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Determinants of Antenatal Care Visits with A Pregnancy Women in Rural Area of TentaWoreda, South Wollo, Ethiopia : Using Count Regression Model

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ABSTRACT

Background:

Antenatal care (ANC) is a preventive obstetric health-care program and crucial for optimizing maternal fetal outcome through regular monitoring of pregnancy. In Ethiopia, even if there is improvement in maternal health care service utilization including antenatal care; most of the women did not attend minimum number of visit recommended by World Health Organization and Consequences of pregnancy and childbirth are still the leading causes of maternal morbidity and mortality. Hence, this study assessed to develop and protect the health of women and their unborn babies by identify the main factors that are significantly influence the number of ANC visit utilization.

Method:

A Community based cross sectional study design that used quantitative data collection method is conducted in TentaWoreda, from March 28/2020 to April 20/2020.Multi-stage sampling technique was used to select 352 women. A significant percentage 103 (29.26%) of women not attended antenatal care. Husband education, women education, distance from home to health center, satisfaction of women from health center, ANC type and previous knowledge about ANC were significantly associated with the number of ANC visit of women. ANC follow up of women of reproductive age group was found below the minimum number of WHO recommendation. Hence,TentaWoreda health bureau should prepare appropriate policies and accomplish on those selected statistically significant variables for the effective utilization of the ANC service.

Conclusion:

The final selected ZIP model fit results indicated that husband education, women education, distance from home to health center, satisfaction of women from health center, ANC type and previous knowledge about ANC were statistically significant factors for the number of ANC visit of women

Key Words: Antenatal care, Number of ANC visit, maternal morbidity, ZIP model, pregnancy

1. Introduction

1.1. Background

Antenatal care (ANC) is a preventive obstetric health-care program and crucial for optimizing maternal fetal outcome through regular monitoring of pregnancy. ANC is a care given by skilled health personnel to a pregnant woman throughout her pregnancy period. Even World Health Organization describe that a minimum of four ANC visits for normal pregnancy, existing evidence from developing countries including Ethiopia indicates there are few pregnancy women who utilize it because of different cases.

The World Health Organization (WHO) recommends that every pregnant woman and newborn receives quality care throughout the pregnancy period, childbirth and the postnatal period. Within the continuum of reproductive health care, ANC provides a platform for important health-care functions, including health promotion, screening and diagnosis, and disease prevention. Crucially, ANC also give the opportunity to communicate with and support women, families and communities at a critical time in the course of a woman's life. The process of facilitating recommendations on ANC has highlighted the importance of giving effective communication about physiological, biomedical, behavioral and socio cultural affairs, and effective support, including social, cultural, emotional and psychological support, to pregnant women in a respectful way (WHO, 2016).

The total proportion of deaths pregnancy women of reproductive age (15–49 years) that are due to maternal causes was estimated at 9.2% in 2017down to 26.3% since 2000. To compare with other causes of death to women of reproductive age, the fraction attributed to maternal causes is decreasing. additionally, the effect of HIV/AIDS on maternal mortality in 2017appears to be less pronounced than in earlier years; HIV-related indirect maternal deaths now account for approximately 1% of all maternal deaths compared with 2.5% in 2005, at the peak of the epidemic(WHO, 2019).

Accessibility and utilization of (ANC) service varies depending on different geographical locations, sociodemographic characteristics, political and other factors. A geographically linked data analysis using population and health facility data is valuable to map ANC use, and identify inequalities in service access and provision(Tegegne et al., 2019).

ANC give the opportunity to detect and treat complications of pregnancy and to deliver preventive health services such as immunization against tetanus, prophylactic treatment of malaria and worms, and HIV testing and counseling leading to Prevention of Mother to Child HIV Transmission (Mgata and Maluka, 2019).

Ethiopia agreed minimizing maternal health complication is directly or indirectly assured if and only if the child-bearing mother takes ANC service or visited doctor as well as health-care providers. Furthermore, the prevalence of the number of ANC service utilization of child-bearing women is absolutely low in developing countries like Ethiopia. Regular antenatal care visits are important to develop confidence between the women and their health-care provider, to individualize health promotion messages, and to identify and manage any maternal risk factors associated with child-bearing mothers(Terefe and Gelaw, 2019).

Ethiopia has been implementing focused antenatal care package to reduce maternal and child deaths. The quality of antenatal care service has not being resolved widely due to un standardized measurement (Selgado et al., 2019).

Therefore, the aim of this study was to identify the factors associated to antenatal care visits of pregnancy women in the rural area of TentaWoreda, South Wollo, and Ethiopia.

1.2 Statement of the problem

Approximately 303,000 women and adolescent girl died from pregnancy and childbirth-related complications in 2015. The same year, 2.6 million babies were stillborn. Almost all of the maternal deaths (99%) and child deaths (98%) occurred in low- and middle-income countries. These maternal deaths could have been prevented if the pregnant women or adolescent girls had been able to access quality antenatal care (ANC). Sixty percent of the stillbirths (1.46 million) occurred during the ante partum period and mainly due to untreated maternal infection, hypertension, and poor fetal growth (WHO, 2015).

While the timing of ANC varies between high and low income countries, there is almost common understanding that ANC attendance is a lifesaving intervention for pregnant women and fetus. Beside the role of detecting risks factors, ANC exposes women to health education on danger signs and birth preparedness and encourages them to deliver with a skilled attendant or in a health facility .Knowledge attained by pregnant women who attend ANC is not only used during the pregnant period but also after giving birth(WHO, 2018).

The global MMR declined from 385 deaths per 100,000 live births in 1990to 216 in 2015, corresponding to a relative decline of 43.9% during the 25-years of period, with 303,000 maternal deaths globally in 2015. Regional progress in reducing the MMR since 1990ranged from an annual rate of reduction of 1.8% in the Caribbean to 5.0% for Eastern Asia. Regional MMRs for 2015range from 12 for developed regions to 546 for sub-Saharan Africa. Accelerated progress will be needed to achieve the SDG; countries will need to reduce their MMRs at an annual rate of reduction of at least 7.5%(Alkema et al., 2016).

Women in every country face heartbreaking obstetric outcomes. But the burden of pregnancy-related deaths and disability falls disproportionately on disadvantaged women with less access to care. In terms of geographic distribution, this hardship has largely been borne by women living in sub-Saharan Africa and South Asian countries, where resources are more constrained(WHO,2019).

The Federal Ministry of Health of Ethiopia(FMOH) has implemented a set of high impact interventions, including antenatal care, skilled birth services and postnatal care with the aim of reducing maternal mortality to 267 per 100,000 live births at the end of 2015. However, although the ANC coverage has shown an increment over the past decade and half, it is still below average. The continuity of service and quality of care is not also optimal as evidenced by low coverage of skilled delivery, tetanus toxic vaccine uptake, screening for syphilis as well as suboptimal uptake of prevention of mother-to-child transmis3sion of HIV services by pregnant women.

According to the 2016Ethiopian demographic and health survey (EDHS)report; 62 percent of women who gave birth in the five years preceding the survey received antenatal care from a skilled health care provider at least once for their last birth and only 32 percent had four or more ANC visits for their most recent live birth.

There are a lot of study which are done before about antenatal care visit with different parts of Ethiopia but those studies were described the associated factors which are linked with antenatal care visit based on the data which given from health center that means those pregnancy women which didn’t come to health center are not included because at that time the pregnancy women make at least one times visit during that study. So my study differs from the previous study due to concluding all pregnancy women who are not came to the health center (no visit) by collecting the data from each household not from the health center and this study concentrated only the rural area of TentaWoreda, South Wollo, Ethiopia because there are a lot of pregnancy related risks in rural area which compared with the urban. In addition to this, most previous studies are analyzed by health professions using descriptive statistics but this study is conducted by count regression model since the model is appropriate for count data.

1.3 Objective of the study

1.3.1 General objective

The main objective of this study was to identify the main factors associated with the average number of antenatal care visits of pregnant women in the rural parts of TentaWoreda,SouthWollo, Ethiopia.

1.3.2 Specific objectives

* To describe the average number of antenatal care visits by socio-economic and demographic factors of pregnant women in the rural parts of TentaWoreda in South Wollo, Ethiopia.

* To identify factors which are caused for low ANC utilization service in TentaWoreda.

* To know the impact of socio-economic and demographic factors with appropriate model.

2. Response variable

The number of antenatal care visit (ANC) of pregnant women in rural area of TentaWoreda.

Explanatory variables

The predictor factors for the number ANC visit of this study were described in the Table 1.

Table 1 Description and Coding of Covariates of the Study Variables

Predictors	Categories,codesand descriptions(Covariates)
Maternal age	0=<20 1=20-30 2=31-40 3=41-49
Marital status	0=Single 1=Married 2=Divorced 3=Widowed
Religion	0=Protestant 1=Muslim 2=Orthodox
Educational status of mother	0=Illiterate 1=Elementary 2=Secondary 3=Higher And Above
Educational status of husband	0=Illiterate 1=Elementary 2=Secondary 3=Higher And Above
Mother occupation	0= Farmer 1= Trader 2= Piecework 3= Office
Family economy status	0=Low 1=Middle 2= High
Abortion case	0=Yes 1= No
Distance from home to health center	0= <6km, 1=≥6km
Availability of Transportation	0=Yes 1=No
Decision based about ANC	0=Myself 1=Husband 2=Jointly 3=Others
Birth interval (order)	0=1-2 1=3-4 2=5 And Above
Sources of Information about ANC	0=Health Profession 1=Traditional Delivery

	2=Radio 3=Partner
Timely visit (admit on time for ANC)	0=Yes 1=No
Satisfaction of pregnancy mother from health center	0=Yes 1=No
Prevalence of Pregnancy at risk	0=No Risk 1=Low Risk 2=High Risk
Type of ANC access	0=Public Only 1=Private Only 2=Both Public And Private
Gravidity	0=1times 1=2 Times 2= 3and Above Times
Workload during pregnancy	0=Yes 1=No
Prevalence Previous Knowledge about ANC	0=Yes 1=No
Time rest of mother during pregnancy	0=2-6 Hour 1=6-8 Hour 2=More Than 8 Hour
Taking of smoking	0=Yes 1=No
Alcohol consumption	0=Yes 1=No

Methods of data analysis

Count data models allow for regression type analyses when the dependent variable of interest is a count. Fortunately, there are many models that deal explicitly with count outcomes. Some of the count models are Poisson, Negative Binomial, Zero Inflated Poisson and Zero Inflated Negative Binomial regression model.

In this study, our variable of interest is a count variable. The dependent variable of this is study is the number of ANC visit; which is count which can take a non-negative integer values (0, 1, 2, 3…) It is appropriate to use non-linear models based on non-normal distribution to describe the relation between the response variable and a set of independent variables. For count data, the standard framework for explaining the relationship between the outcome variable and a set of explanatory variables includes the Poisson and Negative Binomial regression models. Unlike linear regression, count data regression models have counts as the response variable that can take only nonnegative integer values.
In a real-life count data are frequently characterized by over-dispersion and excess zeros. Zero-inflated count models provide a parsimonious yet powerful way to model this type of situation. Such models assume that the data are a mixture of two separate data generation processes: one generates only zeros, and the other is either a Poisson or a negative binomial data-generating process. The result of a Bernoulli trial is used to deter mine which of the two processes generates an observation.

Poisson regression model

Poisson regression is similar to regular multiple regressions except that the dependent (Y) variable is an observed count that follows the Poisson distribution. Thus, the possible values of Y are the nonnegative integers: 0, 1, 2, 3, and so on. It is assumed that large counts are rare. Hence, Poisson regression model is similar to logistic regression, which also has a discrete response variable. However, the response is not limited to specific values as it is in logistic regression.

The Poisson regression model assumes that the observed outcome variable follows a Poisson distribution and is characterized by a mean expected value (λ in the above discussion) which is also its variance. The Poisson regression attempts to 'fit' this parameter (which we will call μ) to a linear model of input or explanatory variables. The simple linear model cannot be used as μ can take on only positive values. A log transformation of μ solves this problem. In Poisson regression, we suppose that the Poisson incidence rate μ is determined by a set of k regressed variables (the X's). The expression relating these quantities is;

$\log(\mu_i) = \beta_0 + \beta_1 xi_1 + \beta_2 xi_2 + \cdots + \beta_k xi_k$ ------------ (1)

Take the exponential of both side of Eq. (1), we have,

$$\mu_i = \exp(\beta_0 + \beta_1 xi_1 + \beta_2 xi_2 + \cdots + \beta_k xi_k)$$

Poisson regression model is a member of an exponential family of distributions. Therefore, methods in the framework of the generalized linear model (GLM) are readily applied. In GLM framework, the random component $y_i \sim \text{poisson}(\mu_i), i = 1,2,\ldots n.$ Let thesystematic component, linear in covariates be given by $\eta_i = x_i^T\beta = \sum_j x_{ij}\beta_j$ And the link function for Poisson model is log-link expressed as $g(\mu_i) = \log(\mu_i) = X'\beta$ This model is known as the Poisson regression model.

The Poisson distribution models the probability of y events with the formula

$$p(Y_i = y_i; \mu_i) = \frac{e^{-\mu_i}\mu i^{yi}}{yi!}; yi = 0,1,2,\ldots \quad, \mu i > 0,$$

$$E(y_i|x_i) = var(y_i|x_i) = \mu_i$$

Parameter estimation of Poisson regression model

In Poisson regression model the parameters of the explanatory variables are estimated by the method of maximum likelihood estimation. The method of maximum likelihood estimation is finding the parameter values that maximize the likelihood function. The likelihood function of Poisson distribution is as follows:

$$L = l(\mu i, \beta) = \prod_{i=1}^{n} \frac{e^{-\mu_i}\mu i^{yi}}{yi!} = \prod_{i=1}^{n} \frac{e^{-e^{Xi^t\beta}}(e^{Xi^t\beta})^{yi}}{yi!}$$

Taking log on both sides and we get:

$$L = \log(l(\mu i, \beta)) = \sum_{i=1}^{n} [yiXi^t\beta - e^{Xi^t\beta} - \log(yi!)]$$

The first derivative of the log likelihood function is:

$$\frac{\partial L}{\partial \beta j} = \sum_{i=1}^{n} [yi - e^{Xi^t\beta}]Xij$$

The second derivative of log likelihood function is given as follows:

$$\frac{\partial^2 L}{\partial \beta j \partial \beta k} = -\sum_{i=1}^{n} e^{Xi^t\beta} XijXik$$

Then, the log-likelihood function of the Poisson regression model is nonlinear in β so that they can be obtained via using an iterative algorithm. The most commonly used iterative algorithms are either Newton-Raphson or Fisher scoring.

In practice $\hat{\beta}$ is the solution of the estimating equations obtained by differentiating the log likelihood, in the above in terms of β and equating them to zero. Therefore, β will be obtained by maximizing using numerical iterative method(Colin and Pravin, 2013).

Over-dispersion

It is known that Poisson distribution has only one parameter and that the mean of a Poisson distribution is equal to its variance. By using a Poisson regression model, we're implicitly making a strong assumption that the mean of the count data we are modeling is equal to its variance. However, the application of Poisson regression model works well for count data, it is constrained with the assumption of equality of variance and mean. When the variance of count data exceeds the mean, Var (Y)>E(Y) a feature of over dispersion will occur. When over dispersion occurs, the Poisson maximum likelihood estimator obtained will be incorrect (Cameron and Trivedi, 1998).

There are unwanted consequences if over dispersion exists, including

1) The model standard errors will not be correct and may be substantially underestimated. Thus the significance of individual regression coefficients might also be incorrect;

2) model selection might favor overly complex models due to incorrectly calculated deviance; and

3) Prediction intervals will be smaller than they should be.

There are many potential causes of over dispersion, including

- The study cohort might be very heterogeneous, and thus impose additional variability;
- There might be correlation between individual responses;
- Excessive 0 counts in the data; and
- Some important factors are not included in the regression model.

If over dispersion exist, Poisson regression modeling is not appropriate. In this case, a negative binomial regression or quasi-likelihood estimation could be applied to handle the excess variation of the data.

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

$H0: \delta = 0$(The Poisson model can be fitted well the data) versus

$H1: \delta > 0$(The data would be better fitted by the negative binomial regression)

A negative binomial distribution is the standard count distribution used in analyzing over-dispersed data. The negative binomial (NB) distribution was perhaps the first probability distribution considered in statistics whose variance is larger than its mean.

There are two basic criteria commonly used to check the presence of over dispersion:

1. **Deviance, $D(y, \mu^{\wedge})$,** is given by

   $D(y,\mu^{\wedge})=2 * \sum_i^n \left\{y_i ln\left(\frac{y_i}{\mu i^{\wedge}}\right) - (y_i - \mu i^{\wedge})\right\}$

   Where, y is the number of events, n is the number of observations and $\mu i^{\wedge}$is the fitted Poisson mean.

2. **Pearson chi-square test,x^2** is also given by

$$x^2 = \sum_{i=1}^{n} \left(\frac{(y_i - \mu i^{\wedge})^2}{\mu i^{\wedge}}\right)$$

If the model fits the data, both deviance and Pearson Chi-square statistics divided by the degrees of freedom are approximately equal to one. Values greater than one indicate the variance is an over dispersion, while values smaller than one indicate an under-dispersion. It is possible to account for over-dispersion with respect to the Poisson model by introducing a scale (dispersion) parameter into the relationship between the variance and the mean.

In this study, the analysis includes descriptive results and finding the significant factors associated with the average number of antenatal care visits of pregnant women in rural area of TentaWoreda, Ethiopia. For this study Poisson, negative binomial, zero-inflated Poisson and zero-inflated negative binomial models were used to analyze the data. The statistical analyses were performed using statistical software package called STATA version 12 and SPSS version 20.

3. Data analysis

Descriptive results

Before proceeding to fit an appropriate count models, we make a descriptive analysis of the data in order to have an overall view of the distribution of the average number of antenatal care visits with pregnant women.

Information on the number of antenatal care visit obtained from a total of 352pregnancy women in the rural parts of TentaWoreda was studied. Table 4.1 shows the frequency and percentage distribution of the number of antenatal care visit in rural parts of TentaWoreda based on information from 352 pregnancy women.

Table 2 Frequency distribution of number of ANC in rural parts of TentaWoreda, Ethiopia

Number of ANC visit	Frequency	Percent
0	103	29.26
1	73	20.74
2	79	22.44
3	44	12.50
4	32	9.09
5	12	3.41
6	6	1.70
7	2	0.57
8	1	0.28
Total	352	100.00

As it is shown in Table 2, about29.26% of pregnancy women did not follow ANC visit whereas20.74%, 22.44%, 12.50%, 9.09%, 3.41%, 1.70%, 0.57% and 0.28% of them have experienced 1, 2, 3, 4, 5, 6, 7 and 8 times ANC visit throughout their pregnancy period.

Table 3: Summary statistics for the dependent variable, number of ANC visit

Variable	Minimum	Maximum	Mean	Variance
Number of ANC visit	0	8	1.73	2.62

As shown in Table 3, the variance of ANC visit is 2.62 and its mean also 1.73.This indicates that there is an over-dispersion in this dataset and the standard Poisson regression model is not appropriate to fit the number of ANC visit data.

Additional inspection of the data also indicated as shown in Figure 1, the distribution of the desired number of ANC visit has a somewhat slowly decreasing tail and is skewed to the right.

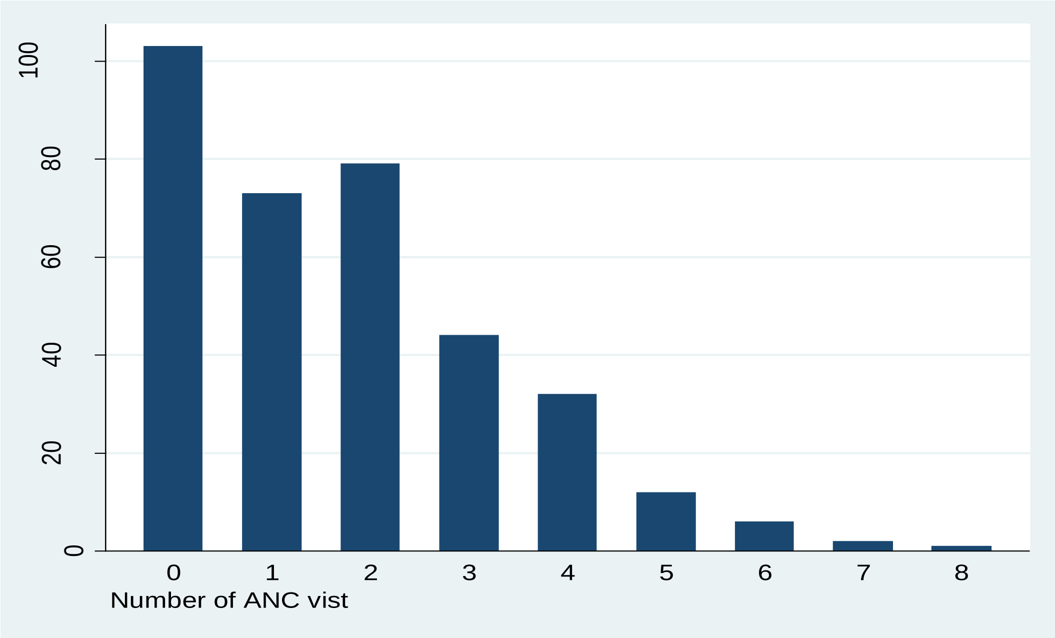

Figure 1: Number of ANC Visit

Table 4 Descriptive results for number of ANC visit related predictors.

Variables	Count/Frequency	Mean	Variance
Age of preg.women			
<20	48	1.27	2.24
20-30	148	1.99	3.05
31-40	123	1.67	2.31
41-49	33	1.48	2.01
Marital status			
single	38	2.21	3.16
married	281	2.41	2.52
divorced	33	2.58	2.92
Mother education			
illiterate	199	1.46	1.92
primary	90	1.79	2.28
secondary	27	2.37	2.78
higher and above	36	2.61	6.02
Mother occupation			
farmer	221	1.52	2.35
trader	95	1.88	1.64
office	36	2.61	6.02
Husband education			
illiterate	171	1.23	1.39
primary	105	1.89	2.60
secondary	34	2.71	2.64
higher and above	42	2.60	5.32

Abortion			
yes	54	1.13	1.51
no	298	1.84	2.76
Birth order			
1-2	141	1.44	1.98
3-4	183	1.98	2.91
5 and above	28	1.57	3.37
Distance from home to health center			
<6km	137	2.29	3.08
≥6km	215	1.37	2.02
Transport			
yes	135	2.10	2.87
no	217	1.50	2.34
Decision			
myself	92	1.58	2.31
husband	22	1.01	1.41
jointly	216	2.01	2.79
others	22	0.23	0.18
Information			
health profession	151	2.23	2.94
traditional delivery	60	0.52	0.59
radio	85	1.8	2.57
partner	56	1.57	1.85
Admission on time			
yes	182	2.32	3.07
no	170	1.10	1.39
Risk			
no risk	167	2.15	3.30
low risk	105	1.80	1.37
high risk	80	0.76	1.58
Family economy status			
poor	190	1.08	0.99
middle	119	2.45	3.23
rich	43	2.58	4.25
ANC type			
public	226	1.49	1.74
private	10	1.6	3.16
both public and private	116	2.21	4.03
Gravidity			
1 times	83	1.67	2.37

2 times	135	1.88	3.11
3 and above	134	1.61	2.30
Intention			
yes	184	1.92	2.70
no	76	1.67	2.60
don't decide	92	1.40	2.37
Knowledge			
yes	210	2.27	3.12
no	142	0.93	0.83
Workload			
yes	256	1.45	1.69
no	96	2.48	4.38
Smoking			
yes	23	1.04	3.23
no	329	1.79	2.56
Alcohol			
yes	200	1.64	2.21
no	152	1.86	3.16
Time rest			
2-6 hr	177	1.28	1.45
7-9 hr	102	2.22	3.12
10hr and above	73	2.15	3.85

Table 4 reveals that the mean and variance of number of antenatal care visit for each predictor variables.

Women age: The women age has four categories. Among those categories women within the age group<20 years had the lowest mean number of ANC visit (1.27) than other categories.

Mother education: When we consider women educational status, the illiterate women has the lowest mean number (1.46) of ANC visit than other categories, while the highest mean number of ANC visit (2.61) are reported by the women who had learned their education higher and above.

Mother occupation: Women whose job is farmer have a minimum mean number of ANC visit (1.52) than the women who works in office (2.61).

Distance: Women whose home is more than 6 km far from the health center have minimum mean number of ANC visits(1.37) than whose home is below 6km far from health center.

Availability of transport: The mean number of ANC visit of women who can't get the transport (1.50) is smaller than the women who can access the transport (2.10).

Family economy status: The family economy status also has a high contribution to the number of ANC visits of women. That is the women who have poor economic status have a lowest mean number of ANC visits (1.08) that is compared to have rich economic status (2.58).

Knowledge of ANC: The women who have previous knowledge about ANC visit have the higher mean number of ANC visit (2.27) compared to the women who have no previous knowledge about ANC (0.93).

Workload: The mean number of ANC visit of pregnancy women who have higher work load is 1.45 and the mean number of ANC visit of pregnancy women who have not workload is 2.48; this indicates women who have higher work load make lower ANC visits than women have not work load.

Alcohol consumption: The mean numbers of ANC visits of pregnant women who consume alcohol are 1.64; whereas the higher mean number of ANC visits are reported by the pregnancy women who didn't consume alcohol (1.86).

Variable selections

In this study, we have used Stepwise variable selection which is a combination of backward elimination and forward selection to identify the predictors in the model. This was done on Poisson regression model as it is the bench mark for other count regression models. Stepwise selection method addresses where variables were added or removed with respect to the p-value in the process.

Based on stepwise variable selection procedure, the following predictor variables are found;

- Husband educational status
- Mother educational status
- Distance from home to health center
- Availability of transport
- Satisfaction of mother from health center
- ANC type
- Previous knowledge
- Workloads of pregnancy mother are included in the models 5% level of significant. Further analyses are made only on those variables which are found significant factors for the number of antenatal care visits in rural area of Tentaworeda,SouthWollo.

Over dispersion test

If the Deviance statistics and Pearson Chi-square statistic divided by their corresponding degrees of freedom are greater than one, then there is over-dispersion in the data suggesting Negative Binomial (NB) regression model.

Table 5: The results of over-dispersion test after fitting a Poisson regression

Statistics	Value	Degree of freedom	$\frac{\text{Value}}{\text{Degree of freedom}}$	P-value
Deviance	436.2424	338	1.290	0.0002
Pearson chi-square	339.0561	338	1.003	0.004

From Table 5 the Deviance statistics and Pearson Chi-square Statistic divided by their corresponding degrees of freedom are greater than one indicating over-dispersion. This is also one way of proofing the existence over-dispersion and indicating that Poisson regression is not appropriate for this ANC dataset.

When the assumption of the equality of variance and mean in the Poisson regression model is violated, over-dispersion occurs and the standard error estimates will be biased which leads to incorrect value of the test statistic. Consequently, the covariates may be wrongly interpreted. Since both AIC and BIC values were lower for the Negative Binomial model than for the Poisson model, the Negative Binomial model is preferred. The Negative binomial model accounts for the over-dispersion in the data.

4.4 Parameter estimation

Table 6 presented parameter estimates with their corresponding robust standard error of the Poisson, negative binomial (NB), zero-inflated Poisson (ZIP), and zeroinflated negative binomial (ZINB) regression models.

Table 6 parameter estimation for Poisson, NB, ZIP and ZINB regression models

Variables	Poisson		NB		ZIP		ZINB	
	Coef.	Robust Std.Err.	Coef.	Robust Std.Err.	Coef.	Robust Std.Err.	Coef.	Robust Std.Err.
Poisson model for non-zero part								
Husband education								
Illiterate	(Ref.)							
Elementary	0.269*	0.0963	0.273*	0.096	0.334*	0.077	0.334*	0.111
Secondary	0.648*	0.1396	0.653*	0.140	0.606*	0.094	0.606*	0.162
Higher and above	0.783 *	0.217	0.779*	0.218	0.724*	0.207	0.724*	0.300
Mother education								
Illiterate	(Ref.)							
Elementary	-0.078	0.106	0-.076	0.105	-0.133	0.086	-0.133	0.118
Secondary	0.333*	0.161	-0.348*	0.158	-0.618*	0.149	-0.618*	0.169
Higher and above	-0.714*	0.320	-0.711*	0.321	-0.482	0.270	-0.482	0.354
Distance								
<6km	(Ref.)							
≥6km	-0.3092*	0.099	-0.321*	0.099	-0.491*	0.074	-0.491*	0.104
Transport								
Yes	(Ref.)							
No	-0.245*	0.092	-0.248*	0.092	-0.108	0.067	-0.108	0.098
Satisfaction								
Yes	(Ref.)							
No	0.367*	0.111	-0.371*	0.111	-0.307*	0.084	-0.308*	0.1206
ANC type								
Public only	(Ref.)							
Private only	-0.415	0.346	-0.415	0.348	-0.253	0.383	-0.253	0.325
Both public and private	0.403*	0.114	0.416*	0.113	0.534*	0.091	0.534*	0.112
Previous Knowledge								
Yes	(Ref.)							
No	-0.636*	0.108	0.637*	0.107	-0.776*	0.093	-0.776*	0.132
Workload								
Yes	(Ref.)							
No	-0.218	0.125	-0.227	0.127	-0.078	0.095	-0.078	0.133
-Const	0.969*	0.093	0.976*	0.092	1.06*	0.073	1.06*	0.114
Inflate/logistic part for zero count								
Knowledge					-14.174*	0.482	-20.185	11034.57
_Cons					-1.610*	0.218	11034.57*	0.219
/lnalpha			-3.12	1.27			-17.35446	257.18
Alpha			0.044	0.056			2.90e-08	7.47e-06

Notes: Robust Standard Error is in Robust Std. Err. * Significant at 5% confidence alpha is dispersion parameter.

Comparison of models

A critical question in data analysis is how to choose the appropriate models for a specific study. Several criteria can be used to compare and select among considered models. In this study, four different count regression models, namely; Poisson, negative binomial, zero-inflated Poisson and zero-inflated negative binomial models were considered. Different model selection criteria: the Log likelihood, Akaike information criterion (AIC) and

Bayesian information criterion (BIC) were used in order to identify the most appropriate fitted model. For non-nested models: ZIP versus Poisson and ZINB versus NB regression models were identified using the Vuong test statistic.

Table 7: Model selection criteria for Poisson, NB, ZIP and ZINB models for the number ANC visit of pregnancy women

Criteria	Models			
	Poisson	**NB**	**ZIP**	**ZINB**
Loglikelihood	-550.06766	-549.57413	**-521.2899**	-521.2899
AIC	1128.135	1129.148	**1074.58**	1076.58
BIC	1182.226	1187.103	**1136.398**	1142.261
Vuong			**3.42**	6.41
P-value			**0.0003**	0.0000

Table 7 shows the model selection criteria used to identify the best/preferred fitted model among the four candidate models. First, the calculated value of the Vuong test statistic (3.42) for comparing ZIP versus Poisson model is greater than 1.96 implying that the ZIP model is preferred to the Poisson model for predicting the number of ANC visit of pregnancy women. Similarly, the calculated value of the Vuong test statistic for comparing ZINB versus NB models is 6.41, indicating that the ZINB model is preferred to NB regression model. Finally, to compare the ZIP and ZINB models, AIC, BIC and Log likelihood were used as shown in Table 4.5.The model with the smallest AIC, smallest BIC and largest Log likelihood is preferred. Thus, the Zero-inflated Poisson regression model with the lowest value of AIC, lowest value of BIC and the highest value of Log likelihood is the most appropriate and preferred model for describing the number of ANC visit of pregnancy women.

Zero inflated Poisson regression results

Table 8: The estimated Zero-inflated Poisson model for number of ANC visit of selected independent variables.

Variables	Coef.	Robust Std. Err.	Z	P>|z|	IRR	95% Conf. Interval for IRR Lower	Upper
Poisson model for non-zero part							
Husband education							
Illiterate	(Ref.)						
Elementary	0.378	0.117	4.72	0.000	1.459	1.247	1.706
Secondary	0.579	0.207	5.01	0.000	1.785	1.423	2.240
Higher and above	0.723	0.427	3.49	0.000	2.061	1.373	3.095
Mother education							
Illiterate	(Ref.)						
Elementary	-0.127	0.072	-1.54	0.123	0.881	0.749	1.035
Secondary	-0.573	0.089	-3.65	0.000	0.564	0.414	0.767
Higher and above	-0.433	0.172	-1.63	0.102	0.649	0.386	1.091
Distance from home to health center							
<6km	(Ref.)						
≥6km	-0.521	0.044	-7.02	0.000	0.594	0.514	0.687
Transport							
Yes	(Ref.)						

No	-0.115	0.061	-1.68	0.094	0.891	0.779	1.019
Satisfaction from health center							
Yes	(Ref.)						
No	-0.290	0.064	-3.37	0.001	0.748	0.632	0.886
ANC type							
Public only	(Ref.)						
Private only	-0.152	0.246	-0.53	0.596	0.859	0.489	1.507
Both public and private	0.505	0.159	5.25	0.000	1.657	1.372	2.001
Previous knowledge							
Yes	(Ref.)						
No	-0.709	0.049	-7.09	0.000	0.492	0.404	0.598
Workload							
Yes	(Ref.)						
No	-0.004	0.096	-0.05	0.963	0.996	0.824	1.202
-Const	0.997	0.203	13.35	0.000	2.711	2.342	3.139
Inflate/logistic part for zero count							
Husband education							
Illiterate	(Ref.)						
Elementary	1.776	1.481	1.20	0.231	5.906	-1.127	4.679
Secondary	-0.056	2.087	-0.03	0.978	0.945	-4.147	4.034
Higher and above	2.409	1.612	1.49	0.135	11.122	-0.750	5.569
Distance from home to health center							
<6km	(Ref.)						
≥6km	-1.592	0.718	-2.22	0.027	0.203	-3.000	-0.185
Transport							
Yes	(Ref.)						
No	0.957	0.605	1.58	0.114	2.603	-0.230	2.142
Previous knowledge							
Yes	(Ref.)						
No	-12.028	5.881	-2.05	0.041	$5.96e^{-6}$	-23.554	-0.502
Workload							
Yes	(Ref.)						
No	2.276	1.097	2.07	0.038	9.737	0.125	4.426
-Const	-4.765	1.271	-3.75	0.000	0.009	-7.256	-2.273

Statistically significant at 5% confidence level p-value < 0.05

Interpretation of ZIP model fit results

To interpret the categorical variables made by the incidence rate ratios ($IRR = exp^{coef}$) which is important to explain the change in percentage ($IRR - 1$) of significant predictors.

Husband education: The estimated coefficients for all husband education categories are statistically significant. The results in Table 8 shows that husband education categories have a significant effect on the expected number of ANC visit of pregnancy women. The expected number of ANC visit of women whose husband learned elementary school is 1.459 times the expected number of ANC visit of women whose husband is illiterate holding all other variables in the model constant. The expected number of ANC visit of women whose husband learned secondary school is 1.785 times the expected number of ANC visit of women whose husband is illiterate holding all other variables in the model constant. The expected number of ANC visit of women whose husband learned higher and above school is 2.061 times the expected number of ANC visit of women whose husband is illiterate holding all other variables in the model constant.

The number of ANC visit of pregnancy women was increased by 45.9%, 78.5% and 106.1% for women whose husband was learned elementary school, secondary and higher and above school respectively, as compared to the women whose husband was illiterate.

Mother education: The statistically significant value for women who have learned secondary school indicates that the expected number of ANC visit is decreased by 0.564 times as compared to the women who were illiterate while all other predictors in the model holds constant.

The number of ANC visit of pregnancy women who have learned secondary school was decreased by 43.6% as compared to women who were illiterate.

Distance from home to health center: The coefficient for distance of 6 km and above is statistically significant implying that the expected number of ANC visit of women whose home far from 6 and above km is decreased by 0.594 times as compared to the women whose home is below 6km far from the health center, while all other predictors in the model holds constant.

The number of ANC visit of pregnancy women whose home is far 6 and above km was decreased by 40.6%, as compared to women whose home is below 6km.

Women satisfaction: The estimated coefficient for women that not satisfied from the health center is -0.290. This indicates the expected number of ANC visit is 0.748 times decreased as compared to the women who are satisfied from health center, while all other predictors in the model holds constant.

ANC access type: In the fitted ZIP model, the coefficient for both public and private ANC type is statistically significant. Thus, the women who used both public and private ANC type are expected to have 65.7% greater than number of ANC visit of women who used public ANC type only (IRR=1.657).

Previous knowledge: The estimated coefficient for women's have not presence of previous knowledge about ANC is statistically significant. The negative estimated coefficient -0.709 for women who had not previous knowledge about ANC suggests the expected number of ANC visit is decreased by 50.8%than the pregnancy women who have previous knowledge about ANC (IRR=0.492).

The bottom half of Table 8, labeled 'inflate', contains coefficients for the factor change in the odds of being in the Always-0 Group compared to the Not Always-0 Group. As shown in Table 8, distance from home to health center has significant impact on the probability of being in the always zero group. The odds of no visit of ANC decreased by 79.7% for women whose home distance is 6km and above as compared to those women whose home distance is below 6km controlling other variables in the model constant.

Discussion

Mother education was the significant factor for the ANC visit. Table 8 showed that the expected number of ANC visit of women who have learned secondary school is decreasedas compared to the women who were illiterate.This finding is consistent with other studies (Dulla et.al (2017); Tesfaye*et al.* (2019) and (Mekonnen*et al.*, 2019).

According to the above results, the presence of previous knowledge about ANC has a significant effect on the number of visit. From this result, the expected number of ANC visit of women who have not previous knowledge about ANC is decreased than women who have previous knowledge. This result was similar to the study (Sekata, 2015) and also contradict to the study conducted by Tsega*et al.*(2013).

Workload also other major determinant factors for the number ANC visit of pregnancy women in Tentaworeda. As shown in Table 8, women who have not workload during pregnancy period have more ANC visit than women who have more workload. This finding also seemed to be in accordance with other study conducted by (Sekata, 2015).

Length of distance from the home to the health center is a significant factor for the ANC utilization of pregnancy women. The result of this study also showed that a pregnancy women whose home far from the health center are made less ANC attendance than whose home is near to the health center. This result also supported by a study conducted by Banda*et al.* (2012).

4. CONCLUSION AND RECOMMENDATION

Conclusion

This paper attempted to identify and analyze the number of antenatal care visit of pregnancy women with associated factors using count regression model. The study also identifies the best count fit model in order to analyze the number of ANC visit data. In this study, out of 352 pregnancy women 103 (29.26%) women did not follow ANC visit. This indicates most pregnancy women and their unborn babies were near to different risk.

The descriptive result suggested that there is high variability in the non-zero values. The variance of the number of ANC visit was larger than its mean, indicate that the possibility of over-dispersion. In addition, the over-dispersion parameter alpha was found to be significantly different from zero in both NB and ZINB regression models. This implies that standard Poisson regression model is not an appropriate model to fit the number of ANC visit dataset.

The most fitted model was selected from different candidate models: Poisson, negative binomial (NB), zero-inflated Poisson (ZIP) and zero-inflated negative binomial (ZINB) using different comparison techniques. The comparison was conducted by using Log pseudo likelihood,Akakie information criteria (AIC), Bayesian information criteria (BIC) and Vuong test. Finally ZIP model was selected.

This study also identified predictor variables that had significant effects on number of ANC visit. The final selected ZIP model fit results indicated that husband education, women education, distance from home to health center, satisfaction of women from health center, ANC type and previous knowledge about ANC were statistically significant factors for the number of ANC visit of women.

Recommendations

Based on the findings that we have obtained, we recommend the following issues:

- TentaWoreda health bureau should prepare appropriate policies and accomplish on those selected statistically significant variables in order to maximize the number of ANC visit especially in the rural area.
- Health extension workers should give awareness for the pregnancy women about ANC and its purpose for them and their babies.
- The government should give more attention for pregnancy women who live in rural parts of Ethiopia.

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