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Varriation in Utilization of Modern Contraceptive Among Married Women in the Seven Woredas of Assosa Zone: A Comparison of Bayesian and Classical Approach. Case Study in Assosa Zone, Benishangul Gumuz, Ethiopia

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Abstract

Introduction: *Contraception is a procedure that can be used to avoid pregnancy or childbirth. When women choose to prevent pregnancy or have a longer birth, they frequently use contraceptives. The global prevalence rate of contraceptive use was 64 percent, with Africa responsible for 33 percent. Ethiopia has an estimated rate of 39.2 percent of its population engaging in this activity.*

Objectives: *This study was aimed to identify the predictors of married women's contraceptive practice using Bayesian and classical approach. In addition, this study has identified the within and between Woredas variation using the hierarchical nature of the data obtained in different woredas. For identifying the better model, researcher has compared the Bayesian and classical multilevel logistic regression models.*

Methods: *This research was conducted in seven Woredas of Assosa zone and was based on a cross-sectional study that primarily focused on married women between the ages of 15 and 49 and the factors that influenced their contraceptive use. Two stage model comparisons were used to approximate the parameters, with the first stage having a null, random intercept, and random slope with a Bayesian approach.*

Result and Conclusion: *The overall contraceptive prevalence rate among 6866 married women 3121(45.46%). According to the intra Woreda correlation of the appropriate model, the between Woreda variance in married women's contraceptive practice was 15.71%, with the remaining 84.29 percent variation attributed to differences in contraceptive practice between women. Finally, predictors for married women contraceptive practice such as women's age, place of residence, women's educational level, husband's educational level, women's job, husband's occupation, wealth index, religion, and knowledge of family planning. The Bayesian multilevel model was found to be the most suitable model for fitting the data after a comparison of classical and Bayesian multilevel models.*

Keywords: Bayesian, EDHS, Contraceptive, Multilevel Model

Background of the Study

Contraception can be defined as the deliberate use of a technique or device to prevent pregnancy. Women who intend to prevent pregnancy and want no more children or wish to postpone a birth are subject to the decision to practice contraception.

The population in the world is substantially increased through time with unprecedented speed. With this regard, it is becoming a global concern for many countries in different parts of the world with which several problems are faced in sustaining the wellbeing of their population [1].

Ethiopia is one of the developing countries which have a high level of fertility together with declining mortality that have given rise rapid population growth. The population size has approximately increased from 83 million in 2007 to 105,350,020 in 2018 (CIA, world fact book 2018). The country's total fertility rate substantially increased over three decades, from about six-lifetime births per woman to 7.7 in the 1990s, after which it gradually declined to 4.99 (CIA, world factbook 2018).

The urban - rural distribution of the population of Benishangul Gumuz region indicate that the overwhelming majority of the population is living in rural areas. About 85 per cent of the population

reside in the rural area of the region, which is very far from the provision of basic services like education, health and other social services including services of reproductive health and family planning and thereby contraceptives. Therefore, the vast majority of the population were living ill rural areas, engaged in traditional way of life and agricultural practices especially using hand digging tools like spade, stick, pick axe for the production of different agricultural food crops. Apart from traditional way of agriculture crop production, they were also involved in domestic animal husbandry specially keeping small animals like sheep and goats and collecting different forest fruits and roots from their surrounding forest resources, one of the potential forest areas of the country.

Three hundred eleven (78.9%) of rural women in Assosa town had ever used family planning services. The majority of women (288 (92.6%) have ever used injectables, accompanied by pills (146). (46.9 percent). However, 111 (or 84.7 percent) of urban women had used at least one form of contraception. The majority of urban women (93.8%) have ever used injectables, accompanied by pills (22.8%) [2].

The aim of this study is to identify socioeconomic and demographic determinant associated with married women's contraceptive practice in the seven woredas. And also, this research article is aiming to determine the within and between woredas variations of married women's modern contraceptive practice in Assosa zone. Finally, this research compared the Bayesian and classical multilevel logistic regression model so as to extract best estimation technique for the data.

Motivation for Bayesian Approach and Multilevel Model

In statistical modeling and data analysis, Bayesian estimation and inference have a range of advantages. It improves estimation in sparse or small datasets by combining the power of the prior distribution of the parameters with the probability (for example, in stratified sampling) [3]. Also, unlike maximum likelihood and other classical approaches, finite sample inferences are allowed without recourse to large sample arguments. It can also measure probabilities on both nested and non-nested models (unlike traditional approaches) and, thanks to modern sampling techniques; it can easily fit complex random effects models that are more difficult to fit using traditional methods [4]. In terms of estimate precision, Bayesian methods can outperform classical estimators. This occurs as a result of specifying the prior, which adds additional information or data based on accumulated knowledge, and the posterior estimation, which is based on the combined sources of information (prior and likelihood), is more precise [3].

Methods

Study Area and Period

Assosa zone is one of the three zones found in Benishangul Gumuz Regional State, located 667 km west of Addis Ababa. Administratively, the zone is structured into seven districts that are (Bambasi, Shirkole, Homosha, Kurumuk, Oda bildigilu, Menge and Assosa). According to the Ethiopian Central Statistical Agency's 2007 Census, this Zone has a total population of 310,822, with 158,932 men and 151,890 women. Urban residents account for 39,957 people, or 12.86 percent of the population. The Berta (59.95%), Amhara (23.86%), Oromo (10.31%), and Tigrayans (1.5%) were the four largest ethnic groups identified in the Assosa zone; accounting for 1.48 percent of the population was from Sudan.

Study Design

Here the researchers have been employed cross-sectional study design.

Source Population

It included all women between the ages of 15 and 49.

Sampling Methods

In this study, the researchers have used probability sampling technique for which systematic random sampling was important to take lists of households in their respective Districts and Kebele.

Instrument

The data were collected using structured questionnaires, interview and focus group discussion. The questionnaires contain socio-demographic characteristics of married women aged from 15 to 49 and factors associated with utilization of modern contraceptive. In this study, the primary outcome is utilization of modern contraceptive which could be binary variable code as 0 for non-user and 1 for users of modern contraceptive. The factors that are included in the study were socio-demographic characteristics (women age, residence, religion) and other factors such as occupation of husband, occupation women, number of living children, knowledge of family planning, women's Educational status, husband's education level, wealth index, mass media exposure, desire for more children.

Data Quality Control

Measures were taken to ensure that the data obtained are of high quality. Before the actual analysis, the checklist was pretested, and any required adjustments were made to increase the data's reliability. Similarly, the study's confidentiality and anonymity were preserved. Finally, the principal investigator double-checked the data for accuracy.

Data Analysis

The researchers used statistical package for social science version 26 for data entry and imported to R software version 3.5.4 for deep analysis of the Bayesian and the classical multilevel logistic regression. The MCMCglmm package was used for Bayesian inference in this case. This is the most important package for Bayesian multilevel models built in the R programming language, which allows for fast Bayesian inference. Similarly, the classical multilevel model was computed using the R package glmmPQL, which is capable of computing using the penalized quasi likelihood estimation process. The selection of a prior is one of the pre-conditions in every Bayesian analysis. Non-informative priors, which

express complete ignorance of the parameter values, were used in this analysis. For fixed parameters, the researchers used a normal distribution with a mean of 0 and a variance of 10000 (large variance). In addition, for single variance (random intercept), a gamma distribution with parameter α=0.001 and β=0.001 has been used. Finally, the prior for random effects in the random coefficient model was the inverse-wishart distribution. However, the scalar values for variance and covariance were taken from a similar example in the MCMCglmm package [5]. Considering various methods for detecting poorly sampled Markov Chains would be useful for examining the convergence of MCMC. Among several ways of test of convergence, the most popular and straight forward convergence assessment methods such as trace plot and density plot were used.

Result and Discussion

This research used cross-sectional data from the seven districts of the Assosa zone to classify determinants of married women's modern contraceptive to examining demographic and economic variables that had previously been considered in similar studies. The aim of this study was to examine both descriptive and inferential analysis in order to identify the determinants of married women's contraceptive practice status. As a result, 6866 married women were used in the report, and the findings are divided into two parts. The bivariate analysis (cross tabulation) is the first part of the result, which looked into the relationship between each explanatory variable and married woman's contraceptive practices. As a result, most explanatory variables such as District, place of residence, women's age, husband education level, desire for child, husband occupation, women occupation, wealth index, women education level, religion, and knowledge of family planning, mass media exposure, number of living have a significant association with married women contraceptive practice at 5% level of significant (see table 1). Similarly, the result in the table below also indicated that out of 6866 married women considered in the analysis 3121(45.46%) were practicing some form of contraceptive at the time of data collection. Utilization of modern contraceptive of married women has also varied significantly across Assosa zone districts.

Table 1: Cross Tabulation of Utilization of Modern Contraceptive and Its Determinants

Variables name	category	Utilization of contraceptive		Total	Pearson chi-square (p-value)
		use	Not use		
		Count (%)	Count (%)		
District	Bambasi	687(61.83)	424(38.16)	1111	831.718(0.000)
	Homosha	389(36.1)	689(63.91)	1078	
	Menge	529(48.31)	566(51.69)	1095	
	Kurmuk	275(29.52)	795(70.47)	1070	
	Assosa	903(79)	240(20.99)	1143	
	Shilkole	232(29.63)	551(70.37)	783	
	Oda bildigilu	106(18.08)	480(81.9)	586	
	Total	3121(45.46)	3745(54.54)	6866	
Place of resident	Urban	1844(83.36)	368(16.63)	2212	378.478(0.000)
	Rural	678(14.57)	3976(85.43)	4654	
Age of women	15-19	148(24.1)	467(75.93)	615	128.012(0.000)
	20-24	476(34.34)	910(65.66)	1386	
	25-29	451(32.85)	922(67.15)	1373	
	30-34	292(29.79)	688(70.20)	980	
	35-39	268(26.38)	748(73.62)	1016	
	40-44	270(32.81)	553(67.19)	823	
	45-49	108(16.05)	565(83.95)	673	
Education level of husband	No education	712(33.82)	1393(66.18)	2105	478.430(0.000)
	primary	1833(66.92)	906(33.07)	2739	
	secondary	682(64.46)	376(35.54)	1058	
	higher	647(67.12)	317(32.88)	964	
Desire for child	Not want	2138(73.93)	754(26.07)	2892	7.171(0.013)
	Want	637(16.03)	3337(83.97)	3974	

Number of living children	No child	301(31.72)	648(68.28)	949	346.308(0.00)
	1_2 child	1075(51.98)	993(48.02)	2068	
	3_4 child	1551(73.51)	559(26.49)	2110	
	+5 child	1217(69.98)	522(30.02)	1739	
Mass media exposure	No	1472(29.94)	3445(70.06)	4917	682.651(0.000)
	Yes	1209(62.03)	740(37.97)	1949	
Husband occupation	Has work	4012(67.36)	1944(32.64)	5956	123.018(0.000)
	Has no work	268(29.45)	642(70.55)	910	
Women occupation	Has work	1548(69.10)	693(30.92)	2241	154.493(0.000)
	Has no work	1382(29.88)	3243(70.12)	4625	
Wealth index	Poor	723(24.52)	2225(75.47)	2948	762.237(0.000)
	Middle	723(66.63)	362(33.37)	1085	
	Rich	2106(74.34)	727(25.66)	2833	
Women Education status	No education	1283(32.24)	2697(67.76)	3980	469.309(0.000)
	primary	1065(68.36)	493(31.64)	1558	
	secondary	642(78.10)	180(21.90)	822	
	higher	434(85.77)	72(14.23)	506	
Knowledge family planning	No	9(4.26)	202(95.73)	211	176.508(0.000)
	Yes	5452(81.92)	1403(21.08)	6655	
Religion	Orthodox	1017(45.90)	1204(54.21)	2221	741.562(0.000)
	Catholic	35(60.34)	23(39.65)	58	
	protestant	1089(63.46)	627(36.53)	1716	
	Muslim	731(17.62)	2018(82.38)	2749	
	Other	14(11.48)	108(88.52)	122	

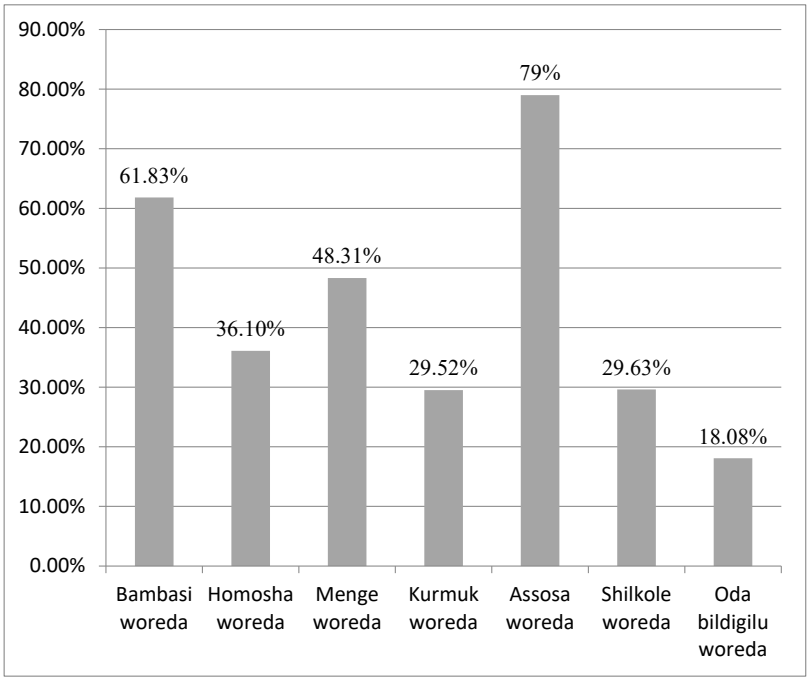

Figure 1: Utilization of Contraceptive Among the Seven Districts of Assosa Zone

As observed in the figure above, the highest percentage of contraceptive use was observed in Assosa district (79%), Bambasi (61.83%), Menge (48.31%). In contrast the least percentage of contraceptive practice was observed in Oda bildigilu (18.08%). The percentage of the rest variables can be observed in the table below (see figure 1).

Test of Heterogeneity Proportions of Modern Contraceptive Use

The two-level structure is used with the district (Woreda) as the second-level unit and the married women as level one unit. This is based on the idea that there may be differences in married women's contraceptive use between district that are not captured by the explanatory variables and hence may be regarded as unexplained variability within the set of all district. Therefore, the Pearson chi-square for the proportion of utilization of modern contraceptive across the seven districts has been investigated in the table below Therefore; the Pearson chi-square for the proportion of utilization of modern contraceptive across the seven districts has been investigated in the table below. Consequently, the Pearson Chi-square, P-value =0.000 which is less than 0.05 level of significance, implying strong evidence of heterogeneity for married women contraceptive practice across districts (see Table 2).

Table 2: Chi-Square Tests of Heterogeneity

Chi-square test			
Statistics	Value	Degree of freedom	P-value
Pearson Chi-square	836.06	6	0.000
N of Valid Cases	6866		

Model Comparison of Bayesian and Classical Approach

Considering the standard errors of the calculated coefficients for comparison of both approaches (Bayesian and classical) is an effective process, and the model with the smaller standard error is the model that fits the data best. The result in the table below displays the approximate coefficients and standard errors for both approaches. Hence, the result indicated that all estimated coefficients' standard errors in Bayesian random intercept model are smaller than the classical random intercept model (see table 3). Therefore, the Bayesian approach is better in fitting for this data than the classical approach.

Table 3: Model Comparison of Bayesian and Classical Models

Covariates	Category estimated	BRIM		CRIM		SE Comparison
		Post.mean	S.EB	β	S.EC	
Intercept	β_0	-3.643	0.0164	-3.2127	0.4408	$S.E_B < S.E_C$
Place of residence	Rural	-0.586	0.0032	-0.4720	0.0863	$S.E_B < S.E_C$
Women's age	20-24	0.3777	0.0044	0.3068	0.1207	$S.E_B < S.E_C$
	25-29	0.464	0.0043	0.3690	0.1221	$S.E_B < S.E_C$
	30-34	0.37	0.036	0.2272	0.1250	$S.E_B < S.E_C$
	35-39	0.1561	0.026	0.1305	0.1277	$S.E_B < S.E_C$
	40-44	-0.1005	0.0014	-0.0787	0.1375	$S.E_B < S.E_C$
	45-49	-0.9974	0.012	-0.8604	0.1609	$S.E_B < S.E_C$
Religion	Catholic	-0.0355	0.0120	-0.0100	0.3037	$S.E_B < S.E_C$
	Protestant	-0.191	0.0042	-0.1515	0.0857	$S.E_B < S.E_C$
	Muslim	-0.645	0.0013	-0.5243	0.129	$S.E_B < S.E_C$
	Others	-1.43	0.034	-1.1850	0.3089	$S.E_B < S.E_C$
Husband education level	Primary	0.345	0.003	0.2831	0.154	$S.E_B < S.E_C$
	secondary	0.087	0.006	0.0841	0.269	$S.E_B < S.E_C$
	Higher	-0.0430	0.0041	-0.0338	0.1150	$S.E_B < S.E_C$
Desire for child	Want	0.0778	0.0021	0.0627	0.0590	$S.E_B < S.E_C$
Women education level	Primary	0.2238	0.0024	0.0091	0.0910	$S.E_B < S.E_C$
	secondary	0.2861	0.0039	-0.0198	0.0959	$S.E_B < S.E_C$
	Higher	0.4129	0.0051	-0.0494	0.0980	$S.E_B < S.E_C$

Number of living children	1_2	0.0118	0.0033	0.1854	0.0670	$S.E_B < S.E_C$
	3_4	-0.0240	0.0034	0.2333	0.1071	$S.E_B < S.E_C$
	>=5	-0.0537	0.0036	0.3401	0.1360	$S.E_B < S.E_C$
Women occupation	Has work	0.4291	0.0029	0.3649	0.0834	$S.E_B < S.E_C$
Husband's work	Has work	0.1231	0.0019	0.1055	0.0533	$S.E_B < S.E_C$
Wealth index	Middle	0.6164	0.0028	0.5271	0.0780	$S.E_B < S.E_C$
	Rich	0.9119	0.0026	0.7722	0.0714	$S.E_B < S.E_C$
Mass media exposure	YES	0.0152	0.0021	1.4716	0.3565	$S.E_B < S.E_C$
Knowledge of family planning	YES	1.6120	0.0128	0.0118	0.0559	$S.E_B < S.E_C$
Note: BRIM stands for Bayesian random intercept model, while CRIM stands for classical random intercept model.						

As compared to women in urban areas, women in rural areas have a 42.9 percent lower probability of using contraception (odd ratio: 0.571, 95 percent credible interval (-0.763361 -0.367230). This may be due to the fact that family planning services are not distributed or accessible in rural areas as much as they are in urban areas. For women aged 20-24, the likelihood of using contraception is 43.5 percent (odd ratio: 1.435:95 percent) credible interval (0.0733, 0.6307) times higher than the reference age group of 15-49 years. It's also been discovered that women in the 25-29 age group are 55 percent more likely than women in the 15-19 age group to use contraception. When compared to orthodox women, married Muslim women had a 46.5 percent lower chance of using contraception. Married women with husbands with a primary education level are 0.386 (odd ratio: 1.38597 credible interval (0.176190, 0.479801) times more likely to use contraception than women with husbands with no education level (see Table 4).

Table 4: Posterior Summaries for Parameters of Intercept Model

Fixed Effects							
Covariates	**Categories**	**post.mean**	**S.d**	**Sd.error**	**2.5%**	**50%**	**97.5%**
	Intercept	-3.4330	0.5194	0.0164	-4.4915	-3.4175	-2.4220
Place of residence	Ref (urban)	---	---	---	---	---	---
	Rural	-0.5611	0.1007	0.0032	-0.7634	-0.5605	-0.3672
Women's Age	Ref (15-19)	---	---	--	---	--	---
	20-24	0.3768	0.1386	0.0044	0.0733	0.3659	0.6307
	25-29	0.4423	0.1363	0.0043	0.1694	0.4444	0.7047
	30-34	0.2755	0.1454	0.0046	-0.0135	0.2776	0.5705
	35-39	0.1561	0.1451	0.0046	-0.1237	0.1593	0.4359
	40-44	-0.1005	0.1629	0.0052	-0.4212	-0.0942	0.2066
	45-49	-0.9974	0.1856	0.0059	-1.3472	-0.9914	-0.6461
Religion	Ref (Ortho)	---	---	---	---	---	---
	Catholic	-0.0355	0.3470	0.0110	-0.7105	-0.0305	0.6418
	Protestant	-0.1852	0.1012	0.0032	-0.3834	-0.1886	0.0095
		-0.6247	0.0845	0.0027	-0.7938	-0.6223	-0.4552
		-1.4105	0.3497	0.0111	-2.0858	-1.4128	-0.7361
Husband's education	Ref (No)	---	---	---	---	---	---
	Primary	0.3264	0.0753	0.0024	0.1762	0.3294	0.4798
	Secondary	0.0891	0.1109	0.0035	-0.1328	0.088	0.3092
	Higher	-0.0430	0.1282	0.0041	-0.3089	-0.0467	0.2142
Desire for children	Ref (not want)	---	---	---	---	---	---
	Want	0.0778	0.067	0.0021	-0.0595	0.0798	0.2072

Women's education	Ref (No)	---	---	---	---	---	---
	Primary	0.2238	0.0771	0.0024	0.0738	0.2230	0.3763
	Secondary	0.2861	0.1232	0.0039	0.0458	0.2897	0.5261
	Higher	0.4129	0.1604	0.0051	0.1209	0.4139	0.7192
Number living children	Ref (No)	---	---	---	---	---	---
	1_2	0.0118	0.1037	0.0033	-0.1829	0.0108	0.2239
	3_4	-0.0240	0.1083	0.0034	-0.2293	-0.0232	0.1860
	>=5	-0.0537	0.1122	0.0036	-0.2691	-0.0565	0.1838
Women occupation	Ref (no work)	---	---	---	---	---	---
	Has work	0.4291	0.0924	0.0029	0.2442	0.4322	0.6135
Husband's work status	Ref (no work)	---	---	---	---	---	---
	Has work	0.1231	0.0606	0.0019	0.0017	0.1231	0.2388
Wealth index	Ref (poor)	---	---	---	---	---	---
	Middle	0.6164	0.0897	0.0028	0.4342	0.6180	0.7823
	Rich	0.9119	0.0825	0.0026	0.7463	0.9115	1.0746
Mass media	Ref (No)	---	---	---	---	---	---
	Yes	0.0152	0.0652	0.0021	-0.1127	0.0146	0.1410
Knowledge of Family planning	Ref (No)	---	---	---	---	---	---
	Yes	1.6120	0.4052	0.0128	0.8545	1.5971	2.4533
Random effect							
var (δ_u^2)		0.613	0.3926	0.0124	0.2856	0.6433	1.7660

Intra class correlation

The intra woreda correlation coefficient for this study was estimated $\rho\hat{}$=0.613/(0.613+3.29)=0.1571. Where 3.29 is the logistic distribution variance. This indicated that about 15.71% of the total variability in married women contraceptive practice is due to the fact that differences across regions and the remaining unexplained 84.29% accounts the between married women differences.

Checking Convergence

This is the graph that shows the number of iterations versus the generated values. If all of the values in this graph are found within an area with no strong periodicities, convergence can be achieved (up and down periods). As a consequence, none of the trace plots below have any up and down times. Furthermore, density plots are almost identical to normal plots. This means that all posterior figures have been converged (see figure 2).

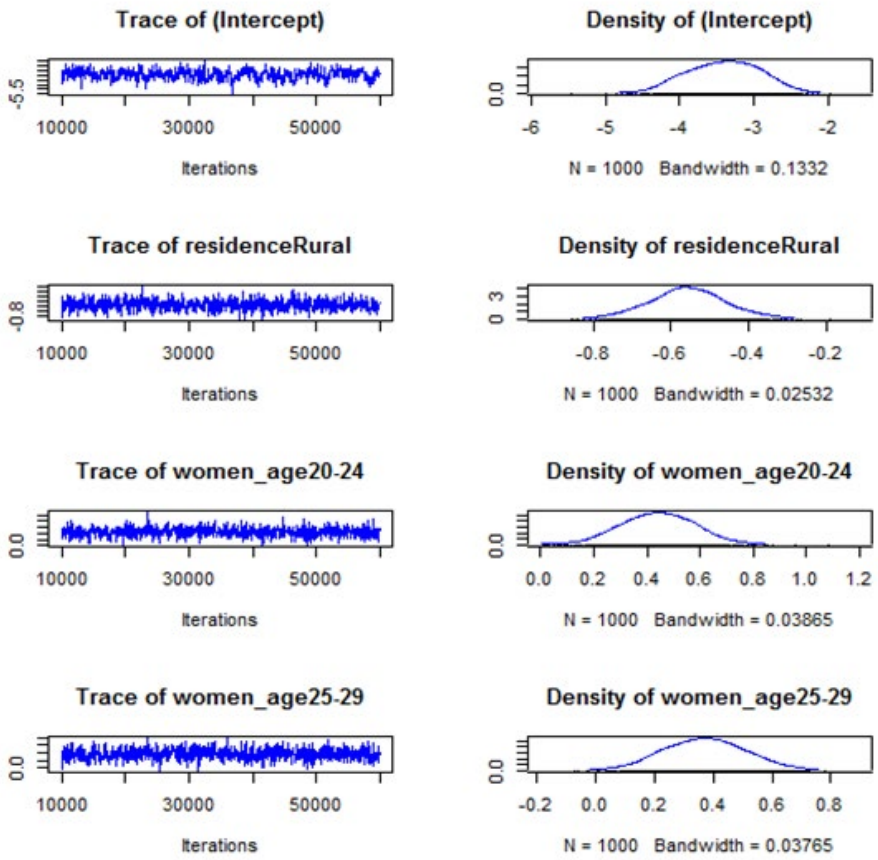

Figure 2: Trace and Density Plot for Convergence Check

Discussions of the Results

On the basis of their respective standard errors, the models chosen in the Bayesian framework were compared to the classical model. As a result, the Bayesian model was found to be superior to the classical model since the standard errors of predictors in this model were lower. The Bayesian random intercept model has shown that the random intercept is significantly different from zero in this model, suggesting that contraceptive practice among married women differs by woreda. This analysis appears to be in agreement with previous research [6].

The location of a woman's residence has a direct impact on her contraceptive use. As a result, women who live in rural areas are less likely to use contraception than women who live in urban areas. This finding is consistent with previous studies. Similarly, the study found that women of Muslim and other religions have a detrimental effect on contraceptive use, which seems to agree with the findings of a study conducted in Ethiopia [6, 7].

According to the findings, a woman's occupation is a major determinant of her contraceptive use status. As a result, working women were more likely than non-employed women to use contraception. This logic may have arisen as a result of the fact that working women are more likely to have access to contraception than their counterparts due to improved economic conditions. This finding appears to be consistent with a previous analysis of a similar scenario [8].

With the MCMCglmm packages in R program, the posterior inference was implemented with the Metropolis-Hasting algorithm with 60000 iterations, 10,000 samples as burn in, and 50 thinning intervals to render the sequence sampling independent or low autocorrelation.

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