”
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21	<b>Results</b>				
22	Participants	13*	(a) Report numbers of individuals at each stage of study— e.g., numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	7	“Result, Paragraph 1 line 188-191”
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27			(b) Give reasons for non-participation at each stage		“N/A”
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29			(c) Consider use of a flow diagram		“N/A”
30	Descriptive data	14*	(a) Give characteristics of study participants (e.g., demographic, clinical, social) and information on exposures and potential confounders	8	“Result, Paragraph 3 line 206 -216 or Table 3”
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33			(b) Indicate number of participants with missing data for each variable of interest		“N/A”
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36			Report numbers of outcome events or summary measures	7	“Result, Paragraph 1 line 188 -192 or table 1”
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39	Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	11	“Result, Paragraph 5 line 237-260 or table 4 /”
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44			(b) Report category boundaries when continuous variables were categorized	8	“Result, Paragraph 3/ line 232 and 233 or Table 3
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48			(c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period		“N/A”
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2	Other analyses	17	Report other analyses done—e.g., analyses of subgroups and interactions, and sensitivity analyses	“N/A”
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5	<b>Discussion</b>			
6	Key results	18	Summarise key results with reference to study objectives	13 “Discussion, Paragraph 1 line 280-285”
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9	Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	14 “Strengths and limitation of study, Paragraph 1 line 329-337”
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13	Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	13-14 “Discussion, Paragraph 2 to 5 line 287 -327”
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18	Generalizability	21	Discuss the Generalizability (external validity) of the study results	14 “Conclusion, Paragraph 1 line 340 -349”
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21	<b>Other information</b>			
22	Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	“Funding line 355 &354”
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\*Give information separately for exposed and unexposed groups.

\*N/A

# BMJ Open

## Magnitude of Antenatal Care Service uptake and associated factors among Pregnant Women: analysis of the 2016 Ethiopia demographic and health survey

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Secondary Subject Heading:	Intensive care, Public health
Keywords:	Antenatal < GENETICS, Health & safety < HEALTH SERVICES ADMINISTRATION & MANAGEMENT, Health policy < HEALTH SERVICES ADMINISTRATION & MANAGEMENT

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3 **Magnitude of Antenatal Care Service uptake and associated factors among Pregnant**  
4 **Women; analysis of the 2016 Ethiopia demographic and health survey**  
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8 Setegn Muche Fenta\*<sup>1</sup>, Girum Meseret Ayenew<sup>2</sup>, Berhanu Engidaw Getahun<sup>3</sup>  
9

10 <sup>1</sup>Department of Statistics, Debre Tabor University. Box272 Debre Tabor, Ethiopia.  
11

12 <sup>2</sup>Research and Technology Transfer Directorate, Amhara Public Health Institute, P.O. Box 477  
13 Bahir Dar, Ethiopia; [girum.m21@gmail.com](mailto:girum.m21@gmail.com)  
14

15 <sup>3</sup>Department of English language and Literature, Bahir Dar University, Bahir Dar, Ethiopia;  
16 [bgsilvie47@gmail.com](mailto:bgsilvie47@gmail.com)  
17  
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20 \*Corresponding: [setegn14@gmail.com](mailto:setegn14@gmail.com)  
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## Abstract

**Objective:** Antenatal and postnatal cares are crucial for the survival and well-being of both the mother and the child. World Health Organization recommends a minimum of four antenatal care visits during a pregnancy. In Ethiopia, only 38% of women in the reproductive age make a minimum of first antenatal care visits. This value is far below the typical rates of least developed countries. This study aimed to calculate the magnitude and identify associated factors of antenatal care service utilization among pregnant women in Ethiopia.

**Design:** Cross-sectional study design

**Setting:** Ethiopia

**Participants:** A total of 7913 pregnant women participated in the study.

**Primary outcome measures:** Antenatal Care Service uptake among pregnant women

**Result:** Only 35.5% of the pregnant mothers have utilized antenatal care services at least four times and 64.5% of the pregnant mothers have utilized less than three times during their periods of pregnancy. The study showed that rich women (PR=1.077, 95% CI: 1.029,1.127), having access to mass media (PR=1.086, 95% CI: 1.045, 1.128), having pregnancy complications (PR=1.203, 95% CI: 1.165, 1.242), secondary school and above-educated women (PR=1.112, 95% CI:1.052, 1.176), husbands' having secondary school and above in their level of education (PR=1.085, 95% CI: 1.031, 1.142), married (PR = 1.187; 95% CI: 1.087,1.296), rural women (PR=0.884, 95% CI: 0.846, 0.924) and women >30 years of age (PR=1.067, 95% CI: 1.024, 1.111) significantly associated with the antenatal care service uptake.

**Conclusion:** The magnitude of ANC service uptake was low. This low magnitude of ANC service utilization calls for a need to improve community awareness about maternal health. More importantly, intensive health education is required for pregnant women to have better ANC service uptake and follow-up adherence.

**Keywords:** Antenatal Care services uptake, Ethiopia, Zero Inflated Poisson Regression Model

### Strengths and limitation

- The study provides a timely evidence for policymakers to reduce maternal and infant mortality.
- The study gives solid information to the scientific community about how to use over dispersed and excesses zero data.
- Large sample size and high-quality data reduced the risk of sampling and measurement bias.
- It was not possible to measure the causal effects, and know whether the data are time-dependent or not.
- DHS did not include information on distance to a health facility and the quality of healthcare that could affect the uptake of ANC service.

## Introduction

Maternal mortality is one of the most significant health problems in low and middle income countries<sup>1 2</sup>. Worldwide, about 295, 000 maternal deaths, 2.4 million newborn and 2 million stillbirths occur each year and most causes of these deaths were found to be not only preventable but also associated with pregnancy and childbirth. Around 99% of these deaths occurred in developing countries including Ethiopia. About 85% of the total global maternal deaths occurred in Sub-Saharan Africa and Southern Asia, two-thirds of it from sub-Saharan Africa<sup>3-5</sup>. The maternal mortality rate in developing countries in the year 2015 is 239 per 100 000 live births and 12 per 100,000 live births in developed countries<sup>6 7</sup>. In Ethiopia, the maternal mortality rate is 412 deaths per 100,000 live births. This indicates that in Ethiopia a female's lifetime hazard of maternal death is 1 in 243<sup>7 8</sup>.

Antenatal and postnatal cares are crucial to salvage the mother and the child. Antenatal care (ANC) helps women prepare for childbirth and contemplate the warning signs during pregnancy and birth<sup>9</sup>. The World Health Organization (WHO) suggested encouraging the positive experience of ANC pregnancy and increasing the recommended number of ANC visits from four to eight by 2018. However, it revealed that only 64 percent of women worldwide had  $\geq$  four ANC visit<sup>9 10</sup>. In Ethiopia, about sixty-two percent of women didn't attend a minimum of four ANC visits throughout their pregnancy<sup>8</sup>. Health Sector Transformation Plan of the Ethiopian Federal Ministry of Health addresses troubles associated with having targeted ANC with a minimal of four visits consistent with pregnancy as mainstream in the least provider delivery levels with a target to grow the proportion from 68% to 95 % at the highest by 2020<sup>11</sup>. But, according to the Ethiopian Demography and Health Survey (EDHS) 2016, the ANC service utilization with a minimum of four visits is merely 32%<sup>8</sup>. This indicated that in Ethiopia ANC went immobile underneath any suitable standard.

Previous research in Ethiopia covered in small geographical regions and there is no sufficient study nationwide to the best knowledge of the authors<sup>12-17</sup>. The studies investigated the associated factor of antenatal care service utilization through binary logistic. Binary logistic regression undercounts the total number of antenatal care visits. Thus, multiple service utilization is collapsed into a single unit to fulfill the requirements of binary logistic regression as it provides sufficient information for studying the pattern of multiple service utilization. Since the

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3 Zero-Inflated Poisson regression model provides a way of modeling the excessive proportion of  
4 zero values by allowing over dispersion, in this study, the Zero-Inflated Poisson regression  
5 model is the preferred model for analysis. It provides a good fit than Poisson or negative  
6 binomial model<sup>18</sup>, when the number of zeros is large. This study therefore, aimed to calculate  
7 the magnitude and identify associated factors of ANC service uptake for the country at large.  
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## 12 **Method**

### 14 **Patient and public involvement**

16 This study used a publicly available data set (EDHS 2016). Therefore, there were no patients or  
17 members of the public involved.  
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### 20 **Data source**

22 The data used for this study was taken from the 2016 EDHS. This survey is the fourth  
23 comprehensive survey designed to provide estimates for the health and demographic variables  
24 of interest for the whole urban and rural areas of Ethiopia as a domain. Women who had 9  
25 months of pregnancy during the survey interview were included in the analysis. The study  
26 includes 7193 cases of the reproductive age group within the country.  
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### 30 **Sampling Design**

32 The EDHS 2016 employed a stratified two-stage cluster sampling procedure designed to provide  
33 a representative sample for multiple health and population indicators at national and sub-national  
34 levels (nine regions and two city administrations). Initially, 645 Enumeration Areas (EAs) (202  
35 in urban areas and 443 in rural areas) were drawn using Probability Proportional to Size (PPS)  
36 sampling approach from a whole list of 84,915 EAs defined within the recent 2007 population  
37 census. Then, in every selected EA, an exhaustive listing of households was made and 28  
38 households were selected using a systematic sampling approach. Within the chosen households,  
39 enumeration of the entire members was made and information about the ANC service utilization  
40 among all household members was collected primarily from the women<sup>19</sup>.  
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### 49 **Study variables**

51 The outcome variable of interest in this study was a count response of the number of ANC visits  
52 during their last pregnancy. The independent variables of this study were selected by reviewing  
53 related work of literature<sup>12-17 20-25</sup>. Women's educational level (no education, primary, secondary  
54 and higher), husband's occupation (not working, working), wealth index (poor, middle, rich),  
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marital status(living alone, married, Divorced/widowed), women occupation (housewife, employed), age of women ( 15–24, 25–29 and  $\geq 30$  years), husbands educational level (no education, primary, secondary and higher), planned pregnancy (yes, no), access to mass media (yes, no), pregnancy complications (yes, no), the desire of pregnancy(yes, no), history of terminated pregnancy ever in her life (yes, no) and residence (urban, rural) were considered to independent variables within the study.

### Data management and analysis

The cleaned and recoded data were analyzed using R software version 3.5.3. Frequencies and percentages were used to describe the categorical variables. Data were presented using tables. Zero Inflated Poisson Regression (ZIPR) model was conducted to identify factors associated with antenatal care service utilization among the pregnant. In recent years, the ZIPR model has gained popularity for modeling count data with excess zeroes<sup>18</sup>. The ZIP models can be viewed as a finite mixture model with a degenerative distribution where its mass is concentrated at zero. Excess zeroes arise when the event of interest is not experienced by many of the subjects<sup>26</sup>. In this study, the ZIPR model was employed to identify the determinant factors of ANC service uptake among pregnant women. Suppose  $Y_i$  is the number of ANC service uptake among the pregnant. Thus,, the probability mass function of ZIPR is given by<sup>18 27 28</sup>

$$p(Y_i = y_i) = \begin{cases} \pi_i + (1 - \pi_i)\exp(-\mu_i), & \text{if } y_i = 0 \\ (1 - \pi_i)\frac{\exp(-\mu_i)\mu_i^{y_i}}{y_i!}, & \text{if } y_i = 1, 2, 3, \dots \end{cases} \quad 0 \leq \pi_i \leq 1$$

The parameter  $\mu_i$  and  $\pi_i$  depend on the covariates  $x_i$  and  $z_i$ , respectively. The mean and the variance of ZIP regression model, respectively, are:

$E(y_i) = (1 - \pi_i)\mu_i$  and  $Var(y_i) = \mu_i(1 - \pi_i)(1 + \pi_i\mu_i)$ . To apply the ZIPR model in practical modeling situations, <sup>18 27 28</sup> suggested the following joint models for  $\mu$  and  $\pi$

$\ln(\mu) = X^T\beta$  and  $\ln\left(\frac{\pi}{1-\pi}\right) = Z^T\gamma$  where  $X$  and  $Z$  are covariate matrices and  $\beta, \gamma$  are  $(p + 1) \times 1$  and  $(q + 1) \times 1$  vectors of unknown parameters respectively. The two sets of covariates may or may not coincide. Finally, the odds ratio (OR) and prevalence ratios (PR) with a 95% confidence interval (CI) were used to assess the strength of associations between the outcome and the independent variables using Poisson and Bernoulli regression models' assumptions. P-values of  $\leq 0.05$  were considered for statistically significant.

## Ethical Issues

Publicly available EDHS 2016 data were used for this study. Informed consent was taken from each participant, and all identifiers were removed

## Results

From a total of 7913 pregnant women, 64.6 % of the pregnant women have utilized the service, 35.4% of the pregnant women didn't receive any ANC service, and 35.5% of the pregnant women have received at least four ANC visits. The mean and variance of observation are 2.53 and 5.614, respectively. The variance to mean ratio is 2.22, which indicates some over-dispersion (Table 1).

**Table 1: The number of women that experienced ANC visits**

Number of visits	Count	Percent
0	2545	35.4
1	342	4.8
2	563	7.8
3	1187	16.5
4	1136	15.8
5	621	8.6
6	402	5.6
7	187	2.6
8+	108	2.9
Total	7193	100.0
Mean	2.53	
Variance	5.614	



### Test of over dispersion

The Pearson residual  $\chi^2$ -statistic for Poisson and ZIP model was summarized in Table 2. The Pearson dispersion value of the Poisson model is 1.829 ( $p < 0.001$ ), which clearly shows the existence of over-dispersion in the data and the Poisson model is over-dispersed. It follows that the options for modeling and analyzing such over dispersed and excess zero ANC count response data should be considered. Then fit ZIP and 1.001 is the Pearson dispersion value. This indicates that the ZIP has modeled and captured the over-dispersion in the data set very well because the dispersion value is very close to 1. For this reason, ZIP model is used for the analysis to identify the associated factors of ANC service uptake (Table 2).

**Table 2: Test of over-dispersion based on Pearson residual  $\chi^2$ -statistic**

Model	Dispersion Test (Ratio Statistic & P-value)
Poisson	1.829(0.001)
ZIP	1.001 ( 0.004)

### Socio-demographic characteristics of study participants

The majority of the study respondents were from rural residences (79%). Most of the respondents were housewives (70%) and 30% of the respondents were employed. About 60.6% of mothers didn't attend primary school, and only 12.4% of the mothers attended secondary and above level education. The majority (69.4%) of the respondents had no pregnancy complications and 64.4% had no access to mass media. About 91.5 percent of women were married, 3.2 percent were living alone while 5.3% were divorced and widowed. The majority (79.8%) of the pregnancies were planned while 9% of the pregnancies were terminated. 31.7% of the husbands had no formal education while 30% of husbands attended primary education. About half (50.7%) of women had poor wealth index, 35.0% were rich while others have middle wealth index (14.3%). Regarding mother's age, the majority (46.2%) of them were under the age group of 30 years (Table 3).

### Magnitude of ANC services uptake by socio-demographic characteristics of study participants

The mean and median numbers of ANC visits by socio-demographic characteristics of study participants are shown in Table 3. The mean numbers of ANC visits for urban women (4.26) were higher than for rural women (2.07). Among poor women, the lowest mean numbers of

ANC visits were recorded (1.71). The lowest mean numbers of ANC visits were observed for uneducated husbands (1.93), while the highest mean numbers of ANC visits were observed for husbands with secondary education and above (3.83). Women exposed to the media had the highest mean numbers of ANC visits (3.65), while the mean numbers of ANC visits for women not exposed to the media were low (1.92). The lowest mean numbers of ANC visits occurred among uneducated women (1.88), while the highest mean numbers of ANC visits have been recorded for women with secondary education and above (4.36). Compared with women who had no symptoms of pregnancy problems (1.78), women who had seen signs of pregnancy complications had a higher mean number of ANC visits (4.28) (Table 3).

Table 3: Magnitude of ANC services uptake by socio-demographic characteristics of study participants

Characteristics		Frequency (%)	Mean	Median
Residence	Urban	1512(21.0)	4.26	4
	Rural	5681(79.0)	2.07	2
Occupation of women	Housewife	5033(70.0)	2.37	2
	Employed	2160(30.0)	2.92	3
Planned pregnancy	No	1452(20.2)	2.53	3
	Yes	5741(79.8)	2.54	3
Terminated pregnancy	No	6556(91.1)	2.51	3
	Yes	637(8.9)	2.79	3
Wealth index	Low	3607(50.7)	1.71	1
	Medium	1028(14.3)	2.47	3
	Rich	2558(35.0)	3.71	4
Marital status	Never married	230(3.2)	2.52	3
	Married	6579(91.5)	3.26	4
	Divorced/widowed	384(5.3)	2.56	3
Age of women in a year	15-24	1852(25.1)	2.60	3
	25-29	2015(28.1)	2.73	3
	30 and above	3326(46.2)	2.38	3

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Husband education	No education	3719(51.7)	1.93	1
	Primary	2160(30.0)	2.79	3
	Secondary and above	1314(18.3)	3.83	4
Woman education	No education	4359(60.6)	1.88	1
	Primary	1942(27.0)	3.15	3
	Secondary and above	892(12.4)	4.36	4
Access to mass media	No	4646(64.6)	1.92	1
	Yes	2547(35.4)	3.65	4
Pregnancy complications	No	5015(69.7)	1.78	1
	Yes	2178(30.3)	4.28	4
Husband's occupation	Not working	1285(17.9)	2.19	2
	Working	5908(82.1)	2.61	3

### Factors associated with ANC service uptake, application of Zero Inflated Poisson regression models

As shown in the below table (Table 4), the Poisson component shows that the prevalence ratios (PR) of ANC visits. This study revealed that women's and husbands' levels of education are a significant factor in ANC service uptake. Compared to women with no formal education, the expected number of ANC service uptake for women with primary education is 1.06 (PR =1.06; 95%CI: 1.02, 1.10) times higher. Further, compared to women with no formal education, the expected number of ANC service uptake for women with secondary and above education was 1.11 (PR =1.11; 95% CI: 1.05, 1.18) times higher. The expected number of ANC service uptake for husbands with primary education was 1.05 (PR =1.05; 95% CI: 1.01, 1.10) times higher compared to husbands with no formal education. Similarly, compared to husbands with no formal education, ANC service uptake for husbands with secondary and above education increased by 9%(PR =1.09; 95%CI: 1.03, 1.14) . The expected number of ANC service uptake of the rural women was 0.88 (PR =0.88; 95%CI: 1.85, 1.92) times lower compared to urban women. The expected number of ANC service uptake for women with a rich wealth index was 1.08 (PR =1.08; 95% CI: 1.03, 1.13) times higher compared to those having poor wealth index.

Moreover, compared to women living alone, the expected number of ANC service uptake for married women was 1.19 (PR =1.19; 95% CI: 1.09, 1.30) times higher. The expected number of ANC service uptake for women who had seen signs of pregnancy complications was 1.20 (PR =1.20; 95% CI: 1.17, 1.24) times higher compared to those women who had no signs of pregnancy complication. Furthermore, compared to women who don't use mass media, the expected number of ANC service uptake for women using mass media was 1.09 (PR =1.09; 95% CI: 1.05, 1.13) times higher. The expected number of ANC service uptake for mothers in the age group of 25-29 was 1.06 (PR =1.06; 95% CI: 1.02, 1.10) times higher compared with the age group of 15-24 years. The expected number of ANC service uptake for mothers of age 30 and above was 1.07 (PR =1.07; 95% CI: 1.02, 1.11) times higher compared with the age group of 15-24 years (Table 4).

Table 4: Factors associated with ANC service uptake, application of application of Zero Inflated Poisson regression models

Characteristics		Poisson part PR (95% CI of PR)	Bernoulli part AOR (95%CI of AOR)
Residence	Urban	1	1
	Rural	0.884(0.846, 0.924) *	2.254(1.780, 2.855)*
Access to mass media	No	1	1
	Yes	1.086(1.045, 1.128) *	0.612(0.525,0.713)*
Planned pregnancy	No	1	1
	Yes	1.028( 0.989, 1.069)	0.794(0.685, 0.920*
Husbands occupation	Not working	1	1
	Working	1.017(0.959, 1.077)	0.761(0.655,0.884)*
Wealth index	Low	1	1
	Medium	1.039(0.989, 1.093)	0.594(0.501, 0.704)*
	Rich	1.077( 1.029, 1.127)*	0.568(0.479, 0.672)*
Women's education	No education	1	1
	Primary	1.057(1.015, 1.101)*	0.454(0.388, 0.531)*
	Secondary and above	1.112(1.052, 1.176)*	0.389(0.286, 0.530)*
Husband education	No education	1	1
	Primary	1.052(1.010, 1.096)*	0.625(0.542, 0.721)*
	Secondary and above	1.085(1.031, 1.142)*	0.666(0.532, 0.836)*
Age of women (year)	15-24	1	1
	25-29	1.060(1.016, 1.104)*	0.991(0.830, 1.184)
	30 and above	1.067(1.024, 1.111)*	0.827(0.656,1.042)
Marital status	living alone	1	1

	Married	1.187(1.087, 1.296)*	0.865(0.576, 1.301)
	Divorced/widowed	1.083(0.990, 1.184)	0.639(0.460, 0.888)*
Pregnancy complications	No	1	1
	Yes	1.203(1.165, 1.242)*	0.859(0.569, 1.297)
Occupation of women	Housewife	1	1
	Working	0.982(0.950, 1.016)	0.937(0.809, 1.085)
Terminated pregnancy	No	1	1
	Yes	1.039(0.986, 1.094)	0.817(0.649, 1.027)

**Note:** 1 = reference category of the categorical variable.

\* Significant at 5% level of significance

The Bernoulli part also indicated that the estimated odds that the number of ANC service uptake becomes zero with who is living in the rural area was 2.25 (OR = 2.25; 95%CI: 1.78, 2.86) times that of the urban women. The estimated odds the number of ANC service uptake which was zero with women who attend primary education was 0.45 (OR = 0.45; 95%CI: 0.39, 0.53) times that of the non-educated women. Similarly, the estimated odds by which the number of ANC service uptake becomes zero with husbands who have primary education was 0.63 (OR = 0.63; 95%CI: 0.54, 0.72) times that of the non-educated husbands. The estimated odds by which the number of ANC service uptake becomes zero with rich women was 0.57 (OR = 0.57; 95%CI: 0.48, 0.67) times that of the poor wealth index. The odds of the number that the ANC service uptake becomes zero with husbands who work is 0.76 (OR = 0.76; 95%CI: 0.66, 0.88) times that of husbands without work. The estimated odds at which the number of ANC service uptake becomes zero with women who have used mass media was 0.61 (AOR = 0.61; 95%CI: 0.53, 0.71) times that of women who did not use any mass media (Table 4).

## Discussion

Antenatal care during pregnancy is important for the health of the mother and the development of the fetus. Therefore, this study sought to determine the magnitude and associated factors of ANC service uptake among pregnant women in Ethiopia. The results of this study showed that about 64.6 % of the pregnant women have utilized the service and 35.4% haven't received ANC services during their pregnancy which is less than the figure reported from 2016 EDHS for urban Ethiopia<sup>19</sup>. This percentage figure is also less than those reported from the studies conducted in different parts of Ethiopia<sup>12 29 30</sup>.

The findings of this study revealed that education had a positive relationship with ANC service uptake, that is; the amount of ANC service uptake increased with the rise in woman's and

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3 husband's education level. This study shows a result similar with other studies<sup>15 20 25 31-35</sup>, which  
4 revealed that uneducated women and husbands were fewer ANC attendants than those who were  
5 educated. The justification could be that educated women took more ANC because they had  
6 more awareness about regular ANC uptake benefits such as reduced risks of pregnancy and safe  
7 childbirth. Educated husbands may have better communication with their wives and be able to  
8 explore the importance of ANC uptake and other maternal health services<sup>36</sup> which could in turn  
9 provide their wives with more freedom<sup>37</sup>.

10 The uptake of ANC services among married women was higher compared to women living  
11 alone. This finding is consistent with the studies conducted in Ethiopia<sup>15</sup>, Kenya<sup>32</sup>, Rwanda<sup>38</sup>  
12 and Bangladesh<sup>35</sup>. The higher ANC uptake could be attributed to the psychological and  
13 economic support obtained from their husbands, plannedness and desirability of their pregnancy,  
14 and the societal acceptability and support of their pregnancy state when compared with their  
15 unmarried women.

16 Wealth index correlated negatively with the use of ANC services. Relative to the richest wealth  
17 quintile, women belonging to the lowest wealth quintiles were less likely to uptake ANC  
18 services. Studies elsewhere have also documented a positive relationship between economic  
19 status and ANC service uptake<sup>17 21 22 31 35 39</sup>. The justification for this might be that rich women  
20 may obtain more ANC information from mass media and had greater access to health care. In  
21 addition, this may be attributed to the indirect cost of antenatal care, such as transport cost when  
22 traveling to distant health facilities<sup>40</sup>.

23 Compared to rural women, women living in urban areas were more likely to utilize ANC service.  
24 This finding is supported by the studies conducted in<sup>16 17 33 41</sup>. The reason could be that urban  
25 women had a better education, access to health services and are more informed about the  
26 importance of ANC service uptake. The exposure of mass media positively associated with ANC  
27 services. Women exposed to media had more ANC service uptake than women not exposed to  
28 media. This finding is in line with reports of other previous studies<sup>17 23 33 35</sup>. Compared to  
29 housewife women, the number of ANC uptake was higher among employed women. This  
30 finding is similar a study in Kenya<sup>42</sup> and 31 sub-Saharan Africa countries<sup>43</sup> which showed the  
31 odds of antenatal care utilization were higher among working women than non-working<sup>43</sup>. This  
32 may be because employed women, especially those in the formal sector benefit from a pregnancy  
33 care health insurance system. The finding indicated that women with pregnancy complications  
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3 tend to uptake ANC service than those who did not develop pregnancy complications. This  
4 finding is in line with findings of studies in Ethiopia<sup>44</sup>, Northern Jordan<sup>24</sup> and Tanzanian<sup>25</sup> and  
5 Pakistan<sup>25</sup>.  
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9 Relative to unplanned/unwanted pregnancies, women whose pregnancies were planned and  
10 desired were more likely to use ANC services. These findings are consistent with findings of  
11 previous studies<sup>22-24 32</sup>. The study results also showed that the number of ANC visits increased  
12 significantly as the age of women increased. Previous studies supported that women's age plays  
13 a significant role in the utilization of maternal health care<sup>12 20</sup>.  
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### 16 17 18 **Strengths and limitation**

19 This study used EDHS data having a larger sample size and higher-quality, which substantially  
20 reduces the risk of sampling bias and measurement bias. The study results also provide a timely  
21 evidence for policymakers and health sectors with respect to reducing levels of maternal and  
22 infant mortality which are highly depend on increased use of reproductive and maternal health  
23 services. The study provides other researchers with information about how to use over dispersed  
24 excesses zero and zero-inflated Poisson regression model. Due to the cross-sectional study  
25 design, causal effects are not measured and it is impossible to know whether the data are time-  
26 dependent or not. The other limitation was that the DHS did not include information on distance  
27 to a health facility and the quality of healthcare which could affect the uptake of ANC service.  
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### 36 37 38 **Conclusion**

39 About 64.6 percent of the pregnant women have utilized the service and only 35.5 percent of the  
40 pregnant women have received at least four ANC visits. Compared to the minimum requirement  
41 of ANC service uptake recommended by WHO, ANC service uptake in Ethiopia is extremely  
42 low and below average. This study revealed that rural women, poor women, lower maternal and  
43 paternal education, mothers not having access to mass media, women living alone, mothers  
44 without pregnancy complication significantly associated with less number of ANC service  
45 utilization. The low ANC service utilization calls for a need to improve community awareness  
46 about maternal health. More importantly, pregnant women need intensive health education so as  
47 to boost their ANC service uptake and follow-up adherence.  
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57

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**Competing interests:** None declared.

**Patient consent for publication:** Not required.

**Data sharing statement:** The survey datasets used in this study was based on a publicly available dataset that is freely available online with no participant's identity from <http://www.dhsprogram.com/data/available-datasets.cfm>.

**Ethics approval and consent to participate:** The study used available secondary data accessed under the National Data Sharing and Accessibility Policy (NDSAP) of the Government of Ethiopia. The data set had no identifiable information on the survey participants; therefore, no ethical approval is required for this work.

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**Abbreviations:** ANC: Antenatal Care; AOR: Adjusted Odd Ratio; EDHS: Ethiopian Demographic and Health Survey; HSTP: Health Sector Transformation Plan; IR: Incidence Rate; SDG: Sustainable development Goal; WHO: World Health Organization; ZIP: Zero Inflated Regression Poisson

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STROBE Statement—Checklist of items that should be included in reports of *cross-sectional studies*

bmjopen-2020-043904.R2 - "Magnitude of Antenatal Care Service uptake and associated factors among Pregnant Women: analysis of the 2016 Ethiopia demographic and health survey"

	Item No.	Recommendation	Page No.	Relevant text from manuscript
<b>Title and abstract</b>	1	(a) Indicate the study's design with a commonly used term in the title or the abstract	2	"Abstract Study's design, Paragraph 2, line 37"
		(b) Provide in the abstract an informative and balanced summary of what was done and what was found	2	"Abstract, objective section Paragraph 1 and Result section Paragraph 6"
<b>Introduction</b>				
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4	"Introduction, paragraph 1, paragraph 2 and paragraph 3"
Objectives	3	State specific objectives, including any prespecified hypotheses	5	"Introduction, paragraph 3, line 128 and 129"
<b>Methods</b>				
Study design	4	Present key elements of study design early in the paper	5	"Methods, paragraph 3, Sampling Design, line 142 and 143"
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	5	"Methods, paragraph 2/data source, line 136-140"
Participants	6	Give the eligibility criteria, and the sources and methods of selection of participants	5	"Methods, paragraph 2/data source line 138 -140 and Paragraph 3/Sampling Design line 142-150"
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	6	"Methods, paragraph 3/ Study variables, line 152-161"
Data sources/measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	6	"Methods, paragraph 3/ Study variables, line 152-161"
Bias	9	Describe any efforts to address potential sources of bias	5	"Methods, Paragraph 3/Sampling Design line 142-150"
Study size	10	Explain how the study size was arrived at	5	"Methods, paragraph 2/data source, line 138-140"

Continued on next page

1					
2	Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	6	“Methods, paragraph 5/Data management and analysis, line 163&164”
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6	Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding	6	“Methods, paragraph 5/Data management and analysis, line 165 -183”
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10			(b) Describe any methods used to examine subgroups and interactions	6	“Methods, paragraph 5/Data analysis”
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13			(c) Explain how missing data were addressed	6	“Methods, paragraph 5/Data analysis line 180-183”
14					
15					
16			(d) If applicable, describe analytical methods taking account of sampling strategy		“N/A”
17					
18					
19			(e) Describe any sensitivity analyses		“N/A”
20					
21	<b>Results</b>				
22	Participants	13*	(a) Report numbers of individuals at each stage of study— e.g., numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	7	“Result, Paragraph 1 line 188-191”
23					
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27			(b) Give reasons for non-participation at each stage		“N/A”
28					
29			(c) Consider use of a flow diagram		“N/A”
30	Descriptive data	14*	(a) Give characteristics of study participants (e.g., demographic, clinical, social) and information on exposures and potential confounders	8	“Result, Paragraph 3 line 206 -216 or Table 3”
31					
32					
33			(b) Indicate number of participants with missing data for each variable of interest		“N/A”
34					
35					
36			Report numbers of outcome events or summary measures	7	“Result, Paragraph 1 line 188 -192 or table 1”
37					
38					
39	Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	11	“Result, Paragraph 5 line 237-260 or table 4 /”
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44			(b) Report category boundaries when continuous variables were categorized	8	“Result, Paragraph 3/ line 232 and 233 or Table 3
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48			(c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period		“N/A”
49					

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2	Other analyses	17	Report other analyses done—e.g., analyses of subgroups and interactions, and sensitivity analyses	“N/A”
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4				
5	<b>Discussion</b>			
6	Key results	18	Summarise key results with reference to study objectives	13 “Discussion, Paragraph 1 line 280-285”
7				
8				
9	Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	14 “Strengths and limitation of study, Paragraph 1 line 329-337”
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13	Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	13-14 “Discussion, Paragraph 2 to 5 line 287 -327”
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18	Generalizability	21	Discuss the Generalizability (external validity) of the study results	14 “Conclusion, Paragraph 1 line 340 -349”
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21	<b>Other information</b>			
22	Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	“Funding line 355 &354”
23				
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26				

\*Give information separately for exposed and unexposed groups.

\*N/A

# BMJ Open

## Determinant of Antenatal Care Service uptake among Pregnant Women: analysis of the 2016 Ethiopia demographic and health survey

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3 **Determinant of Antenatal Care Service uptake among Pregnant Women: analysis of the**  
4 **2016 Ethiopia demographic and health survey**  
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6 Setegn Muche Fenta\*<sup>1</sup> and Girum Meseret Ayenew<sup>2</sup>  
7

8 <sup>1</sup>Department of Statistics, Debre Tabor University, P.O.Box272 Debre Tabor, Ethiopia.  
9

10 <sup>2</sup>Research and Technology Transfer Directorate, Amhara Public Health Institute, P.O. Box 477  
11 Bahir Dar, Ethiopia; [girum.m21@gmail.com](mailto:girum.m21@gmail.com)  
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14  
15 **\*Corresponding:** [setegn14@gmail.com](mailto:setegn14@gmail.com)  
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## Abstract

**Objective:** Antenatal and postnatal cares are crucial for the survival and well being of both the mother and the child. World Health Organization recommends a minimum of four antenatal care visits during a pregnancy. In Ethiopia, only 38% of women in the reproductive age received a minimum of first antenatal care visits. This value is far more below the typical rates of least developed countries. This study aimed to identify the determinant factors of antenatal care service utilization among pregnant women in Ethiopia.

**Design:** Cross-sectional study design

**Setting:** Ethiopian.

**Participants:** A total of 7913 pregnant women were included in the study.

**Primary outcome measures:** Antenatal Care Service uptake among Pregnant

**Result:** Only 35.5% of the pregnant mothers have utilized antenatal care services at least four times and 64.5% of the pregnant mothers have utilized less than three times during their periods of pregnancy. The study showed that rich women (IRR 1.077, 95% CI: 1.029,1.127), having access to mass media (IRR=1.086, 95% CI: 1.045, 1.128), having pregnancy complications (IRR=1.203, 95% CI: 1.165, 1.242), secondary school and above-educated women (IRR=1.112, 95% CI:1.052, 1.176), husbands' having secondary school and above level of education (IRR=1.085, 95% CI: 1.031, 1.142), being married (IRR = 1.187; 95% CI: 1.087,1.296), rural women (IRR=0.884, 95% CI: 0.846, 0.924) and women age >30 years (IRR=1.067, 95% CI: 1.024, 1.111) were significantly associated with the antenatal care service uptake.

**Conclusion:** Efforts have to be done to increase the socioeconomic status, and to promote the decision making role of women. Besides, this study indicates a need for improving community awareness on maternal health and for motivating women to utilize maternal care services.

**Keywords:** Antenatal Care services uptake, Ethiopia, Zero Inflated Poisson Regression Model

### Strengths and limitation

- Used EDHS data with a large sample size and high-quality data which reduced the risk of sampling bias and measurement bias in this study.
- The result of this study also enable for policy maker and health sectors to reducing levels of maternal and infant mortality and morbidity depends on increasing the use of reproductive and maternal health services.
- The study offers flawless information to other researcher how to use to use over dispersed, excess zero and zero-inflated Poisson regression model.
- It is difficult to measure the causal effects, and it is not possible to know whether the data are time-dependent or not.

## Introduction

Each day, 830 women die of preventable reasons associated with pregnancy and childbirth. Most maternal deaths arise in developing countries like Ethiopia. Sub-Saharan Africa and Southern Asia accounted for approximately 85% of the estimated global maternal deaths of which two-third from sub-Saharan Africa. The maternal mortality ratio in developing countries in the year 2015 is 239 per 100 000 live births and 12 per 100,000 live births in developed countries<sup>1 2</sup>. In Ethiopia, the maternal mortality ratio is 412 deaths per 100,000 live births. This indicates a female lifetime hazard of maternal death is 1 in 243 Ethiopia<sup>2 3</sup>.

Regular Antenatal care service utilization assists the fitness care company to perceive capability fitness problems early and take steps to control them, to protect the fitness of the mother and therefore the developing fetus. Antenatal Care (ANC) may be described because of the care supplied by the use of skilled health-care providers to pregnant women to ensure the health situations for each mother and child during pregnancy<sup>4 5</sup>. The reason for this is to possess a healthy mother and child<sup>4-7</sup>. ANC also will help to understand the Sustainable Development Goals (SDG) of drop child mortality as low as 25 in line with 100,000 live births and maternal mortality to as low as 70 per 100,000 live births by the end of 2030<sup>1</sup>. In recent times, the World Health Organization (WHO) has changed the ANC version increasing the amount of ANC visits with a fitness issuer from 4 to 8<sup>6</sup>.

In Ethiopia, sixty-two percent of women didn't attend a minimum of 4 ANC visits throughout their pregnancy<sup>3</sup>. Health Sector Transformation Plan of the Ethiopian Federal Ministry of Health addresses troubles associated with having targeted ANC with a minimal of 4 visits consistent with pregnancy as mainstream in the least provider delivery levels with a target to grow the proportion from 68% to ninety-five % at the highest by 2020<sup>8</sup>. But, according to the Ethiopia Demography and Health Survey (EDHS) 2016, the ANC service utilization with a minimum of four visits is merely 32%<sup>3</sup>. This indicated that ANC going to in Ethiopia immobile underneath any suitable standard.

Previous research in Ethiopia has been covered in small geographical regions and there is no sufficient study at nationwide to the best knowledge of the authors<sup>9-14</sup>. These studies also

investigated the determinant factor of antenatal care service utilization through binary logistic. While, binary logistic regression undercounts the total number of antenatal care visit since multiple service utilization are collapsed into a single unit to fulfill the requirements of binary logistic regression, provides sufficient information for studying the pattern of multiple service utilization. In this study, the Zero-Inflated Poisson regression model is the preferred model of analysis since Zero-Inflated Poisson regression model provide a way of modeling the excessive proportion of zero values by allowing over dispersion. When number of zeros is large, provides a good fit than Poisson or negative binomial model<sup>15</sup>. Therefore, this study aimed to identify the determinant factors of ANC service uptake for the country at large.

## Method

### Patient and public involvement

This study used a publicly available data set (EDHS 2016); therefore, there were no patients or members of the public involved.

### Data source

The data used for this study were taken from the 2016 EDHS. This survey is the fourth compressive survey designed to provide estimates for the health and demographic variables of interest for the whole urban and rural areas of Ethiopia as a domain. Women who had 9 months of pregnancy during the survey interview were included in the analysis. The study includes 7193 of the reproductive age group within the country.

### Sampling Design

The EDHS 2016 employed a stratified two-stage cluster sampling procedure designed to provide a representative sample for multiple health and population indicators at national and sub-national levels (nine regions and two city administrations). Initially, 645 Enumeration Areas (EAs) (202 in urban areas and 443 in rural areas) were drawn using Probability Proportional to Size (PPS) sampling approach from a whole list of 84,915 EAs defined within the recent 2007 population census. Then in every selected EA, an exhaustive listing of households was made and 28 households were selected using a systematic sampling approach. Within the chosen households, enumeration of the entire members was made and information about the ANC service utilization among all household members was collected primarily from the women<sup>16</sup>.

### Variable of the study

### Dependent variables

The dependant variable was count variable: the quantity (number) of ANC visits.

### Independent variables

The independent variables of this study were selected by reviewing related work of literature<sup>9-14 17-22</sup>. Women's educational level, husband's occupation, wealth index, marital status, women's occupation, women's age, husband's educational level, planned pregnancy, access to mass media, pregnancy complications, the desire of pregnancy and residence, were considered to be a possible independent variable within the study.

### Data analysis

The cleaned and recoded data were analyzed using R software version 3.5.3. Frequencies and percentages were used to describe the categorical variables. Data was presented using tables. Zero Inflated Poisson Regression (ZIPR) model were conducted to identify factors associated with antenatal care service utilization among pregnant. In recent years, the ZIPR model has gained popularity for modeling count data with excess zeroes<sup>15</sup>. The ZIP models can be viewed as a finite mixture model with a degenerate distribution whose mass is concentrated at zero. Excess zeroes arise when the event of interest is not experienced by many of the subjects<sup>23</sup>. In this study, the ZIPR model was employed to identify the determinant factors of ANC service uptake among pregnant women. Suppose  $Y_i$  is the number of ANC service uptake among pregnant then, the probability mass function of ZIPR is given by<sup>15 24 25</sup>

$$p(Y_i = y_i) = \begin{cases} \pi_i + (1 - \pi_i) \exp(-\mu_i), & \text{if } y_i = 0 \\ (1 - \pi_i) \frac{\exp(-\mu_i) \mu_i^{y_i}}{y_i!}, & \text{if } y_i = 1, 2, \dots \end{cases} \quad 0 \leq \pi_i \leq 1$$

The parameter  $\mu_i$  and  $\pi_i$  depends on the covariates  $x_i$  and  $z_i$ , respectively. The mean and the variance of ZIP regression model, respectively, are:

$E(y_i) = (1 - \pi_i) \mu_i$  and  $Var(y_i) = \mu_i (1 - \pi_i) (1 + \pi_i \mu_i)$ . To apply the ZIPR model in practical modeling situations,<sup>15 24 25</sup> suggested the following joint models for  $\mu$  and  $\pi$

$$\ln(\mu) = X^T \beta \quad \text{and} \quad \ln\left(\frac{\pi}{1 - \pi}\right) = Z^T \gamma \quad \text{where } X \text{ and } Z \text{ are covariate matrices and } \beta, \gamma \text{ are}$$

$(p + 1) \times 1$  and  $(q + 1) \times 1$  vectors of unknown parameters respectively. The two sets of covariates

may or may not coincide. Finally, the adjusted odds ratio (AOR) and incidence rate ratio (IR) with 95% confidence interval (CI) were used to assess the strength of associations between the outcome and the independent variables. P-values of  $\leq 0.05$  were considered for statistical significant.

### Ethical Issues

Publicly available EDHS 2016 data were used for this study. Informed consent was taken from each participant, and all identifiers were removed

### Results

From a total of 7913 pregnant women, 2545(35.4%) didn't receive any ANC service and 35.5% visited four and more than four times. The mean and variance of observation are 2.53 and 5.614, respectively. The variance to mean ratio is 2.22, which indicates some over-dispersion (Table 1).

**Table 1:** The number of women that experienced ANC visits

Number of visits	Count	Percent
0	2545	35.4
1	342	4.8
2	563	7.8
3	1187	16.5
4	1136	15.8
5	621	8.6
6	402	5.6
7	187	2.6
8+	108	2.9
Total	7193	100.0
Mean	2.53	
Variance	5.614	

### Socio-demographic characteristics of study participants

The majority of the study respondents were from rural residences (79%). Most of the respondents were housewives (70%) and 30% of the respondents were employed. About 60.6% of mothers didn't attend primary school and only 12.4% of mothers attended secondary and above education. The majority (69.4%) of the respondents had no pregnancy complications and 64.4% had not an access to mass media. About 91.5 percent of women were married, 3.2 percent of women were living alone women while 5.3% were divorced and widowed. The majorities (79.8%) of pregnancies were planned and 9% pregnancies were terminated. Regarding husband

education, 31.7% of the husband had no formal education while 30% of husbands attend primary education. About half (50.7%) of had poor wealth index, 35.0% were rich wealth while others were middle wealth index (14.3%). Regarding the mother age, the majorities (46.2%) of mothers were under the age group of 30 years plus, then followed 25-29 years (Table 2).

**Table 2:** Socio demographic characteristics of pregnant women in Ethiopia.

Categories	Frequency (n)	Percentage (%)
<b>Residence</b>		
Urban	1512	21
Rural	5681	79
<b>Occupation of mothers</b>		
Housewife	5033	70
Others	2160	30
<b>Planned pregnancy</b>		
No	1452	20.2
Yes	5741	79.8
<b>Terminated pregnancy</b>		
No	6556	91.1
Yes	637	8.9
<b>Wealth index</b>		
Low	3607	50.7
Medium	1028	14.3
Rich	2558	35.0
<b>Marital status</b>		
Never married	230	3.2
Married	6579	91.5
Divorced/widowed	384	5.3
<b>Age of women in a year</b>		
15-24	1852	25.7
25-29	2015	28.1
30 and above	3326	46.2
<b>Husband education</b>		
No education	3719	51.7
Primary	2160	30.0
Secondary and above	1314	18.3
<b>Woman education</b>		
No education	4359	60.6
Primary	1942	27
Secondary and above	892	12.4
<b>Access to mass media</b>		
No	4646	64.6
Yes	2547	35.4
<b>Pregnancy complications</b>		

No	5015	69.7
Yes	2178	30.3
<b>Husband's occupation</b>		
Not working	1285	17.9
Working	5908	82.1

### Determinant Factor of ANC service uptake

As shown in the below table (Table 3), the Poisson component shows that the incidence rate of ANC visits (IR). The finding of this study revealed that women's and husbands' levels of education have a significant factor for ANC service uptake. The ANC service uptake for women with primary education was 1.06 (IRR =1.06; 95%CI: 1.02, 1.10) times higher compared to women with no education. The ANC service uptake for women with secondary and above education was 1.11 (IRR =1.11; 95% CI: 1.05, 1.18) times compared with women having no formal education. Likewise, ANC service uptake for husbands with primary education increased by 5% (IRR =1.05; 95% CI: 1.01, 1.10) compared with husbands having no formal education. Similarly, ANC service uptake for husbands with secondary and above education increased by 9% (IRR =1.09; 95%CI: 1.03, 1.14) compared with husbands having no formal education. The ANC service uptake of the rural women was decreased by 12% (IRR =0.88; 95%CI: 1.85, 1.92) compared to the urban residents.

The study also indicated that the husbands' wealth index and marital status were a significant factor in the ANC service uptake. The ANC service uptake for rich wealth index would be 1.08 (IRR =1.08; 95% CI: 1.03, 1.13) times higher compared to their poor wealth index. ANC service uptake for married women was 1.19 (IRR =1.19; 95% CI: 1.09, 1.30) times higher compared to living alone women.

Moreover, ANC service uptake for women who had seen signs of pregnancy complications was 1.20 (IRR =1.20; 95% CI: 1.17, 1.24) times higher compared to those women who had no signs of pregnancy complication. The ANC service uptake for women being the use of mass media was 1.09 (IRR =1.09; 95% CI: 1.05, 1.13) times higher compared to those don't use of mass media. The ANC service uptake for mothers age 25-29 was 1.06 (IRR =1.06; 95% CI: 1.02, 1.10) times higher compared to whose age is 15-24. The ANC service uptake for mothers age 30 and above was 1.07 (IRR =1.07; 95% CI: 1.02, 1.11) times higher compared to whose age is 15-24 (Table 3).

**Table 3:** Zero Inflated Poisson regression model result (IRR and AOR)



Parameter	Poisson part	Bernoulli part
	IR(95% CI of IR)	AOR(95%CI of AOR)
Intercept	3.051( 2.777,3.352)*	0.542(0.399, 0.738)*
<b>Residence</b>		
Urban	1	1
Rural	0.884(0.846, 0.924)*	2.254(1.780, 2.855)*
<b>Access to mass media</b>		
No	1	1
Yes	1.086(1.045, 1.128)*	0.612(0.525,0.713)*
<b>Planned pregnancy</b>		
No	1	1
Yes	1.028( 0.989, 1.069)	0.794(0.685, 0.920)*
<b>Husbands occupation</b>		
not working	1	1
Working	1.017(0.959, 1.077)	0.761(0.655,0.884)*
<b>Wealth index</b>		
Low	1	1
Medium	1.039(0.989, 1.093)	0.594(0.501, 0.704)*
Rich	1.077( 1.029, 1.127)*	0.568(0.479, 0.672)*
<b>Women's education</b>		
No education	1	1
Primary	1.057(1.015, 1.101)*	0.454(0.388, 0.531)*
Secondary and above	1.112(1.052, 1.176)*	0.389(0.286, 0.530)*
<b>Husband education</b>		
No education	1	1
Primary	1.052(1.010, 1.096)*	0.625(0.542, 0.721)*
Secondary and above	1.085(1.031, 1.142)*	0.666(0.532, 0.836)*
<b>Age of mother (year)</b>		
15-24	1	1
25-29	1.060(1.016, 1.104)*	1
30 and above	1.067(1.024, 1.111)*	1
<b>Marital status</b>		
living alone	1	1
Married	1.187(1.087, 1.296)*	1
Divorced/widowed	1.083(0.990, 1.184)	1
<b>Pregnancy complications</b>		
No	1	1
Yes	1.203(1.165, 1.242)*	1
<b>Occupation of mother</b>		
Housewife	1	1
Working	0.982(0.950, 1.016)	1
<b>Terminated pregnancy</b>		

No	1
Yes	1.039(0.986,1.094)

**Note:** 1 = reference category of the categorical variable.

\* Significant at 5% level of significance

The Bernoulli or logit part used to show the likelihood of ANC service uptake (AOR) on the household level. Compared to urban women, being a rural resident (OR = 2.25; 95%CI: 1.78, 2.86) increases the odds of ANC non-utilization by about 2.25 times. Women who had primary (OR = 0.45; 95%CI: 0.39, 0.53) and secondary and higher (OR = 0.39; 95%CI: 0.29, 0.53) education had decreased odds of not attending ANC compared with those of no education category. Again, women in the middle (OR = 0.59; 95%CI: 0.50, 0.70) and rich (OR = 0.57; 95%CI: 0.48, 0.67) wealth quintiles respectively had a 41%, and 43 % reduction in the odds of not attending ANC compared with those in the poor class. On the other hand, being employed (OR = 0.76; 95%CI: 0.66, 0.88) reduced the odds of ANC non-utilization by 24% compared to unemployed husbands/partners. Similarly, women whose husband/partner's had primary (OR = 0.63; 95%CI: 0.54, 0.72), secondary and above (OR = 0.67; 95% CI: 0.53, 0.84) education respectively had a 37.0% and 33.0% reduction in the odds of not utilizing ANC compared to those whose husbands/partners had no education. Women who have used mass media (AOR = 0.61; 95%CI: 0.53, 0.71) had a 39.0% reduction in the odds of not utilizing ANC compared to those not to use of mass media (Table 3).

## Discussion

Antenatal care during pregnancy is important for the health of the mother and the development of the unborn baby. Therefore, this study aimed at assessing the determinant factors of ANC service uptake among pregnant women in Ethiopia. The results of this study showed that about 64.6 % of the pregnant women have utilized the service and 35.4% haven't received ANC services during their pregnancy which is less than that reported from 2016 EDHS urban Ethiopia<sup>16</sup>. It's also less than reported from the studies conducted in Hadiya and Jimma<sup>9 26</sup>.

The findings of this study revealed that education had a positive relationship with ANC service uptake, that is, the amount of ANC service uptake increase with the rise in woman's and husband's education level. The study shows an identical result with other studies<sup>12 17 22 27-31</sup> which revealed that non-educated women were less ANC attendants than those that have educated women.

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3 This study also showed that marital status was found to be a significant determinant factor for  
4 ANC service uptake. The ANC service uptake among married women was higher compared to  
5 live alone women. This finding is in favor of study conducted in Tigray, of Ethiopia, Kenya and  
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8 Rwanda<sup>12 28 31 32</sup>

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10 Wealth index and husbands' occupation was positively related to ANC service uptake. The study  
11 showed that poor women were less ANC service uptake than those of middle and rich women.  
12 Studies elsewhere have also documented a positive relationship between economic status and  
13 ANC service uptake<sup>14 18 19 27 31 33</sup>. The results of this study indicated that residence and access to  
14 mass media are significantly associated with ANC service uptake. The ANC service uptake of  
15 rural women was lower than the urban woman. This is consistent with the study done in Amhara  
16 and Oromia, Ethiopia<sup>13 14 29 34</sup>. This may be because urban women were more informed than  
17 rural women about the importance of ANC service uptake. Women who were exposed to media  
18 were more ANC service uptake than women weren't exposed to media. It's also supported by<sup>14</sup>  
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30 Besides, women who had seen signs of pregnancy complications were better in ANC  
31 service uptake than women who had no signs of pregnancy complications. This finding is in line  
32 with studies done in Amhara, Ethiopia and Northern Jordan<sup>13 21 22 33</sup>.

31 Moreover, the will for the pregnancy and age of girls was also significantly associated with ANC  
32 service uptake. Women who had planned pregnancy had a better number of ANC service uptake  
33 than an unplanned pregnancy. This finding is supported by<sup>19-21 28</sup>. Similarly, women within the age  
34 of 30years and above are more likely to use ANC service e than women within the age group of  
35 15–19. Several studies supported that women's age plays a big role in the utilization of maternal  
36 health care<sup>9 17</sup>.

### 37 38 39 40 41 **Conclusion**

42 Only 35.5 percent of women have received a minimum of four ANC visits during their  
43 pregnancy. ANC service uptake in Ethiopia is extremely low and below average as compared to  
44 the minimum requirement of ANC service uptake recommended by WHO. This study was  
45 revealed that rural women, poor women, lower maternal and paternal education, mothers not  
46 having access to mass media, Living alone women, mothers have not complicated pregnancy  
47 was significantly associated with less number of ANC service utilization. Therefore, efforts have  
48 to be done to increase the socioeconomic status and to promote the decision making role of  
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women. Besides, there is a need for improving community awareness on maternal health and for motivating women to ANC service uptake.

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**Data sharing statement:** The survey datasets used in this study was based on a publicly available dataset that is freely available online with no participant's identity from <http://www.dhsprogram.com/data/available-datasets.cfm>.

**Ethics approval and consent to participate:** The study used available secondary data accessed under the National Data Sharing and Accessibility Policy (NDSAP) of the Government of Ethiopia. The data set had no identifiable information on the survey participants; therefore, no ethical approval is required for this work.

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**Abbreviations:** ANC: Antenatal Care; AOR: Adjusted Odd Ratio; EDHS: Ethiopian Demographic and Health Survey; HSTP: Health Sector Transformation Plan; IR: Incidence Rate; SDG: Sustainable development Goal; WHO: World Health Organization; ZIP: Zero Inflated Regression Poisson

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# BMJ Open

## Magnitude of Antenatal Care Service uptake and associated factors among Pregnant Women: analysis of the 2016 Ethiopia demographic and health survey

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3 **Magnitude of Antenatal Care Service uptake and associated factors among Pregnant**  
4 **Women: analysis of the 2016 Ethiopia demographic and health survey**  
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6 Setegn Muche Fenta\*<sup>1</sup> and Girum Meseret Ayenew<sup>2</sup>  
7

8 <sup>1</sup>Department of Statistics, Debre Tabor University, P.O.Box272 Debre Tabor, Ethiopia.  
9

10 <sup>2</sup>Research and Technology Transfer Directorate, Amhara Public Health Institute, P.O. Box 477  
11 Bahir Dar, Ethiopia; [girum.m21@gmail.com](mailto:girum.m21@gmail.com)  
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15 **\*Corresponding:** [setegn14@gmail.com](mailto:setegn14@gmail.com)  
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## Abstract

**Objective:** Antenatal and postnatal cares are crucial for the survival and well being of both the mother and the child. World Health Organization recommends a minimum of four antenatal care visits during a pregnancy. In Ethiopia, only 38% of women in the reproductive age received a minimum of first antenatal care visits. This value is far more below the typical rates of least developed countries. This study aimed to calculate the magnitude and identify associated factors of antenatal care service utilization among pregnant women in Ethiopia.

**Design:** Cross-sectional study design

**Setting:** Ethiopian.

**Participants:** A total of 7913 pregnant women were included in the study.

**Primary outcome measures:** Antenatal Care Service uptake among Pregnant

**Result:** Only 35.5% of the pregnant mothers have utilized antenatal care services at least four times and 64.5% of the pregnant mothers have utilized less than three times during their periods of pregnancy. The study showed that rich women (IRR 1.077, 95% CI: 1.029,1.127), having access to mass media (IRR=1.086, 95% CI: 1.045, 1.128), having pregnancy complications (IRR=1.203, 95% CI: 1.165, 1.242), secondary school and above-educated women (IRR=1.112, 95% CI:1.052, 1.176), husbands' having secondary school and above level of education (IRR=1.085, 95% CI: 1.031, 1.142), being married (IRR = 1.187; 95% CI: 1.087,1.296), rural women (IRR=0.884, 95% CI: 0.846, 0.924) and women age >30 years (IRR=1.067, 95% CI: 1.024, 1.111) were significantly associated with the antenatal care service uptake.

**Conclusion:** Efforts have to be done to increase the socioeconomic status, and to promote the decision making the role of women. Besides, this study indicates a need for improving community awareness on maternal health and for motivating women to utilize maternal care services.

**Keywords:** Antenatal Care services uptake, Ethiopia, Zero Inflated Poisson Regression Model

### Strengths and limitation

- Using a large sample size and high-quality data reduced the risk of sampling bias and measurement bias.
- Providing timely evidence for policy makers and health sectors to reducing levels of maternal and infant mortality.
- Ability to provide other researchers with flawless information about how to use over dispersed and excesses zero data.
- It is difficult to measure the causal effects, and impossible to know whether the data are time-dependent or not.

## Introduction

Maternal mortality is one of the most significant health problems in low and middle income country<sup>1 2</sup>. For preventable reasons associated with pregnancy and childbirth, 830 maternal deaths, 225000 newborns and 227000 stillbirths occur worldwide every day. Around 99% of these deaths have occurred in developing countries including Ethiopia. About 85% of the total global maternal deaths occurred in Sub-Saharan Africa and Southern Asia, of which two-thirds were from sub-Saharan Africa<sup>3-5</sup>. The maternal mortality rate in developing countries in the year 2015 is 239 per 100 000 live births and 12 per 100,000 live births in developed countries<sup>6 7</sup>. In Ethiopia, the maternal mortality rate is 412 deaths per 100,000 live births. This indicates a female lifetime hazard of maternal death is 1 in 243 Ethiopia<sup>7 8</sup>.

Antenatal and postnatal cares are crucial for the survival and well-being of both the mother and the child. Antenatal care (ANC) helps women to prepare for childbirth and consider the warning signs during pregnancy and birth<sup>9</sup>. The World Health Organization (WHO) suggested encouraging the positive experience of ANC pregnancy and increasing the recommended number of ANC visits from four to eight by 2018. However, it revealed that only 64 percent of women worldwide had  $\geq$  four ANC visit<sup>9 10</sup>. In Ethiopia, about sixty-two percent of women didn't attend a minimum of four ANC visits throughout their pregnancy<sup>8</sup>. Health Sector Transformation Plan of the Ethiopian Federal Ministry of Health addresses troubles associated with having targeted ANC with a minimal of four visits consistent with pregnancy as mainstream in the least provider delivery levels with a target to grow the proportion from 68% to 95 % at the highest by 2020<sup>11</sup>. But, according to the Ethiopia Demography and Health Survey (EDHS) 2016, the ANC service utilization with a minimum of four visits is merely 32%<sup>8</sup>. This indicated that ANC going to in Ethiopia immobile underneath any suitable standard.

Previous research in Ethiopia has been covered in small geographical regions and there is no sufficient study nationwide to the best knowledge of the authors<sup>12-17</sup>. These studies also investigated the associated factor of antenatal care service utilization through binary logistic. While binary logistic regression undercounts the total number of antenatal care visit since multiple service utilization is collapsed into a single unit to fulfill the requirements of binary

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3 logistic regression, provides sufficient information for studying the pattern of multiple service  
4 utilization. In this study, the Zero-Inflated Poisson regression model is the preferred model of  
5 analysis since the Zero-Inflated Poisson regression model provides a way of modeling the  
6 excessive proportion of zero values by allowing over dispersion. When the number of zeros is  
7 large, provides a good fit than Poisson or negative binomial model<sup>18</sup>. Therefore, this study  
8 aimed to calculate the magnitude and identify associated factors of ANC service uptake for the  
9 country at large.

## 15 **Method**

### 16 **Patient and public involvement**

17 This study used a publicly available data set (EDHS 2016); therefore, there were no patients or  
18 members of the public involved.

### 19 **Data source**

20 The data used for this study were taken from the 2016 EDHS. This survey is the fourth  
21 compressive survey designed to provide estimates for the health and demographic variables of  
22 interest for the whole urban and rural areas of Ethiopia as a domain. Women who had 9 months  
23 of pregnancy during the survey interview were included in the analysis. The study includes 7193  
24 of the reproductive age group within the country.

### 25 **Sampling Design**

26 The EDHS 2016 employed a stratified two-stage cluster sampling procedure designed to provide  
27 a representative sample for multiple health and population indicators at national and sub-national  
28 levels (nine regions and two city administrations). Initially, 645 Enumeration Areas (EAs) (202  
29 in urban areas and 443 in rural areas) were drawn using Probability Proportional to Size (PPS)  
30 sampling approach from a whole list of 84,915 EAs defined within the recent 2007 population  
31 census. Then in every selected EA, an exhaustive listing of households was made and 28  
32 households were selected using a systematic sampling approach. Within the chosen households,  
33 enumeration of the entire members was made and information about the ANC service utilization  
34 among all household members was collected primarily from the women<sup>19</sup>.

### 35 **Study variables**

36 The outcome variable of interest in this study was a count response of the number of ANC visits  
37 during their last pregnancy. The independent variables of this study were selected by reviewing  
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related work of literature<sup>12-17</sup>. Women educational level (no education, primary, secondary and higher), husband's occupation (not working, working), wealth index (poor, middle, rich), marital status (living alone, married, Divorced/widowed), women occupation (housewife, employed), age of women (15–24, 25–29 and  $\geq 30$  years), husbands educational level (no education, primary, secondary and higher), planned pregnancy (yes, no), access to mass media (yes, no), pregnancy complications (yes, no), the desire of pregnancy (yes, no), history of terminated pregnancy ever in her life (yes, no) and residence (urban, rural) were considered to be a possible independent variable within the study.

### Data analysis

The cleaned and recoded data were analyzed using R software version 3.5.3. Frequencies and percentages were used to describe the categorical variables. Data were presented using tables. Zero Inflated Poisson Regression (ZIPR) model was conducted to identify factors associated with antenatal care service utilization among pregnant. In recent years, the ZIPR model has gained popularity for modeling count data with excess zeroes<sup>18</sup>. The ZIP models can be viewed as a finite mixture model with a degenerate distribution whose mass is concentrated at zero. Excess zeroes arise when the event of interest is not experienced by many of the subjects<sup>26</sup>. In this study, the ZIPR model was employed to identify the determinant factors of ANC service uptake among pregnant women. Suppose  $Y_i$  is the number of ANC service uptake among pregnant then, the probability mass function of ZIPR is given by<sup>18 27 28</sup>

$$p(Y_i = y_i) = \begin{cases} \pi_i + (1 - \pi_i)\exp(-\mu_i), & \text{if } y_i = 0 \\ (1 - \pi_i)\frac{\exp(-\mu_i)\mu_i^{y_i}}{y_i!}, & \text{if } y_i = 1, 2, 3, \dots \end{cases} \quad 0 \leq \pi_i \leq 1$$

The parameter  $\mu_i$  and  $\pi_i$  depends on the covariates  $x_i$  and  $z_i$ , respectively. The mean and the variance of ZIP regression model, respectively, are:

$E(y_i) = (1 - \pi_i)\mu_i$  and  $Var(y_i) = \mu_i(1 - \pi_i)(1 + \pi_i\mu_i)$ . To apply the ZIPR model in practical modeling situations,<sup>18 27 28</sup> suggested the following joint models for  $\mu$  and  $\pi$

$\ln(\mu) = X^T\beta$  and  $\ln\left(\frac{\pi}{1-\pi}\right) = Z^T\gamma$  where  $X$  and  $Z$  are covariate matrices and  $\beta, \gamma$  are  $(p + 1) \times 1$  and  $(q + 1) \times 1$  vectors of unknown parameters respectively. The two sets of covariates may or may not coincide. Finally, the odds ratio (OR) and incidence rate (IR) with a 95% confidence

interval (CI) were used to assess the strength of associations between the outcome and the independent variables. P-values of  $\leq 0.05$  were considered for statistical significant.

### Ethical Issues

Publicly available EDHS 2016 data were used for this study. Informed consent was taken from each participant, and all identifiers were removed

### Results

From a total of 7913 pregnant women, 64.6 % of the pregnant women have utilized the service, 35.4% of the pregnant women didn't receive any ANC service and 35.5% of the pregnant women have received at least four ANC visits. The mean and variance of observation are 2.53 and 5.614, respectively. The variance to mean ratio is 2.22, which indicates some over-dispersion (Table 1).

**Table 1:** The number of women that experienced ANC visits

Number of visits	Count	Percent
0	2545	35.4
1	342	4.8
2	563	7.8
3	1187	16.5
4	1136	15.8
5	621	8.6
6	402	5.6
7	187	2.6
8+	108	2.9
Total	7193	100.0
Mean	2.53	
Variance	5.614	

### Test of over dispersion

The Pearson residual  $\chi^2$ -statistic for Poisson and ZIP model was summarized in Table 2. The Pearson dispersion value of the Poisson model is 1.829 ( $p < 0.001$ ), which clearly shows the existence of over-dispersion in the data and the Poisson model is over-dispersed. It follows that the options for modeling and analyzing such over dispersed and excess zero ANC count response data should be considered. Then fit ZIP and 1.001 is the Pearson dispersion value. This indicates that the ZIP has modeled and captured the over-dispersion in the data set very well; because the dispersion value is very close to 1. For this reason, ZIP model used for the analysis in order to identify the associated factors of ANC service uptake (Table 2).

**Table 2:** Test of over-dispersion based on Pearson residual  $\chi^2$ -statistic

Model	Dispersion Test (Ratio Statistic & p-value)
Poisson	1.829(0.001)
ZIP	1.001 ( 0.004)

### Socio-demographic characteristics of study participants

The majority of the study respondents were from rural residences (79%). Most of the respondents were housewives (70%) and 30% of the respondents were employed. About 60.6% of mothers didn't attend primary school and only 12.4% of mothers attended secondary and above education. The majority (69.4%) of the respondents had no pregnancy complications and 64.4% had no access to mass media. About 91.5 percent of women were married, 3.2 percent of women were living alone women while 5.3% were divorced and widowed. The majorities (79.8%) of pregnancies were planned and 9% of pregnancies were terminated. Regarding husband education, 31.7% of the husband had no formal education while 30% of husbands attend primary education. About half (50.7%) of had poor wealth index, 35.0% were rich wealth while others were middle wealth index (14.3%). Regarding the mother age, the majorities (46.2%) of mothers were under the age group of 30 years plus, then followed 25-29 years (Table 3).

**Table 3:** Socio demographic characteristics of pregnant women in Ethiopia

Variable	Frequency (n)	Percentage (%)
Residence		
Urban	1512	21
Rural	5681	79
Occupation of women		
Housewife	5033	70
Employed	2160	30
Planned pregnancy		
No	1452	20.2
Yes	5741	79.8
Terminated pregnancy		
No	6556	91.1
Yes	637	8.9
Wealth index		
Low	3607	50.7
Medium	1028	14.3
Rich	2558	35.0
Marital status		
Never married	230	3.2
Married	6579	91.5
Divorced/widowed	384	5.3



Age of women in a year		
15-24	1852	25.7
25-29	2015	28.1
30 and above	3326	46.2
Husband education		
No education	3719	51.7
Primary	2160	30.0
Secondary and above	1314	18.3
Woman education		
No education	4359	60.6
Primary	1942	27
Secondary and above	892	12.4
Access to mass media		
No	4646	64.6
Yes	2547	35.4
Pregnancy complications		
No	5015	69.7
Yes	2178	30.3
Husband's occupation		
Not working	1285	17.9
Working	5908	82.1

### Associated factors of ANC service uptake

As shown in the below table (Table 4), the Poisson component shows that the incidence rate (IR) of ANC visits. The finding of this study revealed that women's and husbands' levels of education have a significant factor for ANC service uptake. The expected number of ANC service uptake for women with primary education was 1.06 (IRR =1.06; 95%CI: 1.02, 1.10) times higher compared to women with no formal education. The expected number of ANC service uptake for women with secondary and above education was 1.11 (IRR =1.11; 95% CI: 1.05, 1.18) times higher compared to women with no formal education. The expected number of ANC service uptake for husbands with primary education was 1.05 (IRR =1.05; 95% CI: 1.01, 1.10) times higher compared to husbands with no formal education. Similarly, ANC service uptake for husbands with secondary and above education increased by 9% (IRR =1.09; 95%CI: 1.03, 1.14) times higher compared to husbands with no formal education. The expected number of ANC service uptake of the rural women was 0.88 (IRR =0.88; 95%CI: 1.85, 1.92) times lower compared to urban women. The incidence rate of ANC service uptake for the rich wealth index would be 1.08 (IRR =1.08; 95% CI: 1.03, 1.13) times higher compared to their poor wealth

index. The incidence rate of ANC service uptake for married women was 1.19 (IRR =1.19; 95% CI: 1.09, 1.30) times higher compared to living alone women. The incidence rate of ANC service uptake for women who had seen signs of pregnancy complications was 1.20 (IRR =1.20; 95% CI: 1.17, 1.24) times higher compared to those women who had no signs of pregnancy complication. The incidence rate of ANC service uptake for women being the use of mass media was 1.09 (IRR =1.09; 95% CI: 1.05, 1.13) times higher compared to those who don't use mass media. The incidence rate of ANC service uptake for mothers age 25-29 was 1.06 (IRR =1.06; 95% CI: 1.02, 1.10) times higher compared to those whose aged is 15-24. The incidence rate of ANC service uptake for mothers age 30 and above was 1.07 (IRR =1.07; 95% CI: 1.02, 1.11) times higher compared to those whose aged is 15-24 (Table 4).

**Table 4:** Zero Inflated Poisson regression model result (IRR and AOR)

Variable	Poisson part	Bernoulli part
	IR(95% CI of IR)	AOR(95%CI of AOR)
Residence		
Urban	1	1
Rural	0.884(0.846, 0.924)*	2.254(1.780, 2.855)*
Access to mass media		
No	1	1
Yes	1.086(1.045, 1.128)*	0.612(0.525,0.713)*
Planned pregnancy		
No	1	1
Yes	1.028( 0.989, 1.069)	0.794(0.685, 0.920)*
Husbands occupation		
Not working	1	1
Working	1.017(0.959, 1.077)	0.761(0.655,0.884)*
Wealth index		
Low	1	1
Medium	1.039(0.989, 1.093)	0.594(0.501, 0.704)*
Rich	1.077( 1.029, 1.127)*	0.568(0.479, 0.672)*
Women's education		
No education	1	1
Primary	1.057(1.015, 1.101)*	0.454(0.388, 0.531)*
Secondary and above	1.112(1.052, 1.176)*	0.389(0.286, 0.530)*
Husband education		
No education	1	1
Primary	1.052(1.010, 1.096)*	0.625(0.542, 0.721)*
Secondary and above	1.085(1.031, 1.142)*	0.666(0.532, 0.836)*
Age of women (year)		
15-24	1	1
25-29	1.060(1.016, 1.104)*	0.991(0.830, 1.184)
30 and above	1.067(1.024, 1.111)*	0.827(0.656,1.042)
Marital status		
living alone	1	1

Married	1.187(1.087, 1.296)*	0.865(0.576, 1.301)
Divorced/widowed	1.083(0.990, 1.184)	0.639(0.460, 0.888)*
Pregnancy complications		
No	1	1
Yes	1.203(1.165, 1.242)*	0.859(0.569, 1.297)
Occupation of women		
Housewife	1	1
Working	0.982(0.950, 1.016)	0.937(0.809, 1.085)
Terminated pregnancy		
No	1	1
Yes	1.039(0.986, 1.094)	0.817(0.649, 1.027)

**Note:** 1 = reference category of the categorical variable.

\* Significant at 5% level of significance

The Bernoulli part also indicated that the estimated odds that the number of ANC service uptake becomes zero with who is living in the rural area was 2.25 (OR = 2.25; 95%CI: 1.78, 2.86) times that of urban women. The estimated odds the number of ANC service uptake becomes zero with women who attend primary education was 0.45 (OR = 0.45; 95%CI: 0.39, 0.53) times that of the non-educated women. Similarly, the estimated odds the number of ANC service uptake becomes zero with husbands who have primary education was 0.63 (OR = 0.63; 95%CI: 0.54, 0.72) times that of the non-educated husbands. The estimated odds the number of ANC service uptake becomes zero with rich women was 0.57 (OR = 0.57; 95%CI: 0.48, 0.67) times that of the poor wealth index. The odds of the number of ANC service uptake becomes zero with husbands who work is 0.76 (OR = 0.76; 95%CI: 0.66, 0.88) times that of husbands without work. The estimated odds the number of ANC service uptake becomes zero with women who have used mass media was 0.61 (AOR = 0.61; 95%CI: 0.53, 0.71) times that of women who did not use any mass media (Table 4).

## Discussion

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3 Antenatal care during pregnancy is important for the health of the mother and the development  
4 of the unborn baby. Therefore, this study aimed at determining the magnitude and associated  
5 factors of ANC service uptake among pregnant women in Ethiopia. The results of this study  
6 showed that about 64.6 % of the pregnant women have utilized the service and 35.4% haven't  
7 received ANC services during their pregnancy which is less than that reported from 2016 EDHS  
8 urban Ethiopia<sup>19</sup>. It's also less than reported from the studies conducted in different parts of  
9 Ethiopia<sup>12 29 30</sup>.

10 The findings of this study revealed that education had a positive relationship with ANC service  
11 uptake, that is, the amount of ANC service uptake increase with the rise in woman's and  
12 husband's education level. The study shows an identical result with other studies<sup>15 20 25 31-35</sup>,  
13 which revealed that non-educated women and husbands were less ANC attendants than those  
14 that have educated women. The possible justification behind this could be that educated women  
15 have taken more ANC because they have more awareness of the benefits of regular ANC uptake,  
16 such as reducing risks of pregnancy and ensuring safe childbirth. Educated husbands may have  
17 better communication with their wives and may be able to explore the importance of ANC  
18 uptake and other maternal health services<sup>36</sup>. This could also provide their wives with more  
19 freedom as well<sup>37</sup>.

20 The uptake of ANC services among married women was higher compared to women living  
21 alone. This finding is consistent with the studies conducted in Ethiopia<sup>15</sup>, Kenya<sup>32</sup>, Rwanda<sup>38</sup>  
22 and Bangladesh<sup>35</sup>. This may be attributed to the psychological and economic support obtained  
23 from their husbands, planning/desirability of their pregnancy and the societal acceptability and  
24 support of their pregnant state when compared with their unmarried women.

25 Wealth index has been negatively correlated with the use of ANC services. Relative to the richest  
26 wealth quintile, women belonging to the lowest wealth quintiles were less likely to uptake ANC  
27 service. Studies elsewhere have also documented a positive relationship between economic status  
28 and ANC service uptake<sup>17 21 22 31 35 39</sup>. The possible justification of this finding might be that rich  
29 women may obtain more ANC information from mass media and may have greater access to  
30 health care. In addition, this may be attributed to the indirect cost of antenatal care, such as  
31 transport cost, while traveling to distant health facility<sup>40</sup>.

32 Compared to rural women, women living in urban areas were more likely to utilize ANC service.  
33 This finding is supported by the studies conducted in<sup>16 17 33 41</sup>. The potential reason may be that

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3 urban women had a better education, access to health services and more informed about the  
4 importance of ANC service uptake. The exposure of mass media was positively associated with  
5 ANC services. Women who were exposed to media were more ANC service uptake than women  
6 who weren't exposed to media. This finding is in line with reports of other previous studies<sup>17 23 33</sup>  
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35. Compared to housewife women, the number of ANC uptake among employed women was  
higher. This finding is similar to the study done in Kenya<sup>42</sup> and 31 sub-Saharan Africa countries  
<sup>43</sup> which showed that the odds of antenatal care utilization were higher among working women  
than non-working<sup>43</sup>. This may be due to the fact that employed women, especially those in the  
formal sector, have the ability to benefit from a pregnancy care health insurance system. The  
finding indicated that women who did develop pregnancy complications were more likely to  
uptake ANC service than those who did not develop pregnancy complications. This finding is in  
line with studies done in Ethiopia<sup>44</sup>, Northern Jordan<sup>24</sup> and Tanzanian<sup>25</sup> and Pakistan<sup>25</sup>.

Relative to unplanned/unwanted pregnancies, women whose pregnancies were planned and  
desired were more likely to use ANC services. These findings were consistent with previous  
studies<sup>22-24 32</sup>. Results also showed that the number of ANC visit increased significantly as the  
age of women increased. Previous studies supported that women's age plays a big role in the  
utilization of maternal health care<sup>12 20</sup>.

### **Strengths and limitation**

This study used EDHS data with large sample size and high-quality data which reduced the risk  
of sampling bias and measurement bias. The result of this study also providing timely evidence  
for policymakers and health sectors to reducing levels of maternal and infant mortality depends  
on increasing the use of reproductive and maternal health services. The study is also able to  
provide other researchers with flawless information about how to use over dispersed excesses  
zero and zero-inflated Poisson regression model. Due to cross sectional study design, It is  
difficult to measure the causal effects, and impossible to know whether the data are time-  
dependent or not.

### **Conclusion**

About 64.6 percent of the pregnant women have utilized the service and only 35.5 percent of the  
pregnant women have received at least four ANC visits. ANC service uptake in Ethiopia is  
extremely low and below average as compared to the minimum requirement of ANC service  
uptake recommended by WHO. This study was revealed that rural women, poor women, lower

maternal and paternal education, mothers not having access to mass media, living alone women, mothers who have not complicated pregnancy was significantly associated with less number of ANC service utilization. Therefore, efforts have to be done to increase the socioeconomic status and to promote the decision making the role of women. Besides, there is a need for improving community awareness on maternal health and for motivating women to ANC service uptake.

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**Contributors:** SM drafted the proposal, did the analysis, wrote the results and prepared the manuscript. GM revised and critically reviewed the manuscript. Both authors read and approved the final manuscript.

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**Competing interests:** None declared.

**Patient consent for publication:** Not required.

**Data sharing statement:** The survey datasets used in this study was based on a publicly available dataset that is freely available online with no participant's identity from <http://www.dhsprogram.com/data/available-datasets.cfm>.

**Ethics approval and consent to participate:** The study used available secondary data accessed under the National Data Sharing and Accessibility Policy (NDSAP) of the Government of Ethiopia. The data set had no identifiable information on the survey participants; therefore, no ethical approval is required for this work.

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**Abbreviations:** ANC: Antenatal Care; AOR: Adjusted Odd Ratio; EDHS: Ethiopian Demographic and Health Survey; HSTP: Health Sector Transformation Plan; IR: Incidence Rate; SDG: Sustainable development Goal; WHO: World Health Organization; ZIP: Zero Inflated Regression Poisson

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## Magnitude of Antenatal Care Service uptake and associated factors among Pregnant Women: analysis of the 2016 Ethiopia demographic and health survey

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3 **Magnitude of Antenatal Care Service uptake and associated factors among Pregnant**  
4 **Women; analysis of the 2016 Ethiopia demographic and health survey**  
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8 Setegn Muche Fenta\*<sup>1</sup>and Girum Meseret Ayenew<sup>2</sup>  
9

10 <sup>1</sup>Department of Statistics, Debre Tabor University,P.O. Box272 Debre Tabor, Ethiopia.  
11

12 <sup>2</sup>Research and Technology Transfer Directorate, Amhara Public Health Institute, P.O. Box 477  
13 Bahir Dar, Ethiopia;[girum.m21@gmail.com](mailto:girum.m21@gmail.com)  
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17 **\*Corresponding:**[setegn14@gmail.com](mailto:setegn14@gmail.com)  
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## Abstract

**Objective:** Antenatal and postnatal cares are crucial for the survival and well-being of both the mother and the child. World Health Organization recommends a minimum of four antenatal care visits during a pregnancy. In Ethiopia, only 38% of women in the reproductive age received a minimum of first antenatal care visits. This value is far more below the typical rates of least developed countries. This study aimed to calculate the magnitude and identify associated factors of antenatal care service utilization among pregnant women in Ethiopia.

**Design:** Cross-sectional study design

**Setting:** Ethiopian.

**Participants:** A total of 7913 pregnant women were included in the study.

**Primary outcome measures:** Antenatal Care Service uptake among Pregnant

**Result:** Only 35.5% of the pregnant mothers have utilized antenatal care services at least four times and 64.5% of the pregnant mothers have utilized less than three times during their periods of pregnancy. The study showed that rich women (PR=1.077, 95% CI: 1.029,1.127), having access to mass media (PR=1.086, 95% CI: 1.045, 1.128), having pregnancy complications (PR=1.203, 95% CI: 1.165, 1.242), secondary school and above-educated women (PR=1.112, 95% CI:1.052, 1.176), husbands' having secondary school and above level of education (PR=1.085, 95% CI: 1.031, 1.142), being married (PR = 1.187; 95% CI: 1.087,1.296), rural women (PR=0.884, 95% CI: 0.846, 0.924) and women age >30 years (PR=1.067, 95% CI: 1.024, 1.111) were significantly associated with the antenatal care service uptake.

**Conclusion:** The magnitude of ANC service uptake was low. This low magnitude of ANC service utilization calls for a need for improving community awareness on maternal health. More importantly, intensive health education is required for pregnant women to have better ANC service uptake and follow-up adherence.

**Keywords:** Antenatal Care services uptake, Ethiopia, Zero Inflated Poisson Regression Model

### Strengths and limitation

- Large sample size and high-quality data reduced the risk of sampling and measurement bias.
- Timely evidence for policymakers and health sectors to reduce maternal and infant mortality.
- Gives flawless information to the scientific community about how to use over dispersed and excesses zero data.
- Unable to measure the causal effects, and impossible to know whether the data are time-dependent or not.

## Introduction

Maternal mortality is one of the most significant health problems in low and middle income country<sup>1 2</sup>. Worldwide; about 295, 000 maternal deaths, 2.4 million newborn and 2 million stillbirths occur each year and most causes of these death were found to be preventable which are associated with pregnancy and childbirth. Around 99% of these deaths have occurred in developing countries including Ethiopia. About 85% of the total global maternal deaths occurred in Sub-Saharan Africa and Southern Asia, of which two-thirds were from sub-Saharan Africa<sup>3-5</sup>. The maternal mortality rate in developing countries in the year 2015 is 239 per 100 000 live births and 12 per 100,000 live births in developed countries<sup>6 7</sup>. In Ethiopia, the maternal mortality rate is 412 deaths per 100,000 live births. This indicates a female lifetime hazard of maternal death is 1 in 243 Ethiopia<sup>7 8</sup>.

Antenatal and postnatal cares are crucial for the survival and well-being of both the mother and the child. Antenatal care (ANC) helps women to prepare for childbirth and consider the warning signs during pregnancy and birth<sup>9</sup>. The World Health Organization (WHO) suggested encouraging the positive experience of ANC pregnancy and increasing the recommended number of ANC visits from four to eight by 2018. However, it revealed that only 64 percent of women worldwide had  $\geq$  four ANC visit<sup>9 10</sup>. In Ethiopia, about sixty-two percent of women didn't attend a minimum of four ANC visits throughout their pregnancy<sup>8</sup>. Health Sector Transformation Plan of the Ethiopian Federal Ministry of Health addresses troubles associated with having targeted ANC with a minimal of four visits consistent with pregnancy as mainstream in the least provider delivery levels with a target to grow the proportion from 68% to 95 % at the highest by 2020<sup>11</sup>. But, according to the Ethiopia Demography and Health Survey (EDHS) 2016, the ANC service utilization with a minimum of four visits is merely 32%<sup>8</sup>. This indicated that ANC going to in Ethiopia immobile underneath any suitable standard.

Previous research in Ethiopia has been covered in small geographical regions and there is no sufficient study nationwide to the best knowledge of the authors<sup>12-17</sup>. These studies also investigated the associated factor of antenatal care service utilization through binary logistic. While binary logistic regression undercounts the total number of antenatal care visit since multiple service utilization is collapsed into a single unit to fulfill the requirements of binary

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3 logistic regression, provides sufficient information for studying the pattern of multiple service  
4 utilization. In this study, the Zero-Inflated Poisson regression model is the preferred model of  
5 analysis since the Zero-Inflated Poisson regression model provides a way of modeling the  
6 excessive proportion of zero values by allowing over dispersion. When the number of zeros is  
7 large, provides a good fit than Poisson or negative binomial model<sup>18</sup>. Therefore, this study aimed  
8 to calculate the magnitude and identify associated factors of ANC service uptake for the country  
9 at large.

## 15 **Method**

### 16 **Patient and public involvement**

17 This study used a publicly available data set (EDHS 2016); therefore, there were no patients or  
18 members of the public involved.

### 19 **Data source**

20 The data used for this study were taken from the 2016 EDHS. This survey is the fourth  
21 compressive survey designed to provide estimates for the health and demographic variables of  
22 interest for the whole urban and rural areas of Ethiopia as a domain. Women who had 9 months  
23 of pregnancy during the survey interview were included in the analysis. The study includes 7193  
24 of the reproductive age group within the country.

### 25 **Sampling Design**

26 The EDHS 2016 employed a stratified two-stage cluster sampling procedure designed to provide  
27 a representative sample for multiple health and population indicators at national and sub-national  
28 levels (nine regions and two city administrations). Initially, 645 Enumeration Areas (EAs) (202  
29 in urban areas and 443 in rural areas) were drawn using Probability Proportional to Size (PPS)  
30 sampling approach from a whole list of 84,915 EAs defined within the recent 2007 population  
31 census. Then in every selected EA, an exhaustive listing of households was made and 28  
32 households were selected using a systematic sampling approach. Within the chosen households,  
33 enumeration of the entire members was made and information about the ANC service utilization  
34 among all household members was collected primarily from the women<sup>19</sup>.

### 35 **Study variables**

36 The outcome variable of interest in this study was a count response of the number of ANC visits  
37 during their last pregnancy. The independent variables of this study were selected by reviewing  
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related work of literature<sup>12-17 20-25</sup>. Women educational level (no education, primary, secondary and higher), husband's occupation (not working, working), wealth index (poor, middle, rich), marital status (living alone, married, Divorced/widowed), women occupation (housewife, employed), age of women (15–24, 25–29 and  $\geq 30$  years), husbands educational level (no education, primary, secondary and higher), planned pregnancy (yes, no), access to mass media (yes, no), pregnancy complications (yes, no), the desire of pregnancy (yes, no), history of terminated pregnancy ever in her life (yes, no) and residence (urban, rural) were considered to be a possible independent variable within the study.

### Data analysis

The cleaned and recoded data were analyzed using R software version 3.5.3. Frequencies and percentages were used to describe the categorical variables. Data were presented using tables. Zero Inflated Poisson Regression (ZIPR) model was conducted to identify factors associated with antenatal care service utilization among pregnant. In recent years, the ZIPR model has gained popularity for modeling count data with excess zeroes<sup>18</sup>. The ZIP models can be viewed as a finite mixture model with a degenerate distribution whose mass is concentrated at zero. Excess zeroes arise when the event of interest is not experienced by many of the subjects<sup>26</sup>. In this study, the ZIPR model was employed to identify the determinant factors of ANC service uptake among pregnant women. Suppose  $Y_i$  is the number of ANC service uptake among pregnant then, the probability mass function of ZIPR is given by<sup>18 27 28</sup>

$$p(Y_i = y_i) = \begin{cases} \pi_i + (1 - \pi_i)\exp(-\mu_i), & \text{if } y_i = 0 \\ (1 - \pi_i)\frac{\exp(-\mu_i)\mu_i^{y_i}}{y_i!}, & \text{if } y_i = 1, 2, 3, \dots \end{cases} \quad 0 \leq \pi_i \leq 1$$

The parameter  $\mu_i$  and  $\pi_i$  depends on the covariates  $x_i$  and  $z_i$ , respectively. The mean and the variance of ZIP regression model, respectively, are:

$E(y_i) = (1 - \pi_i)\mu_i$  and  $Var(y_i) = \mu_i(1 - \pi_i)(1 + \pi_i\mu_i)$ . To apply the ZIPR model in practical modeling situations, <sup>18 27 28</sup> suggested the following joint models for  $\mu$  and  $\pi$

$\ln(\mu) = X^T\beta$  and  $\ln\left(\frac{\pi}{1-\pi}\right) = Z^T\gamma$  where  $X$  and  $Z$  are covariate matrices and  $\beta, \gamma$  are  $(p + 1) \times 1$  and  $(q + 1) \times 1$  vectors of unknown parameters respectively. The two sets of covariates may or may not coincide. Finally, the odds ratio (OR) and prevalence ratios (PR) with a 95% confidence interval (CI) were used to assess the strength of associations between the outcome and the

independent variables using Poisson and Bernoulli regression models' assumptions. P-values of  $\leq 0.05$  were considered for statistically significant.

### Ethical Issues

Publicly available EDHS 2016 data were used for this study. Informed consent was taken from each participant, and all identifiers were removed

### Results

From a total of 7913 pregnant women, 64.6 % of the pregnant women have utilized the service, 35.4% of the pregnant women didn't receive any ANC service and 35.5% of the pregnant women have received at least four ANC visits. The mean and variance of observation are 2.53 and 5.614, respectively. The variance to mean ratio is 2.22, which indicates some over-dispersion (Table 1).

**Table 1: The number of women that experienced ANC visits**

Number of visits	Count	Percent
0	2545	35.4
1	342	4.8
2	563	7.8
3	1187	16.5
4	1136	15.8
5	621	8.6
6	402	5.6
7	187	2.6
8+	108	2.9
Total	7193	100.0
Mean	2.53	
Variance	5.614	

### Test of over dispersion

The Pearson residual  $\chi^2$ -statistic for Poisson and ZIP model was summarized in Table 2. The Pearson dispersion value of the Poisson model is 1.829 ( $p < 0.001$ ), which clearly shows the existence of over-dispersion in the data and the Poisson model is over-dispersed. It follows that the options for modeling and analyzing such over dispersed and excess zero ANC count response data should be considered. Then fit ZIP and 1.001 is the Pearson dispersion value. This indicates that the ZIP has modeled and captured the over-dispersion in the data set very well; because the dispersion value is very close to 1. For this reason, ZIP model used for the analysis in order to identify the associated factors of ANC service uptake (Table 2).

**Table 2: Test of over-dispersion based on Pearson residual  $\chi^2$ -statistic**

Model	Dispersion Test (Ratio Statistic & P-value)
Poisson	1.829(0.001)
ZIP	1.001 ( 0.004)

### Socio-demographic characteristics of study participants

The majority of the study respondents were from rural residences (79%). Most of the respondents were housewives (70%) and 30% of the respondents were employed. About 60.6% of mothers didn't attend primary school and only 12.4% of mothers attended secondary and above education. The majority (69.4%) of the respondents had no pregnancy complications and 64.4% had no access to mass media. About 91.5 percent of women were married, 3.2 percent of women were living alone women while 5.3% were divorced and widowed. The majorities (79.8%) of the pregnancies were planned and 9% of the pregnancies were terminated. Regarding husband education, 31.7% of the husband had no formal education while 30% of husbands attend primary education. About half (50.7%) of women had poor wealth index, 35.0% were rich wealth while others were middle wealth index (14.3%). Regarding the mother age, the majorities (46.2%) of mothers were under the age group of 30 years plus, then followed 25-29 years (Table 3).

### Magnitude of ANC services uptake by socio-demographic characteristics of study participants

The mean and median numbers of ANC visits by socio-demographic characteristics of study participants are shown in Table 3. The mean numbers of ANC visits for urban women (4.26)

were higher than for rural women (2.07). Among poor women, the lowest mean numbers of ANC visits were recorded (1.71). The lowest mean numbers of ANC visits were observed for uneducated husbands (1.93), while the highest mean numbers of ANC visits were observed for husbands with secondary education and above (3.83). Women exposed to the media had the highest mean numbers of ANC visits (3.65), while the mean numbers of ANC visits for women not exposed to the media were low (1.92). The lowest mean numbers of ANC visits occur in uneducated women (1.88), while the highest mean numbers of ANC visits have been recorded for women with secondary education and above (4.36). Compared with women who had no symptoms of pregnancy problems (1.78), women who had seen signs of pregnancy complications had a higher mean number of ANC visits (4.28). Furthermore; residency, occupation of women, planned pregnancy, wealth index, marital status, age of women, husbands' education status, women education level, access to mass media, pregnancy complication and occupation of husbands were significantly correlated with the median number of ANC visits (Table 3).

Table 3: Magnitude of ANC services uptake by socio-demographic characteristics of study participants and the associated Chi-Square ( $\chi^2$ ) test for equality of the medians

Characteristics		Frequency (%)	Mean	Median	X <sup>2</sup> value (p-value)
Residence	Urban	1512(21.0)	4.26	4	184.60 (<0.001)
	Rural	5681(79.0)	2.07	2	
Occupation of women	Housewife	5033(70.0)	2.37	2	93.14 (<0.001)
	Employed	2160(30.0)	2.92	3	
Planned pregnancy	No	1452(20.2)	2.53	3	28.81 (<0.001)
	Yes	5741(79.8)	2.54	3	
Terminated pregnancy	No	6556(91.1)	2.51	3	4.97(0.893)
	Yes	637(8.9)	2.79	3	
Wealth index	Low	3607(50.7)	1.71	1	237.13 (<0.001)
	Medium	1028(14.3)	2.47	3	
	Rich	2558(35.0)	3.71	4	
Marital status	Never married	230(3.2)	2.52	3	59.19 (<0.001)
	Married	6579(91.5)	3.26	4	

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3		Divorced/widowed	384(5.3)	2.56	3	
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5	Age of	15-24	1852(25.1)	2.60	3	
6	women in a	25-29	2015(28.1)	2.73	3	75.50 (<0.001)
7	year	30 and above	3326(46.2)	2.38	3	
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9	Husband	No education	3719(51.7)	1.93	1	
10	education	Primary	2160(30.0)	2.79	3	742.45 (<0.001)
11		Secondary and above	1314(18.3)	3.83	4	
12	Woman	No education	4359(60.6)	1.88	1	
13	education	Primary	1942(27.0)	3.15	3	205.01 (<0.001)
14		Secondary and above	892(12.4)	4.36	4	
15	Access to	No	4646(64.6)	1.92	1	188.39 (<0.001)
16	mass media	Yes	2547(35.4)	3.65	4	
17	Pregnancy	No	5015(69.7)	1.78	1	848.99 (<0.001)
18	complications	Yes	2178(30.3)	4.28	4	
19	Husband's	Not working	1285(17.9)	2.19	2	56.98 (<0.001)
20	occupation	Working	5908(82.1)	2.61	3	
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## Factors associated with ANC service uptake, application of Zero Inflated Poisson regression models

As shown in the below table (Table 4), the Poisson component shows that the prevalence ratios (PR) of ANC visits. The finding of this study revealed that women's and husbands' levels of education have had a significant factor in ANC service uptake. The expected number of ANC service uptake for women with primary education was 1.06 (PR =1.06; 95%CI: 1.02, 1.10) times higher compared to women with no formal education. The expected number of ANC service uptake for women with secondary and above education was 1.11 (PR =1.11; 95% CI: 1.05, 1.18) times higher compared to women with no formal education. The expected number of ANC service uptake for husbands with primary education was 1.05 (PR =1.05; 95% CI: 1.01, 1.10) times higher compared to husbands with no formal education. Similarly, ANC service uptake for husbands with secondary and above education increased by 9% (IRR =1.09; 95%CI: 1.03, 1.14) times higher compared to husbands with no formal education. The expected number of ANC service uptake of the rural women was 0.88 (PR =0.88; 95%CI: 1.85, 1.92) times lower compared to urban women. The expected number of ANC service uptake for the rich wealth index was 1.08 (PR =1.08; 95% CI: 1.03, 1.13) times higher compared to their poor wealth index. The expected number of ANC service uptake for married women was 1.19 (PR =1.19; 95% CI: 1.09, 1.30) times higher compared to living alone women. The expected number of ANC service uptake for women who had seen signs of pregnancy complications was 1.20 (PR =1.20; 95% CI: 1.17, 1.24) times higher compared to those women who had no signs of pregnancy complication. The expected number of ANC service uptake for women using mass media was 1.09 (PR =1.09; 95% CI: 1.05, 1.13) times higher compared to those who don't use mass media. The expected number of ANC service uptake for mothers in the age group of 25-29 was 1.06 (PR =1.06; 95% CI: 1.02, 1.10) times higher compared with the age group of 15-24 years. The expected number of ANC service uptake for mothers age 30 and above was 1.07 (PR =1.07; 95% CI: 1.02, 1.11) times higher compared with the age group of 15-24 years (Table 4).

Table 4: Factors associated with ANC service uptake, application of application of Zero Inflated Poisson regression models

Characteristics		Poisson part PR (95% CI of PR)	Bernoulli part AOR (95%CI of AOR)
Residence	Urban	1	1
	Rural	0.884(0.846, 0.924) *	2.254(1.780, 2.855)*
Access to mass media	No	1	1
	Yes	1.086(1.045, 1.128) *	0.612(0.525,0.713)*
Planned pregnancy	No	1	1
	Yes	1.028( 0.989, 1.069)	0.794(0.685, 0.920)*
Husbands occupation	Not working	1	1
	Working	1.017(0.959, 1.077)	0.761(0.655,0.884)*
Wealth index	Low	1	1
	Medium	1.039(0.989, 1.093)	0.594(0.501, 0.704)*
	Rich	1.077( 1.029, 1.127)*	0.568(0.479, 0.672)*
Women's education	No education	1	1
	Primary	1.057(1.015, 1.101)*	0.454(0.388, 0.531)*
	Secondary and above	1.112(1.052, 1.176)*	0.389(0.286, 0.530)*
Husband education	No education	1	1
	Primary	1.052(1.010, 1.096)*	0.625(0.542, 0.721)*
	Secondary and above	1.085(1.031, 1.142)*	0.666(0.532, 0.836)*
Age of women (year)	15-24	1	1
	25-29	1.060(1.016, 1.104)*	0.991(0.830, 1.184)
	30 and above	1.067(1.024, 1.111)*	0.827(0.656,1.042)
Marital status	living alone	1	1
	Married	1.187(1.087, 1.296)*	0.865(0.576, 1.301)
	Divorced/widowed	1.083(0.990, 1.184)	0.639(0.460, 0.888)*
Pregnancy complications	No	1	1
	Yes	1.203(1.165, 1.242)*	0.859(0.569,1.297)
Occupation of women	Housewife	1	1
	Working	0.982(0.950, 1.016)	0.937(0.809, 1.085)
Terminated pregnancy	No	1	1
	Yes	1.039(0.986,1.094)	0.817(0.649, 1.027)

**Note:** 1 = reference category of the categorical variable.

\* Significant at 5% level of significance

The Bernoulli part also indicated that the estimated odds that the number of ANC service uptake becomes zero with who is living in the rural area was 2.25 (OR = 2.25; 95%CI: 1.78, 2.86) times that of urban women. The estimated odds the number of ANC service uptake becomes zero with women who attend primary education was 0.45 (OR =0.45; 95%CI: 0.39, 0.53) times that of the non-educated women. Similarly, the estimated odds the number of ANC service uptake becomes zero with husbands who have primary education was 0.63 (OR = 0.63; 95%CI: 0.54, 0.72) times that of the non-educated husbands. The estimated odds the number of ANC service uptake

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3 becomes zero with rich women was 0.57 (OR = 0.57; 95%CI: 0.48, 0.67) times that of the poor  
4 wealth index. The odds of the number of ANC service uptake becomes zero with husbands who  
5 work is 0.76 (OR = 0.76; 95%CI: 0.66, 0.88) times that of husbands without work. The estimated  
6 odds the number of ANC service uptake becomes zero with women who have used mass media  
7 was 0.61 (AOR = 0.61; 95%CI: 0.53, 0.71) times that of women who did not use any mass media  
8 (Table 4).  
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## 14 Discussion

15  
16 Antenatal care during pregnancy is important for the health of the mother and the development  
17 of the fetus. Therefore, this study aimed at determining the magnitude and associated factors of  
18 ANC service uptake among pregnant women in Ethiopia. The results of this study showed that  
19 about 64.6 % of the pregnant women have utilized the service and 35.4% haven't received ANC  
20 services during their pregnancy which is less than that reported from 2016 EDHS urban  
21 Ethiopia<sup>19</sup>. It's also less than reported from the studies conducted in different parts of Ethiopia<sup>12</sup>  
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28 The findings of this study revealed that education had a positive relationship with ANC service  
29 uptake, that is; the amount of ANC service uptake increase with the rise in woman's and  
30 husband's education level. The study shows an identical result with other studies<sup>15 20 25 31-35</sup>,  
31 which revealed that non-educated women and husbands were fewer ANC attendants than those  
32 that have educated women. The possible justification behind this could be that educated women  
33 have taken more ANC because they have more awareness of the benefits of regular ANC uptake,  
34 such as reducing risks of pregnancy and ensuring safe childbirth. Educated husbands may have  
35 better communication with their wives and may be able to explore the importance of ANC  
36 uptake and other maternal health services<sup>36</sup>. This could also provide their wives with more  
37 freedom as well<sup>37</sup>.  
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39 The uptake of ANC services among married women was higher compared to women living  
40 alone. This finding is consistent with the studies conducted in Ethiopia<sup>15</sup>, Kenya<sup>32</sup>, Rwanda<sup>38</sup>  
41 and Bangladesh<sup>35</sup>. This may be attributed to the psychological and economic support obtained  
42 from their husbands, planning/desirability of their pregnancy and the societal acceptability and  
43 support of their pregnant state when compared with their unmarried women.  
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45 Wealth index has been negatively correlated with the use of ANC services. Relative to the richest  
46 wealth quintile, women belonging to the lowest wealth quintiles were less likely to uptake ANC  
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3 service. Studies elsewhere have also documented a positive relationship between economic status  
4 and ANC service uptake<sup>17 21 22 31 35 39</sup>. The possible justification of this finding might be that rich  
5 women may obtain more ANC information from mass media and may have greater access to  
6 health care. In addition, this may be attributed to the indirect cost of antenatal care, such as  
7 transport cost, while traveling to distant health facility<sup>40</sup>.

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12 Compared to rural women, women living in urban areas were more likely to utilize ANC service.  
13 This finding is supported by the studies conducted in<sup>16 17 33 41</sup>. The potential reason may be that  
14 urban women had a better education, access to health services and more informed about the  
15 importance of ANC service uptake. The exposure of mass media was positively associated with  
16 ANC services. Women who were exposed to media were more ANC service uptake than women  
17 who weren't exposed to media. This finding is in line with reports of other previous studies<sup>17 23 33</sup>  
18 <sup>35</sup>. Compared to housewife women, the number of ANC uptake among employed women was  
19 higher. This finding is similar to the study done in Kenya<sup>42</sup> and 31 sub-Saharan Africa countries  
20 <sup>43</sup> which showed that the odds of antenatal care utilization were higher among working women  
21 than non-working<sup>43</sup>. This may be due to the fact that employed women, especially those in the  
22 formal sector, have the ability to benefit from a pregnancy care health insurance system. The  
23 finding indicated that women who did develop pregnancy complications were more likely to  
24 uptake ANC service than those who did not develop pregnancy complications. This finding is in  
25 line with studies done in Ethiopia<sup>44</sup>, Northern Jordan<sup>24</sup> and Tanzanian<sup>25</sup> and Pakistan<sup>25</sup>.

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Relative to unplanned/unwanted pregnancies, women whose pregnancies were planned and  
desired were more likely to use ANC services. These findings were consistent with previous  
studies<sup>22-24 32</sup>. Results also showed that the number of ANC visit increased significantly as the  
age of women increased. Previous studies supported that women's age plays a big role in the  
utilization of maternal health care<sup>12 20</sup>.

### **Strengths and limitation**

This study used EDHS data with a large sample size and high-quality data which reduced the risk  
of sampling bias and measurement bias. The result of this study also providing timely evidence  
for policymakers and health sectors to reducing levels of maternal and infant mortality depends  
on increasing the use of reproductive and maternal health services. The study is also able to  
provide other researchers with flawless information about how to use over dispersed excesses

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3 zero and zero-inflated Poisson regression model. Due to the cross-sectional study design, It is  
4 difficult to measure the causal effects and impossible to know whether the data are time-  
5 dependent or not.  
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## 8 **Conclusion**

9  
10 About 64.6 percent of the pregnant women have utilized the service and only 35.5 percent of the  
11 pregnant women have received at least four ANC visits. ANC service uptake in Ethiopia is  
12 extremely low and below average as compared to the minimum requirement of ANC service  
13 uptake recommended by WHO. This study was revealed that rural women, poor women, lower  
14 maternal and paternal education, mothers not having access to mass media, living alone women,  
15 mothers who have not complicated pregnancy was significantly associated with less number of  
16 ANC service utilization. This low magnitude of ANC service utilization calls for a need for  
17 improving community awareness on maternal health. More importantly, intensive health  
18 education is required for pregnant women to have better ANC service uptake and follow-up  
19 adherence.  
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33 the final manuscript.  
34  
35

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38

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40

41 **Patient consent for publication:** Not required.  
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43 **Data sharing statement:** The survey datasets used in this study was based on a publicly  
44 available dataset that is freely available online with no participant's identity  
45 from <http://www.dhsprogram.com/data/available-datasets.cfm>.  
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47 **Ethics approval and consent to participate:** The study used available secondary data accessed  
48 under the National Data Sharing and Accessibility Policy (NDSAP) of the Government of  
49 Ethiopia. The data set had no identifiable information on the survey participants; therefore, no  
50 ethical approval is required for this work.  
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**Abbreviations:** ANC: Antenatal Care; AOR: Adjusted Odd Ratio; EDHS: Ethiopian Demographic and Health Survey; HSTP: Health Sector Transformation Plan; IR: Incidence Rate; SDG: Sustainable development Goal; WHO: World Health Organization; ZIP: Zero Inflated Regression Poisson

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# BMJ Open

## Magnitude of Antenatal Care Service uptake and associated factors among Pregnant Women: analysis of the 2016 Ethiopia demographic and health survey

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3 **Magnitude of Antenatal Care Service uptake and associated factors among Pregnant**  
4 **Women; analysis of the 2016 Ethiopia demographic and health survey**  
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8 Setegn Muche Fenta\*<sup>1</sup>and Girum Meseret Ayenew<sup>2</sup>  
9

10 <sup>1</sup>Department of Statistics, Debre Tabor University. Box272 Debre Tabor, Ethiopia.  
11

12 <sup>2</sup>Research and Technology Transfer Directorate, Amhara Public Health Institute, P.O. Box 477  
13 Bahir Dar, Ethiopia; [girum.m21@gmail.com](mailto:girum.m21@gmail.com)  
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17 **\*Corresponding:** [setegn14@gmail.com](mailto:setegn14@gmail.com)  
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## Abstract

**Objective:** Antenatal and postnatal cares are crucial for the survival and well-being of both the mother and the child. World Health Organization recommends a minimum of four antenatal care visits during a pregnancy. In Ethiopia, only 38% of women in the reproductive age received a minimum of first antenatal care visits. This value is far more below the typical rates of least developed countries. This study aimed to calculate the magnitude and identify associated factors of antenatal care service utilization among pregnant women in Ethiopia.

**Design:** Cross-sectional study design

**Setting:** Ethiopian.

**Participants:** A total of 7913 pregnant women were included in the study.

**Primary outcome measures:** Antenatal Care Service uptake among Pregnant

**Result:** Only 35.5% of the pregnant mothers have utilized antenatal care services at least four times and 64.5% of the pregnant mothers have utilized less than three times during their periods of pregnancy. The study showed that rich women (PR=1.077, 95% CI: 1.029,1.127), having access to mass media (PR=1.086, 95% CI: 1.045, 1.128), having pregnancy complications (PR=1.203, 95% CI: 1.165, 1.242), secondary school and above-educated women (PR=1.112, 95% CI:1.052, 1.176), husbands' having secondary school and above level of education (PR=1.085, 95% CI: 1.031, 1.142), being married (PR = 1.187; 95% CI: 1.087,1.296), rural women (PR=0.884, 95% CI: 0.846, 0.924) and women age >30 years (PR=1.067, 95% CI: 1.024, 1.111) were significantly associated with the antenatal care service uptake.

**Conclusion:** The magnitude of ANC service uptake was low. This low magnitude of ANC service utilization calls for a need for improving community awareness on maternal health. More importantly, intensive health education is required for pregnant women to have better ANC service uptake and follow-up adherence.

**Keywords:** Antenatal Care services uptake, Ethiopia, Zero Inflated Poisson Regression Model

### Strengths and limitation

- Large sample size and high-quality data reduced the risk of sampling and measurement bias.
- Timely evidence for policymakers to reduce maternal and infant mortality.
- Gives flawless information to the scientific community about how to use over dispersed and excesses zero data.
- Unable to measure the causal effects, and impossible to know whether the data are time-dependent or not.
- DHS did not include information on distance to a health facility and the quality of healthcare that could affect the uptake of ANC service.

## Introduction

Maternal mortality is one of the most significant health problems in low and middle income country<sup>1 2</sup>. Worldwide; about 295, 000 maternal deaths, 2.4 million newborn and 2 million stillbirths occur each year and most causes of these death were found to be preventable which are associated with pregnancy and childbirth. Around 99% of these deaths have occurred in developing countries including Ethiopia. About 85% of the total global maternal deaths occurred in Sub-Saharan Africa and Southern Asia, of which two-thirds were from sub-Saharan Africa<sup>3-5</sup>. The maternal mortality rate in developing countries in the year 2015 is 239 per 100 000 live births and 12 per 100,000 live births in developed countries<sup>6 7</sup>. In Ethiopia, the maternal mortality rate is 412 deaths per 100,000 live births. This indicates a female lifetime hazard of maternal death is 1 in 243 Ethiopia<sup>7 8</sup>.

Antenatal and postnatal cares are crucial for the survival and well-being of both the mother and the child. Antenatal care (ANC) helps women to prepare for childbirth and consider the warning signs during pregnancy and birth<sup>9</sup>. The World Health Organization (WHO) suggested encouraging the positive experience of ANC pregnancy and increasing the recommended number of ANC visits from four to eight by 2018. However, it revealed that only 64 percent of women worldwide had  $\geq$  four ANC visit<sup>9 10</sup>. In Ethiopia, about sixty-two percent of women didn't attend a minimum of four ANC visits throughout their pregnancy<sup>8</sup>. Health Sector Transformation Plan of the Ethiopian Federal Ministry of Health addresses troubles associated with having targeted ANC with a minimal of four visits consistent with pregnancy as mainstream in the least provider delivery levels with a target to grow the proportion from 68% to 95 % at the highest by 2020<sup>11</sup>. But, according to the Ethiopia Demography and Health Survey (EDHS) 2016, the ANC service utilization with a minimum of four visits is merely 32%<sup>8</sup>. This indicated that ANC going to in Ethiopia immobile underneath any suitable standard.

Previous research in Ethiopia has been covered in small geographical regions and there is no sufficient study nationwide to the best knowledge of the authors<sup>12-17</sup>. These studies also investigated the associated factor of antenatal care service utilization through binary logistic. While binary logistic regression undercounts the total number of antenatal care visit since multiple service utilization is collapsed into a single unit to fulfill the requirements of binary logistic regression, provides sufficient information for studying the pattern of multiple service

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3 utilization. In this study, the Zero-Inflated Poisson regression model is the preferred model of  
4 analysis since the Zero-Inflated Poisson regression model provides a way of modeling the  
5 excessive proportion of zero values by allowing over dispersion. When the number of zeros is  
6 large, provides a good fit than Poisson or negative binomial model<sup>18</sup>. Therefore, this study aimed  
7 to calculate the magnitude and identify associated factors of ANC service uptake for the country  
8 at large.  
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## 13 **Method**

### 14 **Patient and public involvement**

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16 This study used a publicly available data set (EDHS 2016); therefore, there were no patients or  
17 members of the public involved.  
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### 20 **Data source**

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22 The data used for this study were taken from the 2016 EDHS. This survey is the fourth  
23 compressive survey designed to provide estimates for the health and demographic variables of  
24 interest for the whole urban and rural areas of Ethiopia as a domain. Women who had 9 months  
25 of pregnancy during the survey interview were included in the analysis. The study includes 7193  
26 of the reproductive age group within the country.  
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### 29 **Sampling Design**

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31 The EDHS 2016 employed a stratified two-stage cluster sampling procedure designed to provide  
32 a representative sample for multiple health and population indicators at national and sub-national  
33 levels (nine regions and two city administrations). Initially, 645 Enumeration Areas (EAs) (202  
34 in urban areas and 443 in rural areas) were drawn using Probability Proportional to Size (PPS)  
35 sampling approach from a whole list of 84,915 EAs defined within the recent 2007 population  
36 census. Then in every selected EA, an exhaustive listing of households was made and 28  
37 households were selected using a systematic sampling approach. Within the chosen households,  
38 enumeration of the entire members was made and information about the ANC service utilization  
39 among all household members was collected primarily from the women<sup>19</sup>.  
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### 50 **Study variables**

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52 The outcome variable of interest in this study was a count response of the number of ANC visits  
53 during their last pregnancy. The independent variables of this study were selected by reviewing  
54 related work of literature<sup>12-17 20-25</sup>. Women educational level (no education, primary, secondary  
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and higher), husband's occupation (not working, working), wealth index (poor, middle, rich), marital status (living alone, married, Divorced/widowed), women occupation (housewife, employed), age of women (15–24, 25–29 and  $\geq 30$  years), husbands educational level (no education, primary, secondary and higher), planned pregnancy (yes, no), access to mass media (yes, no), pregnancy complications (yes, no), the desire of pregnancy (yes, no), history of terminated pregnancy ever in her life (yes, no) and residence (urban, rural) were considered to be a possible independent variable within the study.

### Data management and analysis

The cleaned and recoded data were analyzed using R software version 3.5.3. Frequencies and percentages were used to describe the categorical variables. Data were presented using tables. Zero Inflated Poisson Regression (ZIPR) model was conducted to identify factors associated with antenatal care service utilization among pregnant. In recent years, the ZIPR model has gained popularity for modeling count data with excess zeroes<sup>18</sup>. The ZIP models can be viewed as a finite mixture model with a degenerate distribution whose mass is concentrated at zero. Excess zeroes arise when the event of interest is not experienced by many of the subjects<sup>26</sup>. In this study, the ZIPR model was employed to identify the determinant factors of ANC service uptake among pregnant women. Suppose  $Y_i$  is the number of ANC service uptake among pregnant then, the probability mass function of ZIPR is given by<sup>18 27 28</sup>

$$p(Y_i = y_i) = \begin{cases} \pi_i + (1 - \pi_i) \exp(-\mu_i), & \text{if } y_i = 0 \\ (1 - \pi_i) \frac{\exp(-\mu_i) \mu_i^{y_i}}{y_i!}, & \text{if } y_i = 1, 2, 3, \dots \end{cases} \quad 0 \leq \pi_i \leq 1$$

The parameter  $\mu_i$  and  $\pi_i$  depends on the covariates  $x_i$  and  $z_i$ , respectively. The mean and the variance of ZIP regression model, respectively, are:

$E(y_i) = (1 - \pi_i)\mu_i$  and  $Var(y_i) = \mu_i(1 - \pi_i)(1 + \pi_i\mu_i)$ . To apply the ZIPR model in practical modeling situations,<sup>18 27 28</sup> suggested the following joint models for  $\mu$  and  $\pi$

$\ln(\mu) = X^T\beta$  and  $\ln\left(\frac{\pi}{1-\pi}\right) = Z^T\gamma$  where  $X$  and  $Z$  are covariate matrices and  $\beta, \gamma$  are  $(p + 1) \times 1$  and  $(q + 1) \times 1$  vectors of unknown parameters respectively. The two sets of covariates may or may not coincide. Finally, the odds ratio (OR) and prevalence ratios (PR) with a 95% confidence interval (CI) were used to assess the strength of associations between the outcome and the

independent variables using Poisson and Bernoulli regression models' assumptions. P-values of  $\leq 0.05$  were considered for statistically significant.

### Ethical Issues

Publicly available EDHS 2016 data were used for this study. Informed consent was taken from each participant, and all identifiers were removed

### Results

From a total of 7913 pregnant women, 64.6 % of the pregnant women have utilized the service, 35.4% of the pregnant women didn't receive any ANC service and 35.5% of the pregnant women have received at least four ANC visits. The mean and variance of observation are 2.53 and 5.614, respectively. The variance to mean ratio is 2.22, which indicates some over-dispersion (Table 1).

**Table 1: The number of women that experienced ANC visits**

Number of visits	Count	Percent
0	2545	35.4
1	342	4.8
2	563	7.8
3	1187	16.5
4	1136	15.8
5	621	8.6
6	402	5.6
7	187	2.6
8+	108	2.9
Total	7193	100.0
Mean	2.53	
Variance	5.614	

### Test of over dispersion

The Pearson residual  $\chi^2$ -statistic for Poisson and ZIP model was summarized in Table 2. The Pearson dispersion value of the Poisson model is 1.829 ( $p < 0.001$ ), which clearly shows the existence of over-dispersion in the data and the Poisson model is over-dispersed. It follows that the options for modeling and analyzing such over dispersed and excess zero ANC count response data should be considered. Then fit ZIP and 1.001 is the Pearson dispersion value. This indicates that the ZIP has modeled and captured the over-dispersion in the data set very well; because the dispersion value is very close to 1. For this reason, ZIP model used for the analysis in order to identify the associated factors of ANC service uptake (Table 2).

**Table 2: Test of over-dispersion based on Pearson residual  $\chi^2$ -statistic**

Model	Dispersion Test (Ratio Statistic & P-value)
Poisson	1.829(0.001)
ZIP	1.001 ( 0.004)

### Socio-demographic characteristics of study participants

The majority of the study respondents were from rural residences (79%). Most of the respondents were housewives (70%) and 30% of the respondents were employed. About 60.6% of mothers didn't attend primary school and only 12.4% of mothers attended secondary and above education. The majority (69.4%) of the respondents had no pregnancy complications and 64.4% had no access to mass media. About 91.5 percent of women were married, 3.2 percent of women were living alone women while 5.3% were divorced and widowed. The majorities (79.8%) of the pregnancies were planned and 9% of the pregnancies were terminated. Regarding husband education, 31.7% of the husband had no formal education while 30% of husbands attend primary education. About half (50.7%) of women had poor wealth index, 35.0% were rich wealth while others were middle wealth index (14.3%). Regarding the mother age, the majorities (46.2%) of mothers were under the age group of 30 years plus, then followed 25-29 years (Table 3).

### Magnitude of ANC services uptake by socio-demographic characteristics of study participants

The mean and median numbers of ANC visits by socio-demographic characteristics of study participants are shown in Table 3. The mean numbers of ANC visits for urban women (4.26)

were higher than for rural women (2.07). Among poor women, the lowest mean numbers of ANC visits were recorded (1.71). The lowest mean numbers of ANC visits were observed for uneducated husbands (1.93), while the highest mean numbers of ANC visits were observed for husbands with secondary education and above (3.83). Women exposed to the media had the highest mean numbers of ANC visits (3.65), while the mean numbers of ANC visits for women not exposed to the media were low (1.92). The lowest mean numbers of ANC visits occur in uneducated women (1.88), while the highest mean numbers of ANC visits have been recorded for women with secondary education and above (4.36). Compared with women who had no symptoms of pregnancy problems (1.78), women who had seen signs of pregnancy complications had a higher mean number of ANC visits (4.28) (Table 3).

Table 3: Magnitude of ANC services uptake by socio-demographic characteristics of study participants and the associated Chi-Square ( $\chi^2$ ) test for equality of the medians

Characteristics		Frequency (%)	Mean	Median
Residence	Urban	1512(21.0)	4.26	4
	Rural	5681(79.0)	2.07	2
Occupation of women	Housewife	5033(70.0)	2.37	2
	Employed	2160(30.0)	2.92	3
Planned pregnancy	No	1452(20.2)	2.53	3
	Yes	5741(79.8)	2.54	3
Terminated pregnancy	No	6556(91.1)	2.51	3
	Yes	637(8.9)	2.79	3
Wealth index	Low	3607(50.7)	1.71	1
	Medium	1028(14.3)	2.47	3
	Rich	2558(35.0)	3.71	4
Marital status	Never married	230(3.2)	2.52	3
	Married	6579(91.5)	3.26	4
	Divorced/widowed	384(5.3)	2.56	3
Age of women in a year	15-24	1852(25.1)	2.60	3
	25-29	2015(28.1)	2.73	3



	30 and above	3326(46.2)	2.38	3
Husband education	No education	3719(51.7)	1.93	1
	Primary	2160(30.0)	2.79	3
	Secondary and above	1314(18.3)	3.83	4
Woman education	No education	4359(60.6)	1.88	1
	Primary	1942(27.0)	3.15	3
	Secondary and above	892(12.4)	4.36	4
Access to mass media	No	4646(64.6)	1.92	1
	Yes	2547(35.4)	3.65	4
Pregnancy complications	No	5015(69.7)	1.78	1
	Yes	2178(30.3)	4.28	4
Husband's occupation	Not working	1285(17.9)	2.19	2
	Working	5908(82.1)	2.61	3

### Factors associated with ANC service uptake, application of Zero Inflated Poisson regression models

As shown in the below table (Table 4), the Poisson component shows that the prevalence ratios (PR) of ANC visits. The finding of this study revealed that women's and husbands' levels of education have had a significant factor in ANC service uptake. The expected number of ANC service uptake for women with primary education was 1.06 (PR =1.06; 95%CI: 1.02, 1.10) times higher compared to women with no formal education. The expected number of ANC service uptake for women with secondary and above education was 1.11 (PR =1.11; 95% CI: 1.05, 1.18) times higher compared to women with no formal education. The expected number of ANC service uptake for husbands with primary education was 1.05 (PR =1.05; 95% CI: 1.01, 1.10) times higher compared to husbands with no formal education. Similarly, ANC service uptake for husbands with secondary and above education increased by 9% (PR =1.09; 95%CI: 1.03, 1.14) times higher compared to husbands with no formal education. The expected number of ANC service uptake of the rural women was 0.88 (PR =0.88; 95%CI: 1.85, 1.92) times lower compared to urban women. The expected number of ANC service uptake for the rich wealth

index was 1.08 (PR =1.08; 95% CI: 1.03, 1.13) times higher compared to their poor wealth index. The expected number of ANC service uptake for married women was 1.19 (PR =1.19; 95% CI: 1.09, 1.30) times higher compared to living alone women. The expected number of ANC service uptake for women who had seen signs of pregnancy complications was 1.20 (PR =1.20; 95% CI: 1.17, 1.24) times higher compared to those women who had no signs of pregnancy complication. The expected number of ANC service uptake for women using mass media was 1.09 (PR =1.09; 95% CI: 1.05, 1.13) times higher compared to those who don't use mass media. The expected number of ANC service uptake for mothers in the age group of 25-29 was 1.06 (PR =1.06; 95% CI: 1.02, 1.10) times higher compared with the age group of 15-24 years. The expected number of ANC service uptake for mothers age 30 and above was 1.07 (PR =1.07; 95% CI: 1.02, 1.11) times higher compared with the age group of 15-24 years (Table 4).

Table 4: Factors associated with ANC service uptake, application of application of Zero Inflated Poisson regression models

Characteristics		Poisson part PR (95% CI of PR)	Bernoulli part AOR (95%CI of AOR)
Residence	Urban	1	1
	Rural	0.884(0.846, 0.924) *	2.254(1.780, 2.855)*
Access to mass media	No	1	1
	Yes	1.086(1.045, 1.128) *	0.612(0.525,0.713)*
Planned pregnancy	No	1	1
	Yes	1.028( 0.989, 1.069)	0.794(0.685, 0.920*
Husbands occupation	Not working	1	1
	Working	1.017(0.959, 1.077)	0.761(0.655,0.884)*
Wealth index	Low	1	1
	Medium	1.039(0.989, 1.093)	0.594(0.501, 0.704)*
	Rich	1.077( 1.029, 1.127)*	0.568(0.479, 0.672)*
Women's education	No education	1	1
	Primary	1.057(1.015, 1.101)*	0.454(0.388, 0.531)*
	Secondary and above	1.112(1.052, 1.176)*	0.389(0.286, 0.530)*
Husband education	No education	1	1
	Primary	1.052(1.010, 1.096)*	0.625(0.542, 0.721)*
	Secondary and above	1.085(1.031, 1.142)*	0.666(0.532, 0.836)*
Age of women (year)	15-24	1	1
	25-29	1.060(1.016, 1.104)*	0.991(0.830, 1.184)
	30 and above	1.067(1.024, 1.111)*	0.827(0.656,1.042)
Marital status	living alone	1	1

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	Married	1.187(1.087, 1.296)*	0.865(0.576, 1.301)
	Divorced/widowed	1.083(0.990, 1.184)	0.639(0.460, 0.888)*
Pregnancy complications	No	1	1
	Yes	1.203(1.165, 1.242)*	0.859(0.569, 1.297)
Occupation of women	Housewife	1	1
	Working	0.982(0.950, 1.016)	0.937(0.809, 1.085)
Terminated pregnancy	No	1	1
	Yes	1.039(0.986, 1.094)	0.817(0.649, 1.027)

**Note:** 1 = reference category of the categorical variable.

\* Significant at 5% level of significance

The Bernoulli part also indicated that the estimated odds that the number of ANC service uptake becomes zero with who is living in the rural area was 2.25 (OR = 2.25; 95%CI: 1.78, 2.86) times that of urban women. The estimated odds the number of ANC service uptake becomes zero with women who attend primary education was 0.45 (OR = 0.45; 95%CI: 0.39, 0.53) times that of the non-educated women. Similarly, the estimated odds the number of ANC service uptake becomes zero with husbands who have primary education was 0.63 (OR = 0.63; 95%CI: 0.54, 0.72) times that of the non-educated husbands. The estimated odds the number of ANC service uptake becomes zero with rich women was 0.57 (OR = 0.57; 95%CI: 0.48, 0.67) times that of the poor wealth index. The odds of the number of ANC service uptake becomes zero with husbands who work is 0.76 (OR = 0.76; 95%CI: 0.66, 0.88) times that of husbands without work. The estimated odds the number of ANC service uptake becomes zero with women who have used mass media was 0.61 (AOR = 0.61; 95%CI: 0.53, 0.71) times that of women who did not use any mass media (Table 4).

## Discussion

Antenatal care during pregnancy is important for the health of the mother and the development of the fetus. Therefore, this study aimed at determining the magnitude and associated factors of ANC service uptake among pregnant women in Ethiopia. The results of this study showed that about 64.6 % of the pregnant women have utilized the service and 35.4% haven't received ANC services during their pregnancy which is less than that reported from 2016 EDHS urban Ethiopia<sup>19</sup>. It's also less than reported from the studies conducted in different parts of Ethiopia<sup>12</sup><sup>29 30</sup>.

The findings of this study revealed that education had a positive relationship with ANC service uptake, that is; the amount of ANC service uptake increase with the rise in woman's and

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2  
3 husband's education level. The study shows an identical result with other studies<sup>15 20 25 31-35</sup>,  
4 which revealed that non-educated women and husbands were fewer ANC attendants than those  
5 that have educated women. The possible justification behind this could be that educated women  
6 have taken more ANC because they have more awareness of the benefits of regular ANC uptake,  
7 such as reducing risks of pregnancy and ensuring safe childbirth. Educated husbands may have  
8 better communication with their wives and may be able to explore the importance of ANC  
9 uptake and other maternal health services<sup>36</sup>. This could also provide their wives with more  
10 freedom as well<sup>37</sup>.

11 The uptake of ANC services among married women was higher compared to women living  
12 alone. This finding is consistent with the studies conducted in Ethiopia<sup>15</sup>, Kenya<sup>32</sup>, Rwanda<sup>38</sup>  
13 and Bangladesh<sup>35</sup>. This may be attributed to the psychological and economic support obtained  
14 from their husbands, planning/desirability of their pregnancy and the societal acceptability and  
15 support of their pregnant state when compared with their unmarried women.

16 Wealth index has been negatively correlated with the use of ANC services. Relative to the richest  
17 wealth quintile, women belonging to the lowest wealth quintiles were less likely to uptake ANC  
18 service. Studies elsewhere have also documented a positive relationship between economic status  
19 and ANC service uptake<sup>17 21 22 31 35 39</sup>. The possible justification of this finding might be that rich  
20 women may obtain more ANC information from mass media and may have greater access to  
21 health care. In addition, this may be attributed to the indirect cost of antenatal care, such as  
22 transport cost, while traveling to distant health facility<sup>40</sup>.

23 Compared to rural women, women living in urban areas were more likely to utilize ANC service.  
24 This finding is supported by the studies conducted in <sup>16 17 33 41</sup>. The potential reason may be that  
25 urban women had a better education, access to health services and more informed about the  
26 importance of ANC service uptake. The exposure of mass media was positively associated with  
27 ANC services. Women who were exposed to media were more ANC service uptake than women  
28 who weren't exposed to media. This finding is in line with reports of other previous studies<sup>17 23 33</sup>  
29 <sup>35</sup>. Compared to housewife women, the number of ANC uptake among employed women was  
30 higher. This finding is similar to the study done in Kenya<sup>42</sup> and 31 sub-Saharan Africa countries  
31 <sup>43</sup> which showed that the odds of antenatal care utilization were higher among working women  
32 than non-working <sup>43</sup>. This may be due to the fact that employed women, especially those in the  
33 formal sector, have the ability to benefit from a pregnancy care health insurance system. The  
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3 finding indicated that women who did develop pregnancy complications were more likely to  
4 uptake ANC service than those who did not develop pregnancy complications. This finding is in  
5 line with studies done in Ethiopia<sup>44</sup>, Northern Jordan <sup>24</sup> and Tanzanian<sup>25</sup> and Pakistan<sup>25</sup>.  
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9 Relative to unplanned/unwanted pregnancies, women whose pregnancies were planned and  
10 desired were more likely to use ANC services. These findings were consistent with previous  
11 studies<sup>22-24 32</sup>. Results also showed that the number of ANC visit increased significantly as the  
12 age of women increased. Previous studies supported that women's age plays a big role in the  
13 utilization of maternal health care<sup>12 20</sup>.  
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### 16 17 18 **Strengths and limitation**

19 This study used EDHS data with a large sample size and high-quality data which reduced the risk  
20 of sampling bias and measurement bias. The result of this study also providing timely evidence  
21 for policymakers and health sectors to reducing levels of maternal and infant mortality depends  
22 on increasing the use of reproductive and maternal health services. The study is also able to  
23 provide other researchers with flawless information about how to use over dispersed excesses  
24 zero and zero-inflated Poisson regression model. Due to the cross-sectional study design, It is  
25 difficult to measure the causal effects and impossible to know whether the data are time-  
26 dependent or not. The other limitation was that DHS did not include information on distance to a  
27 health facility and the quality of healthcare that could affect the uptake of ANC service.  
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### 30 31 32 **Conclusion**

33 About 64.6 percent of the pregnant women have utilized the service and only 35.5 percent of the  
34 pregnant women have received at least four ANC visits. ANC service uptake in Ethiopia is  
35 extremely low and below average as compared to the minimum requirement of ANC service  
36 uptake recommended by WHO. This study was revealed that rural women, poor women, lower  
37 maternal and paternal education, mothers not having access to mass media, living alone women,  
38 mothers who have not complicated pregnancy was significantly associated with less number of  
39 ANC service utilization. This low magnitude of ANC service utilization calls for a need for  
40 improving community awareness on maternal health. More importantly, intensive health  
41 education is required for pregnant women to have better ANC service uptake and follow-up  
42 adherence.  
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**Competing interests:** None declared.

**Patient consent for publication:** Not required.

**Data sharing statement:** The survey datasets used in this study was based on a publicly available dataset that is freely available online with no participant's identity from <http://www.dhsprogram.com/data/available-datasets.cfm>.

**Ethics approval and consent to participate:** The study used available secondary data accessed under the National Data Sharing and Accessibility Policy (NDSAP) of the Government of Ethiopia. The data set had no identifiable information on the survey participants; therefore, no ethical approval is required for this work.

**Provenance and peer review:** Not commissioned; externally peer reviewed.

**Abbreviations:** ANC: Antenatal Care; AOR: Adjusted Odd Ratio; EDHS: Ethiopian Demographic and Health Survey; HSTP: Health Sector Transformation Plan; IR: Incidence Rate; SDG: Sustainable development Goal; WHO: World Health Organization; ZIP: Zero Inflated Regression Poisson

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STROBE Statement—Checklist of items that should be included in reports of *cross-sectional studies*

bmjopen-2020-043904.R2 - "Magnitude of Antenatal Care Service uptake and associated factors among Pregnant Women: analysis of the 2016 Ethiopia demographic and health survey"

	Item No.	Recommendation	Page No.	Relevant text from manuscript
<b>Title and abstract</b>	1	(a) Indicate the study's design with a commonly used term in the title or the abstract	2	"Abstract Study's design, Paragraph 2, line 37"
		(b) Provide in the abstract an informative and balanced summary of what was done and what was found	2	"Abstract, objective section Paragraph 1 and Result section Paragraph 6"
<b>Introduction</b>				
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4	"Introduction, paragraph 1, paragraph 2 and paragraph 3"
Objectives	3	State specific objectives, including any prespecified hypotheses	5	"Introduction, paragraph 3, line 128 and 129"
<b>Methods</b>				
Study design	4	Present key elements of study design early in the paper	5	"Methods, paragraph 3, Sampling Design, line 142 and 143"
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	5	"Methods, paragraph 2/data source, line 136-140"
Participants	6	Give the eligibility criteria, and the sources and methods of selection of participants	5	"Methods, paragraph 2/data source line 138 -140 and Paragraph 3/Sampling Design line 142-150"
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	6	"Methods, paragraph 3/ Study variables, line 152-161"
Data sources/measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	6	"Methods, paragraph 3/ Study variables, line 152-161"
Bias	9	Describe any efforts to address potential sources of bias	5	"Methods, Paragraph 3/Sampling Design line 142-150"
Study size	10	Explain how the study size was arrived at	5	"Methods, paragraph 2/data source, line 138-140"

Continued on next page

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2	Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	6	“Methods, paragraph 5/Data management and analysis, line 163&164”
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6	Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding	6	“Methods, paragraph 5/Data management and analysis, line 165 -183”
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10			(b) Describe any methods used to examine subgroups and interactions	6	“Methods, paragraph 5/Data analysis”
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13			(c) Explain how missing data were addressed	6	“Methods, paragraph 5/Data analysis line 180-183”
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16			(d) If applicable, describe analytical methods taking account of sampling strategy		“N/A”
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19			(e) Describe any sensitivity analyses		“N/A”
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21	<b>Results</b>				
22	Participants	13*	(a) Report numbers of individuals at each stage of study— e.g., numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	7	“Result, Paragraph 1 line 188-191”
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27			(b) Give reasons for non-participation at each stage		“N/A”
28					
29			(c) Consider use of a flow diagram		“N/A”
30	Descriptive data	14*	(a) Give characteristics of study participants (e.g., demographic, clinical, social) and information on exposures and potential confounders	8	“Result, Paragraph 3 line 206 -216 or Table 3”
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33			(b) Indicate number of participants with missing data for each variable of interest		“N/A”
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36			Report numbers of outcome events or summary measures	7	“Result, Paragraph 1 line 188 -192 or table 1”
37					
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39	Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	11	“Result, Paragraph 5 line 237-260 or table 4 /”
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44			(b) Report category boundaries when continuous variables were categorized	8	“Result, Paragraph 3/ line 232 and 233 or Table 3
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48			(c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period		“N/A”
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2	Other analyses	17	Report other analyses done—e.g., analyses of subgroups and interactions, and sensitivity analyses	“N/A”
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5	<b>Discussion</b>			
6	Key results	18	Summarise key results with reference to study objectives	13 “Discussion, Paragraph 1 line 280-285”
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9	Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	14 “Strengths and limitation of study, Paragraph 1 line 329-337”
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13	Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	13-14 “Discussion, Paragraph 2 to 5 line 287 -327”
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18	Generalizability	21	Discuss the Generalizability (external validity) of the study results	14 “Conclusion, Paragraph 1 line 340 -349”
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## Magnitude of Antenatal Care Service uptake and associated factors among Pregnant Women: analysis of the 2016 Ethiopia demographic and health survey

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3 **Magnitude of Antenatal Care Service uptake and associated factors among Pregnant**  
4 **Women; analysis of the 2016 Ethiopia demographic and health survey**  
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8 Setegn Muche Fenta\*<sup>1</sup>, Girum Meseret Ayenew<sup>2</sup>, Berhanu Engidaw Getahun<sup>3</sup>  
9

10 <sup>1</sup>Department of Statistics, Debre Tabor University. Box272 Debre Tabor, Ethiopia.  
11

12 <sup>2</sup>Research and Technology Transfer Directorate, Amhara Public Health Institute, P.O. Box 477  
13 Bahir Dar, Ethiopia; [girum.m21@gmail.com](mailto:girum.m21@gmail.com)  
14

15 <sup>3</sup>Department of English language and Literature, Bahir Dar University, Bahir Dar, Ethiopia;  
16 [bgsilvie47@gmail.com](mailto:bgsilvie47@gmail.com)  
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21 **\*Corresponding:** [setegn14@gmail.com](mailto:setegn14@gmail.com)  
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## Abstract

**Objective:** Antenatal and postnatal cares are crucial for the survival and well-being of both the mother and the child. World Health Organization recommends a minimum of four antenatal care visits during a pregnancy. In Ethiopia, only 38% of women in the reproductive age make a minimum of first antenatal care visits. This value is far below the typical rates of least developed countries. This study aimed to calculate the magnitude and identify associated factors of antenatal care service utilization among pregnant women in Ethiopia.

**Design:** Cross-sectional study design

**Setting:** Ethiopia

**Participants:** A total of 7913 pregnant women participated in the study.

**Primary outcome measures:** Antenatal Care Service uptake among pregnant women

**Result:** Only 35.5% of the pregnant mothers have utilized antenatal care services at least four times and 64.5% of the pregnant mothers have utilized less than three times during their periods of pregnancy. The study showed that rich women (PR=1.077, 95% CI: 1.029,1.127), having access to mass media (PR=1.086, 95% CI: 1.045, 1.128), having pregnancy complications (PR=1.203, 95% CI: 1.165, 1.242), secondary school and above-educated women (PR=1.112, 95% CI:1.052, 1.176), husbands' having secondary school and above in their level of education (PR=1.085, 95% CI: 1.031, 1.142), married (PR = 1.187; 95% CI: 1.087,1.296), rural women (PR=0.884, 95% CI: 0.846, 0.924) and women >30 years of age (PR=1.067, 95% CI: 1.024, 1.111) significantly associated with the antenatal care service uptake.

**Conclusion:** The magnitude of ANC service uptake was low. This low magnitude of ANC service utilization calls for a need to improve community awareness about maternal health. More importantly, intensive health education is required for pregnant women to have better ANC service uptake and follow-up adherence.

**Keywords:** Antenatal Care services uptake, Ethiopia, Zero Inflated Poisson Regression Model

### Strengths and limitation

- The study provides a timely evidence for policymakers to reduce maternal and infant mortality.
- The study gives solid information to the scientific community about how to use over dispersed and excesses zero data.
- Large sample size and high-quality data reduced the risk of sampling and measurement bias.
- It was not possible to measure the causal effects, and know whether the data are time-dependent or not.
- DHS did not include information on distance to a health facility and the quality of healthcare that could affect the uptake of ANC service.



## Introduction

Maternal mortality is one of the most significant health problems in low and middle income countries<sup>1 2</sup>. Worldwide, about 295, 000 maternal deaths, 2.4 million newborn and 2 million stillbirths occur each year and most causes of these deaths were found to be not only preventable but also associated with pregnancy and childbirth. Around 99% of these deaths occurred in developing countries including Ethiopia. About 85% of the total global maternal deaths occurred in Sub-Saharan Africa and Southern Asia, two-thirds of it from sub-Saharan Africa<sup>3-5</sup>. The maternal mortality rate in developing countries in the year 2015 is 239 per 100 000 live births and 12 per 100,000 live births in developed countries<sup>6 7</sup>. In Ethiopia, the maternal mortality rate is 412 deaths per 100,000 live births. This indicates that in Ethiopia a female's lifetime hazard of maternal death is 1 in 243<sup>7 8</sup>.

Antenatal and postnatal cares are crucial to salvage the mother and the child. Antenatal care (ANC) helps women prepare for childbirth and contemplate the warning signs during pregnancy and birth<sup>9</sup>. The World Health Organization (WHO) suggested encouraging the positive experience of ANC pregnancy and increasing the recommended number of ANC visits from four to eight by 2018. However, it revealed that only 64 percent of women worldwide had  $\geq$  four ANC visit<sup>9 10</sup>. In Ethiopia, about sixty-two percent of women didn't attend a minimum of four ANC visits throughout their pregnancy<sup>8</sup>. Health Sector Transformation Plan of the Ethiopian Federal Ministry of Health addresses troubles associated with having targeted ANC with a minimal of four visits consistent with pregnancy as mainstream in the least provider delivery levels with a target to grow the proportion from 68% to 95 % at the highest by 2020<sup>11</sup>. But, according to the Ethiopian Demography and Health Survey (EDHS) 2016, the ANC service utilization with a minimum of four visits is merely 32%<sup>8</sup>. This indicated that in Ethiopia ANC went immobile underneath any suitable standard.

Previous research in Ethiopia covered in small geographical regions and there is no sufficient study nationwide to the best knowledge of the authors<sup>12-17</sup>. The studies investigated the associated factor of antenatal care service utilization through binary logistic. Binary logistic regression undercounts the total number of antenatal care visits. Thus, multiple service utilization is collapsed into a single unit to fulfill the requirements of binary logistic regression as it provides sufficient information for studying the pattern of multiple service utilization. Since the

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3 Zero-Inflated Poisson regression model provides a way of modeling the excessive proportion of  
4 zero values by allowing over dispersion, in this study, the Zero-Inflated Poisson regression  
5 model is the preferred model for analysis. It provides a good fit than Poisson or negative  
6 binomial model<sup>18</sup>, when the number of zeros is large. This study therefore, aimed to calculate  
7 the magnitude and identify associated factors of ANC service uptake for the country at large.  
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## 12 **Method**

### 14 **Patient and public involvement**

16 This study used a publicly available data set (EDHS 2016). Therefore, there were no patients or  
17 members of the public involved.  
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### 20 **Data source**

22 The data used for this study was taken from the 2016 EDHS. This survey is the fourth  
23 comprehensive survey designed to provide estimates for the health and demographic variables  
24 of interest for the whole urban and rural areas of Ethiopia as a domain. Women who had 9  
25 months of pregnancy during the survey interview were included in the analysis. The study  
26 includes 7193 cases of the reproductive age group within the country.  
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### 30 **Sampling Design**

32 The EDHS 2016 employed a stratified two-stage cluster sampling procedure designed to provide  
33 a representative sample for multiple health and population indicators at national and sub-national  
34 levels (nine regions and two city administrations). Initially, 645 Enumeration Areas (EAs) (202  
35 in urban areas and 443 in rural areas) were drawn using Probability Proportional to Size (PPS)  
36 sampling approach from a whole list of 84,915 EAs defined within the recent 2007 population  
37 census. Then, in every selected EA, an exhaustive listing of households was made and 28  
38 households were selected using a systematic sampling approach. Within the chosen households,  
39 enumeration of the entire members was made and information about the ANC service utilization  
40 among all household members was collected primarily from the women<sup>19</sup>.  
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### 49 **Study variables**

51 The outcome variable of interest in this study was a count response of the number of ANC visits  
52 during their last pregnancy. The independent variables of this study were selected by reviewing  
53 related work of literature<sup>12-17 20-25</sup>. Women's educational level (no education, primary, secondary  
54 and higher), husband's occupation (not working, working), wealth index (poor, middle, rich),  
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marital status (living alone, married, Divorced/widowed), women occupation (housewife, employed), age of women (15–24, 25–29 and  $\geq 30$  years), husbands educational level (no education, primary, secondary and higher), planned pregnancy (yes, no), access to mass media (yes, no), pregnancy complications (yes, no), the desire of pregnancy (yes, no), history of terminated pregnancy ever in her life (yes, no) and residence (urban, rural) were considered to independent variables within the study.

### Data management and analysis

The cleaned and recoded data were analyzed using R software version 3.5.3. Frequencies and percentages were used to describe the categorical variables. Data were presented using tables. Zero Inflated Poisson Regression (ZIPR) model was conducted to identify factors associated with antenatal care service utilization among the pregnant. In recent years, the ZIPR model has gained popularity for modeling count data with excess zeroes<sup>18</sup>. The ZIP models can be viewed as a finite mixture model with a degenerative distribution where its mass is concentrated at zero. Excess zeroes arise when the event of interest is not experienced by many of the subjects<sup>26</sup>. In this study, the ZIPR model was employed to identify the determinant factors of ANC service uptake among pregnant women. Suppose  $Y_i$  is the number of ANC service uptake among the pregnant. Thus, the probability mass function of ZIPR is given by<sup>18 27 28</sup>

$$p(Y_i = y_i) = \begin{cases} \pi_i + (1 - \pi_i) \exp(-\mu_i), & \text{if } y_i = 0 \\ (1 - \pi_i) \frac{\exp(-\mu_i) \mu_i^{y_i}}{y_i!}, & \text{if } y_i = 1, 2, 3, \dots \end{cases} \quad 0 \leq \pi_i \leq 1$$

The parameter  $\mu_i$  and  $\pi_i$  depend on the covariates  $x_i$  and  $z_i$ , respectively. The mean and the variance of ZIP regression model, respectively, are:

$E(y_i) = (1 - \pi_i) \mu_i$  and  $Var(y_i) = \mu_i(1 - \pi_i)(1 + \pi_i \mu_i)$ . To apply the ZIPR model in practical modeling situations,<sup>18 27 28</sup> suggested the following joint models for  $\mu$  and  $\pi$

$\ln(\mu) = X^T \beta$  and  $\ln\left(\frac{\pi}{1-\pi}\right) = Z^T \gamma$  where  $X$  and  $Z$  are covariate matrices and  $\beta, \gamma$  are  $(p + 1) \times 1$  and  $(q + 1) \times 1$  vectors of unknown parameters respectively. The two sets of covariates may or may not coincide. Finally, the odds ratio (OR) and prevalence ratios (PR) with a 95% confidence interval (CI) were used to assess the strength of associations between the outcome and the independent variables using Poisson and Bernoulli regression models' assumptions. P-values of  $\leq 0.05$  were considered for statistically significant.

## Ethical Issues

Publicly available EDHS 2016 data were used for this study. Informed consent was taken from each participant, and all identifiers were removed

## Results

From a total of 7913 pregnant women, 64.6 % of the pregnant women have utilized the service, 35.4% of the pregnant women didn't receive any ANC service, and 35.5% of the pregnant women have received at least four ANC visits. The mean and variance of observation are 2.53 and 5.614, respectively. The variance to mean ratio is 2.22, which indicates some over-dispersion (Table 1).

**Table 1: The number of women that experienced ANC visits**

Number of visits	Count	Percent
0	2545	35.4
1	342	4.8
2	563	7.8
3	1187	16.5
4	1136	15.8
5	621	8.6
6	402	5.6
7	187	2.6
8+	108	2.9
Total	7193	100.0
Mean	2.53	
Variance	5.614	

### Test of over dispersion

The Pearson residual  $\chi^2$ -statistic for Poisson and ZIP model was summarized in Table 2. The Pearson dispersion value of the Poisson model is 1.829 ( $p < 0.001$ ), which clearly shows the existence of over-dispersion in the data and the Poisson model is over-dispersed. It follows that the options for modeling and analyzing such over dispersed and excess zero ANC count response data should be considered. Then fit ZIP and 1.001 is the Pearson dispersion value. This indicates that the ZIP has modeled and captured the over-dispersion in the data set very well because the dispersion value is very close to 1. For this reason, ZIP model is used for the analysis to identify the associated factors of ANC service uptake (Table 2).

**Table 2: Test of over-dispersion based on Pearson residual  $\chi^2$ -statistic**

Model	Dispersion Test (Ratio Statistic & P-value)
Poisson	1.829(0.001)
ZIP	1.001 ( 0.004)

### Socio-demographic characteristics of study participants

The majority of the study respondents were from rural residences (79%). Most of the respondents were housewives (70%) and 30% of the respondents were employed. About 60.6% of mothers didn't attend primary school, and only 12.4% of the mothers attended secondary and above level education. The majority (69.4%) of the respondents had no pregnancy complications and 64.4% had no access to mass media. About 91.5 percent of women were married, 3.2 percent were living alone while 5.3% were divorced and widowed. The majority (79.8%) of the pregnancies were planned while 9% of the pregnancies were terminated. 31.7% of the husbands had no formal education while 30% of husbands attended primary education. About half (50.7%) of women had poor wealth index, 35.0% were rich while others have middle wealth index (14.3%). Regarding mother's age, the majority (46.2%) of them were under the age group of 30 years (Table 3).

### Magnitude of ANC services uptake by socio-demographic characteristics of study participants

The mean and median numbers of ANC visits by socio-demographic characteristics of study participants are shown in Table 3. The mean numbers of ANC visits for urban women (4.26) were higher than for rural women (2.07). Among poor women, the lowest mean numbers of

ANC visits were recorded (1.71). The lowest mean numbers of ANC visits were observed for uneducated husbands (1.93), while the highest mean numbers of ANC visits were observed for husbands with secondary education and above (3.83). Women exposed to the media had the highest mean numbers of ANC visits (3.65), while the mean numbers of ANC visits for women not exposed to the media were low (1.92). The lowest mean numbers of ANC visits occurred among uneducated women (1.88), while the highest mean numbers of ANC visits have been recorded for women with secondary education and above (4.36). Compared with women who had no symptoms of pregnancy problems (1.78), women who had seen signs of pregnancy complications had a higher mean number of ANC visits (4.28) (Table 3).

Table 3: Magnitude of ANC services uptake by socio-demographic characteristics of study participants

Characteristics		Frequency (%)	Mean	Median
Residence	Urban	1512(21.0)	4.26	4
	Rural	5681(79.0)	2.07	2
Occupation of women	Housewife	5033(70.0)	2.37	2
	Employed	2160(30.0)	2.92	3
Planned pregnancy	No	1452(20.2)	2.53	3
	Yes	5741(79.8)	2.54	3
Terminated pregnancy	No	6556(91.1)	2.51	3
	Yes	637(8.9)	2.79	3
Wealth index	Low	3607(50.7)	1.71	1
	Medium	1028(14.3)	2.47	3
	Rich	2558(35.0)	3.71	4
Marital status	Never married	230(3.2)	2.52	3
	Married	6579(91.5)	3.26	4
	Divorced/widowed	384(5.3)	2.56	3
Age of women in a year	15-24	1852(25.1)	2.60	3
	25-29	2015(28.1)	2.73	3
	30 and above	3326(46.2)	2.38	3

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Husband education	No education	3719(51.7)	1.93	1
	Primary	2160(30.0)	2.79	3
	Secondary and above	1314(18.3)	3.83	4
Woman education	No education	4359(60.6)	1.88	1
	Primary	1942(27.0)	3.15	3
	Secondary and above	892(12.4)	4.36	4
Access to mass media	No	4646(64.6)	1.92	1
	Yes	2547(35.4)	3.65	4
Pregnancy complications	No	5015(69.7)	1.78	1
	Yes	2178(30.3)	4.28	4
Husband's occupation	Not working	1285(17.9)	2.19	2
	Working	5908(82.1)	2.61	3

### Factors associated with ANC service uptake, application of Zero Inflated Poisson regression models

As shown in the below table (Table 4), the Poisson component shows that the prevalence ratios (PR) of ANC visits. This study revealed that women's and husbands' levels of education are a significant factor in ANC service uptake. Compared to women with no formal education, the expected number of ANC service uptake for women with primary education is 1.06 (PR =1.06; 95%CI: 1.02, 1.10) times higher. Further, compared to women with no formal education, the expected number of ANC service uptake for women with secondary and above education was 1.11 (PR =1.11; 95% CI: 1.05, 1.18) times higher. The expected number of ANC service uptake for husbands with primary education was 1.05 (PR =1.05; 95% CI: 1.01, 1.10) times higher compared to husbands with no formal education. Similarly, compared to husbands with no formal education, ANC service uptake for husbands with secondary and above education increased by 9%(PR =1.09; 95%CI: 1.03, 1.14) . The expected number of ANC service uptake of the rural women was 0.88 (PR =0.88; 95%CI: 1.85, 1.92) times lower compared to urban women. The expected number of ANC service uptake for women with a rich wealth index was 1.08 (PR =1.08; 95% CI: 1.03, 1.13) times higher compared to those having poor wealth index.

Moreover, compared to women living alone, the expected number of ANC service uptake for married women was 1.19 (PR =1.19; 95% CI: 1.09, 1.30) times higher. The expected number of ANC service uptake for women who had seen signs of pregnancy complications was 1.20 (PR =1.20; 95% CI: 1.17, 1.24) times higher compared to those women who had no signs of pregnancy complication. Furthermore, compared to women who don't use mass media, the expected number of ANC service uptake for women using mass media was 1.09 (PR =1.09; 95% CI: 1.05, 1.13) times higher. The expected number of ANC service uptake for mothers in the age group of 25-29 was 1.06 (PR =1.06; 95% CI: 1.02, 1.10) times higher compared with the age group of 15-24 years. The expected number of ANC service uptake for mothers of age 30 and above was 1.07 (PR =1.07; 95% CI: 1.02, 1.11) times higher compared with the age group of 15-24 years (Table 4).

Table 4: Factors associated with ANC service uptake, application of application of Zero Inflated Poisson regression models

Characteristics		Poisson part PR (95% CI of PR)	Bernoulli part AOR (95%CI of AOR)
Residence	Urban	1	1
	Rural	0.884(0.846, 0.924) *	2.254(1.780, 2.855)*
Access to mass media	No	1	1
	Yes	1.086(1.045, 1.128) *	0.612(0.525,0.713)*
Planned pregnancy	No	1	1
	Yes	1.028( 0.989, 1.069)	0.794(0.685, 0.920)*
Husbands occupation	Not working	1	1
	Working	1.017(0.959, 1.077)	0.761(0.655,0.884)*
Wealth index	Low	1	1
	Medium	1.039(0.989, 1.093)	0.594(0.501, 0.704)*
	Rich	1.077( 1.029, 1.127)*	0.568(0.479, 0.672)*
Women's education	No education	1	1
	Primary	1.057(1.015, 1.101)*	0.454(0.388, 0.531)*
	Secondary and above	1.112(1.052, 1.176)*	0.389(0.286, 0.530)*
Husband education	No education	1	1
	Primary	1.052(1.010, 1.096)*	0.625(0.542, 0.721)*
	Secondary and above	1.085(1.031, 1.142)*	0.666(0.532, 0.836)*
Age of women (year)	15-24	1	1
	25-29	1.060(1.016, 1.104)*	0.991(0.830, 1.184)
	30 and above	1.067(1.024, 1.111)*	0.827(0.656,1.042)
Marital status	living alone	1	1



	Married	1.187(1.087, 1.296)*	0.865(0.576, 1.301)
	Divorced/widowed	1.083(0.990, 1.184)	0.639(0.460, 0.888)*
Pregnancy complications	No	1	1
	Yes	1.203(1.165, 1.242)*	0.859(0.569, 1.297)
Occupation of women	Housewife	1	1
	Working	0.982(0.950, 1.016)	0.937(0.809, 1.085)
Terminated pregnancy	No	1	1
	Yes	1.039(0.986, 1.094)	0.817(0.649, 1.027)

**Note:** 1 = reference category of the categorical variable.

\* Significant at 5% level of significance

The Bernoulli part also indicated that the estimated odds that the number of ANC service uptake becomes zero with who is living in the rural area was 2.25 (OR = 2.25; 95%CI: 1.78, 2.86) times that of the urban women. The estimated odds the number of ANC service uptake which was zero with women who attend primary education was 0.45 (OR = 0.45; 95%CI: 0.39, 0.53) times that of the non-educated women. Similarly, the estimated odds by which the number of ANC service uptake becomes zero with husbands who have primary education was 0.63 (OR = 0.63; 95%CI: 0.54, 0.72) times that of the non-educated husbands. The estimated odds by which the number of ANC service uptake becomes zero with rich women was 0.57 (OR = 0.57; 95%CI: 0.48, 0.67) times that of the poor wealth index. The odds of the number that the ANC service uptake becomes zero with husbands who work is 0.76 (OR = 0.76; 95%CI: 0.66, 0.88) times that of husbands without work. The estimated odds at which the number of ANC service uptake becomes zero with women who have used mass media was 0.61 (AOR = 0.61; 95%CI: 0.53, 0.71) times that of women who did not use any mass media (Table 4).

## Discussion

Antenatal care during pregnancy is important for the health of the mother and the development of the fetus. Therefore, this study sought to determine the magnitude and associated factors of ANC service uptake among pregnant women in Ethiopia. The results of this study showed that about 64.6 % of the pregnant women have utilized the service and 35.4% haven't received ANC services during their pregnancy which is less than the figure reported from 2016 EDHS for urban Ethiopia<sup>19</sup>. This percentage figure is also less than those reported from the studies conducted in different parts of Ethiopia<sup>12 29 30</sup>.

The findings of this study revealed that education had a positive relationship with ANC service uptake, that is; the amount of ANC service uptake increased with the rise in woman's and

1  
2  
3 husband's education level. This study shows a result similar with other studies<sup>15 20 25 31-35</sup>, which  
4 revealed that uneducated women and husbands were fewer ANC attendants than those who were  
5 educated. The justification could be that educated women took more ANC because they had  
6 more awareness about regular ANC uptake benefits such as reduced risks of pregnancy and safe  
7 childbirth. Educated husbands may have better communication with their wives and be able to  
8 explore the importance of ANC uptake and other maternal health services<sup>36</sup> which could in turn  
9 provide their wives with more freedom<sup>37</sup>.

10  
11 The uptake of ANC services among married women was higher compared to women living  
12 alone. This finding is consistent with the studies conducted in Ethiopia<sup>15</sup>, Kenya<sup>32</sup>, Rwanda<sup>38</sup>  
13 and Bangladesh<sup>35</sup>. The higher ANC uptake could be attributed to the psychological and  
14 economic support obtained from their husbands, plannedness and desirability of their pregnancy,  
15 and the societal acceptability and support of their pregnancy state when compared with their  
16 unmarried women.

17  
18 Wealth index correlated negatively with the use of ANC services. Relative to the richest wealth  
19 quintile, women belonging to the lowest wealth quintiles were less likely to uptake ANC  
20 services. Studies elsewhere have also documented a positive relationship between economic  
21 status and ANC service uptake<sup>17 21 22 31 35 39</sup>. The justification for this might be that rich women  
22 may obtain more ANC information from mass media and had greater access to health care. In  
23 addition, this may be attributed to the indirect cost of antenatal care, such as transport cost when  
24 traveling to distant health facilities<sup>40</sup>.

25  
26 Compared to rural women, women living in urban areas were more likely to utilize ANC service.  
27 This finding is supported by the studies conducted in<sup>16 17 33 41</sup>. The reason could be that urban  
28 women had a better education, access to health services and are more informed about the  
29 importance of ANC service uptake. The exposure of mass media positively associated with ANC  
30 services. Women exposed to media had more ANC service uptake than women not exposed to  
31 media. This finding is in line with reports of other previous studies<sup>17 23 33 35</sup>. Compared to  
32 housewife women, the number of ANC uptake was higher among employed women. This  
33 finding is similar a study in Kenya<sup>42</sup> and 31 sub-Saharan Africa countries<sup>43</sup> which showed the  
34 odds of antenatal care utilization were higher among working women than non-working<sup>43</sup>. This  
35 may be because employed women, especially those in the formal sector benefit from a pregnancy  
36 care health insurance system. The finding indicated that women with pregnancy complications  
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3 tend to uptake ANC service than those who did not develop pregnancy complications. This  
4 finding is in line with findings of studies in Ethiopia<sup>44</sup>, Northern Jordan<sup>24</sup> and Tanzanian<sup>25</sup> and  
5 Pakistan<sup>25</sup>.  
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9 Relative to unplanned/unwanted pregnancies, women whose pregnancies were planned and  
10 desired were more likely to use ANC services. These findings are consistent with findings of  
11 previous studies<sup>22-24 32</sup>. The study results also showed that the number of ANC visits increased  
12 significantly as the age of women increased. Previous studies supported that women's age plays  
13 a significant role in the utilization of maternal health care<sup>12 20</sup>.  
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### 16 17 18 **Strengths and limitation**

19 This study used EDHS data having a larger sample size and higher-quality, which substantially  
20 reduces the risk of sampling bias and measurement bias. The study results also provide a timely  
21 evidence for policymakers and health sectors with respect to reducing levels of maternal and  
22 infant mortality which are highly depend on increased use of reproductive and maternal health  
23 services. The study provides other researchers with information about how to use over dispersed  
24 excesses zero and zero-inflated Poisson regression model. Due to the cross-sectional study  
25 design, causal effects are not measured and it is impossible to know whether the data are time-  
26 dependent or not. The other limitation was that the DHS did not include information on distance  
27 to a health facility and the quality of healthcare which could affect the uptake of ANC service.  
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### 36 37 38 **Conclusion**

39 About 64.6 percent of the pregnant women have utilized the service and only 35.5 percent of the  
40 pregnant women have received at least four ANC visits. Compared to the minimum requirement  
41 of ANC service uptake recommended by WHO, ANC service uptake in Ethiopia is extremely  
42 low and below average. This study revealed that rural women, poor women, lower maternal and  
43 paternal education, mothers not having access to mass media, women living alone, mothers  
44 without pregnancy complication significantly associated with less number of ANC service  
45 utilization. The low ANC service utilization calls for a need to improve community awareness  
46 about maternal health. More importantly, pregnant women need intensive health education so as  
47 to boost their ANC service uptake and follow-up adherence.  
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56 for making the data freely available for research purposes  
57

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**Competing interests:** None declared.

**Patient consent for publication:** Not required.

**Data sharing statement:** The survey datasets used in this study was based on a publicly available dataset that is freely available online with no participant's identity from <http://www.dhsprogram.com/data/available-datasets.cfm>.

**Ethics approval and consent to participate:** The study used available secondary data accessed under the National Data Sharing and Accessibility Policy (NDSAP) of the Government of Ethiopia. The data set had no identifiable information on the survey participants; therefore, no ethical approval is required for this work.

**Provenance and peer review:** Not commissioned; externally peer reviewed.

**Abbreviations:** ANC: Antenatal Care; AOR: Adjusted Odd Ratio; EDHS: Ethiopian Demographic and Health Survey; HSTP: Health Sector Transformation Plan; IR: Incidence Rate; SDG: Sustainable development Goal; WHO: World Health Organization; ZIP: Zero Inflated Regression Poisson

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STROBE Statement—Checklist of items that should be included in reports of *cross-sectional studies*

bmjopen-2020-043904.R2 - "Magnitude of Antenatal Care Service uptake and associated factors among Pregnant Women: analysis of the 2016 Ethiopia demographic and health survey"

	Item No.	Recommendation	Page No.	Relevant text from manuscript
<b>Title and abstract</b>	1	(a) Indicate the study's design with a commonly used term in the title or the abstract	2	"Abstract Study's design, Paragraph 2, line 37"
		(b) Provide in the abstract an informative and balanced summary of what was done and what was found	2	"Abstract, objective section Paragraph 1 and Result section Paragraph 6"
<b>Introduction</b>				
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4	"Introduction, paragraph 1, paragraph 2 and paragraph 3"
Objectives	3	State specific objectives, including any prespecified hypotheses	5	"Introduction, paragraph 3, line 128 and 129"
<b>Methods</b>				
Study design	4	Present key elements of study design early in the paper	5	"Methods, paragraph 3, Sampling Design, line 142 and 143"
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	5	"Methods, paragraph 2/data source, line 136-140"
Participants	6	Give the eligibility criteria, and the sources and methods of selection of participants	5	"Methods, paragraph 2/data source line 138 -140 and Paragraph 3/Sampling Design line 142-150"
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	6	"Methods, paragraph 3/ Study variables, line 152-161"
Data sources/measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	6	"Methods, paragraph 3/ Study variables, line 152-161"
Bias	9	Describe any efforts to address potential sources of bias	5	"Methods, Paragraph 3/Sampling Design line 142-150"
Study size	10	Explain how the study size was arrived at	5	"Methods, paragraph 2/data source, line 138-140"

Continued on next page

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2	Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	6	“Methods, paragraph 5/Data management and analysis, line 163&164”
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6	Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding	6	“Methods, paragraph 5/Data management and analysis, line 165 -183”
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10			(b) Describe any methods used to examine subgroups and interactions	6	“Methods, paragraph 5/Data analysis”
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13			(c) Explain how missing data were addressed	6	“Methods, paragraph 5/Data analysis line 180-183”
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16			(d) If applicable, describe analytical methods taking account of sampling strategy		“N/A”
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19			(e) Describe any sensitivity analyses		“N/A”
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21	<b>Results</b>				
22	Participants	13*	(a) Report numbers of individuals at each stage of study— e.g., numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	7	“Result, Paragraph 1 line 188-191”
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27			(b) Give reasons for non-participation at each stage		“N/A”
28					
29			(c) Consider use of a flow diagram		“N/A”
30	Descriptive data	14*	(a) Give characteristics of study participants (e.g., demographic, clinical, social) and information on exposures and potential confounders	8	“Result, Paragraph 3 line 206 -216 or Table 3”
31					
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33			(b) Indicate number of participants with missing data for each variable of interest		“N/A”
34					
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36			Report numbers of outcome events or summary measures	7	“Result, Paragraph 1 line 188 -192 or table 1”
37					
38					
39	Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	11	“Result, Paragraph 5 line 237-260 or table 4 /”
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44			(b) Report category boundaries when continuous variables were categorized	8	“Result, Paragraph 3/ line 232 and 233 or Table 3
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48			(c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period		“N/A”
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2	Other analyses	17	Report other analyses done—e.g., analyses of subgroups and interactions, and sensitivity analyses	“N/A”
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5	<b>Discussion</b>			
6	Key results	18	Summarise key results with reference to study objectives	13 “Discussion, Paragraph 1 line 280-285”
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9	Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	14 “Strengths and limitation of study, Paragraph 1 line 329-337”
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13	Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	13-14 “Discussion, Paragraph 2 to 5 line 287 -327”
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18	Generalizability	21	Discuss the Generalizability (external validity) of the study results	14 “Conclusion, Paragraph 1 line 340 -349”
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21	<b>Other information</b>			
22	Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	“Funding line 355 &354”
23				
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26				

\*Give information separately for exposed and unexposed groups.

\*N/A