DETERMINANTS OF MARRIED WOMEN'S CONTRACEPTIVE PRACTICE IN ETHIOPIA – ETHIOPIAN DEMOGRAPHIC HEALTH SURVEY 2016: BAYESIAN AND CLASSICAL APPROACH

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Abstract

Contraception is a method which can be undertaken to prevent conception or pregnancy. Contraception is highly practiced when the women have intended to avoid pregnancy or elongate their birth. The world prevalence rate of contraceptive practice was 64%; whereas Africa has shared 33%. Specifically, the current status of Ethiopia with this practice is 39.2%. 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 region variation using the hierarchical nature of the EDHS 2016 data. For identifying the better model, the researcher has compared the Bayesian and classical multilevel logistic regression models. This study was conducted in Ethiopia based on the data obtained from EDHS 2016 which mainly focused on married women of reproductive age from 15-49 and corresponding factors of their contraception exercise. To estimate the parameters, two stage model comparisons have been fitted that the first stage included empty, random intercept and random slope model with the Bayesian approach. Then, based on Bayesian model selection method, the appropriate model was compared with its corresponding classical model.

The overall contraceptive prevalence rate among 9403 married women was 2912(30.97%). Based on intra region correlation of the appropriate model, the between region variation of married women's contraceptive practice was 18.2% and the remaining 81.8% variation is due to between women difference in practicing contraceptive. Finally, comparison of the two consecutive surveys clearly shows that the prevalence rate of contraceptive among married women has increased from 24.88% in 2011 to 30.97% in 2016. In this study, predictors such as women's age, place of residence, women educational level, husband education level, women occupation, husband occupation, wealth index, religion and knowledge of family planning were found to be significant factors for married women contraceptive practice. After a comparison of classical and Bayesian multilevel model, the Bayesian multilevel model was found to be an appropriate model in fitting the data appropriately.

Key words: *Bayesian, EDHS, Contraceptive, Multilevel model.*

Introduction

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 (Nations u. , 2016).

Some study realized that if couples could space their pregnancies by at least two years, up to 35% of maternal deaths and up to13% of child mortalities could be averted, whilst25% of under-five mortalities could be averted if birth intervals were at least three years(sebastian Kofi Eliason, 2018). Also, other findings showed that the estimated percentage of maternal death averted using contraception in the Democratic Republic of Congo is 15.2% and similarly 18.2% in Malawi (Decker, 2015). In developing countries, an estimated35%ofbirthsareunintendedandso me200 million couples reportedly express a desire to delay pregnancy or cease fertility. However, they often do not use contraception (Nations U. , 2011).

Because of illness and disability from complicated pregnancy and childbirth, it has been reported that Ethiopia's maternal mortality is 353 per 1000 live birth in 2015. Consequently, Ethiopia has taken the thirty-fourth rank in the world by maternal mortality (CIA, world factbook 2018).

Ethiopia's FP2020 commitments, the Ministry of Health (MoH) developed the health sector transformation plan of 2015, which aimed to increase the contraceptive prevalence rate (CPR) to 55%. This would mean reaching an additional 6.2 million women and adolescent girls with family planning services by 2020(FMOH, 2015).

The 2016 Ethiopian Demographic and Health Survey (EDHS) data used for this study are based on two stage stratified cluster sampling. The appropriate approach to analyzing contraceptive practice from this survey is therefore based on nested sources of variability. Here the units at a lower level (level-1) are individuals (married women) who are nested within units at a higher level (region). Beside the nested source of variability; the response variable in this study is a contraceptive practice which is a binary response. Because of this, the multilevel logistic regression analysis considers the variations due to the hierarchy structure for a binary response. Therefore, finalizing the data, a multilevel logistic regression model with a Bayesian approach was used.

Statement of the Problem

Even though there is widespread adoption of family planning in the developing world, contraceptive practice is still low in sub-Saharan Africa including Ethiopia and in other regions. The report in 2015 showed that 64% of married or in-union women of reproductive age worldwide were using some form of contraception. However, the contraceptive practice was still much lower in the least developed countries (40%) and was particularly low in Africa (33%)(Nations U. , 2015).

Currently, the prevalence rate of contraceptive in Ethiopia is 39.2 % (CIA, world factbook, 2018). But it needs much more investigation on behave of contraceptive practice to achieve the targeted goal of Ethiopia's FP2020 which aimed to reach CPR 55% (FMOH, 2015). Identifying the risk factors related to women's contraceptive practice can eventual slows population growth, improves birth spacing, maternal health, and reduces the risk of infant and maternal mortality. In addition, it prevents unintended pregnancies, reduces the number of abortions, and lower the incidence of death and disability related to complications of pregnancy and childbirth(Khan, 2013).Despite these benefits, not all women who want to avoid

getting pregnant use contraceptive methods..

Most studies on women's contraceptive practice in the country level have been done routinely based on the frequentist approach only and very limited study was conducted with Bayesian perspective. However, the comparisons of those approaches for women's contraceptive practice have not well done previously. Although the size of the sample for this study seems large enough to estimate the parameters with information from likelihood, due to only 95% of the EDHS, 2016 sample has been covered; the research intended to consider this dataset as non-representative of the target population. Literature confirmed that for the study with a non-representative sample, considering the prior has empowered the estimation of the parameters (Alkema, 2015).

The Objectives of the Study

General Objective

The main purpose of this study is to identify the determinants of married women's contraceptive practice in Ethiopia─ EDHS 2016: using Bayesian and Classical approach.

Specific Objectives

i. To identify socioeconomic and demographic determinant associated with married women's contraceptive practice in Ethiopia.

ii. To determine the within and between regional variations of married women's contraceptive practice in the country.
iii. To compare the Bayesian and classical multilevel logistic regression model.

Significance of the Study

The findings of this study will help planners in the planning, formulation, and implementation of policy concerning awareness creation and distribution of contraceptives over the country. Also, the findings of this study will provide information to the department of family planning workers about the age group of women that are engaged in contraceptive practice more relatively.

Since the study attempts to reveal significant factors and their impact on the use of contraceptive methods, governmental and non-governmental organizations will take intervention measures and set appropriate plans to tackle the existing contraception problems. In addition to reducing fertility, the contraceptive practice has also a vital role in keeping the health of mothers and infants. It is also being expected in reducing the number of abortion and unwanted pregnancy. Particularly the results of the study will benefit family planning program administrators to reduce population growth by increasing contraceptive prevalence rate. It is expected that this study will provide relevant recommendations for policymakers and suggest directions for future studies. This study will, therefore, be important to change the backwardness attitude towards contraceptive practice by making visible the advantage of practicing contraceptive.

The hierarchical level models are very flexible and can handle the variability in the clustered data. Thus, researchers will benefit from this study not to use the traditional models that account the correlated data treated as an independent observation which leads to the standard errors of regression coefficients to be underestimated.

Data and Methodology

Description of the Study Area

Ethiopia is officially known as the Federal Democratic Republic of Ethiopia, is a landlocked country located in the Horn of Africa. It is the second-most populous nation in Africa, with over 105,350,020populations (CIA, world fact book, 2018) and the tenth largest by area, occupying 1,100,000 km2. Ethiopia is bordered by Eritrea to the North, Djibouti, and Somalia to the East Sudan and South Sudan to the West, and Kenya to the South. Ethiopia has eleven geographic or administrative regions: nine regional states (Tigray, Afar, Amhara, Oromia, Somali, Benishangul-Gumuz, SNNPR, Gambella and Harari) and two city administrations (Addis Ababa and Dire Dawa that are considered as a region) with a capital city of Addis Ababa.

Source of Data

The dataset in this study was obtained from the Demographic and Health Survey conducted in Ethiopia in 2016. The 2016 Ethiopia Demographic and Health Survey (EDHS) is the fourth Demographic and Health Survey conducted in Ethiopia. It was implemented by the Central Statistical Agency (CSA) at the request of the Federal Ministry of Health (FMoH). Data collection took place from January 18, 2016, to June 27, 2016. The data provide in-depth information on family planning, fertility, marriage, infant, child, adult and maternal mortality, maternal and child health, gender, nutrition, malaria, knowledge of HIV/AIDS and other sexually transmitted diseases.

Sample Design

The 2016 EDHS sample was selected by considering two-stage cluster design and census enumeration areas (EAs) were the sampling units for the first stage. A typical two-level stratification involves first stratifying the population by region at the first level and then by urban-rural within each region. The sample included 645EAs (202 in urban areas and 443 in rural areas). In the sampling procedure, households comprised the second stage of sampling. A complete listing of households was carried out in each of the 645 selected enumeration areas by equal probability systematic sampling according to proportional to EA's measure of size from January 18, 2016, to June 27, 2016. The total number of 18,008 households by incorporating all women age 15-49 and all men age 15-59 in these households were selected for the sample, of which 16,650 households were successfully interviewed. In the interviewed households, 16,583 eligible women were identified for individual interviews, of which 15,683 women were successfully completed. For this study, married women in the last five years preceding the survey were considered in the analysis. Therefore, the number of eligible married women data collected by the EDHS 2016 is 9403; and this data has completely taken for analysis.

Variables in the Study

The response variable

The response variable considered in this study married women's contraceptive practice which is a dichotomous random variable. Therefore, for this study, married women who were practicing any type of contraceptive methods were coded as 1 whereas married women who were not practicing any type of contraceptive methods were coded as 0.

Explanatory variables

Explanatory variables considered in the study were selected based on some previous studies and those that are expected to be factors/determinants of women's contraceptive practice. As suggested in the

literature review, several variables that are associated with contraceptive practice were considered as predictor variables. Therefore, those variables that are reviewed in the literature are listed below:

- Women's Educational status
- Place of residence
- Husband's education level
- Wealth Index
- Mass media exposure
- Religion
- The desire for more children
- Number of living children
- Knowledge of family planning
- Husband's occupational status
- Region
- Women's Occupation
- Women's Age

Methods of Data Analysis

At present time there exist two very different approaches to statistics. These are the traditional (classical or frequentist) and the Bayesian approaches. In this regard, for the purpose of analysis, both Bayesian and classical multilevel logistic regression models were employed by taking the advantage of geo-referenced data of EDHS 2016.

Result and Discussion

This study was carried out to identify determinants of married women contraceptive practice of any methods available (that is natural and modern contraceptive methods) through analyzing the demographic and economic factors which were considered in similar studies conducted previously and using the geo-referenced data obtained from Ethiopian Demographic Health Survey of 2016.In this study both descriptive and inferential analysis have been investigated for the purpose of identifying the determinants of the status of married women contraceptive practice. Accordingly, the study used 9403 married women from EDHS 2016 and the results are presented in two main parts. The first part of the result is the bivariate analysis (cross tabulation), with which the association between each explanatory variables and married women contraceptive practice was investigated.

As mentioned earlier in order to determine the association between married women contraceptive practice and individual explanatory variables, the Pearson chi-square test was carried out. Simultaneously, the frequency distributions of all independent variables with their respective categories are given in Table 1 below.

Consequently, the result obtained in the Table 1 below clearly indicated that most of explanatory variables such as region, Place of resident, Women's age, Husband education level, Desire for child, Husband occupation, Women occupation, Wealth index, Women Education level, Religion and Knowledge of family planning have significant association with married women contraceptive practice at 5% level of significant. However, mass media exposure of women and number of living children a woman has were statistically found to be non-significant at 5% level of significant. Similarly, the result in the table 4.1 below also indicated that out of 9403 married women considered in the analysis 2912(30.97%) were practicing some form of contraceptive at the time of data collection. Married women's contraceptive practice has also been varied numerically across region. Consequently, the highest percentages of contraceptive practice are observed in Addis Ababa (56.68%), Amhara (48.31%), SNNPR (40.72%), and Tigray (35.56%). In contrast the least percentages of contraceptive practice are observed in Somali (4.24%) and Afar (7.75%). The left five regions have shown almost similar percentage in using contraceptive. Contraceptive practice among married women according to

women's age categories 15-19, 20-24, 25-29, 30-34, 35-39, 40-44, 45-49 were23.94%, 34.35%,34.93% ,33.26%,30.87%,27.19% and 16.05% respectively. An increasing pattern has been observed in using contraceptive between age group of 20-24 and 25-29. But minimum numbers of contraceptive practice is observed in the age group of 45-49. This is may be since the women fertility period is stopped at this age. Percentage of contraceptive practice in terms of place of residence categories: rural and urban were 25.95% and 46.31% respectively.

Contraceptive practice among married women according to their husband educational level reveals that 21.18% of Illiterates, 37.74% of Primary level, 41.11% of Secondary level, and 43.26 % of higher-level women were practicing some form of contraceptive. The proportion of contractive practice for women who did not desire to bear child and women desire to bear child were almost identical. Similarly, women whose husband has work were more likely to use contraceptive (33.08%) than women whose husband has no work (19.01%). Regarding women's occupation it has been seen that women who have work were more likely to use contraceptive (37.52%) than those who have not work (25.95%).

Percentages of contraceptive practice in terms of family wealth index categories: Poor, middle and higher were 17.02%, 34.95%, and 45.06% respectively. Among the women who were included in the study regarding their educational level which is categorized as no education, primary, secondary and higher in using contraceptive were 23.25%, 38.82%, 46.22% and 53.75%respectively. On the other hand, percentage of married women contraceptive practice was highly observed (32.28%) with women who have knowledge about contraceptive than those who do not have knowledge about contraceptive (2.19%).Furthermore, the proportion of contraceptive practice among women in terms of religion categories: Orthodox, Muslim, catholic, protestant and other were 45.18%,17.62%,39.65% ,36.53% and 11.48% respectively.

Insert table 1

Test of heterogeneity proportions of married women's contraceptive practice between Regional States of Ethiopia

The two-level structure is used with the region as the second-level unit and the status of married women contraceptive practice as level one unit. This is based on the idea that there may be differences in married women contraceptive practice between regions that are not captured by the explanatory variables and hence may be regarded as unexplained variability within the set of all regions (Snijders, 1999).Before attempting to multilevel analysis, one has to test the heterogeneity of married women contraceptive practice among regional states of Ethiopia from which essential clues would be obtained for incorporating the random effects. Therefore, the Pearson chi-square for the proportion of contraceptive practice across the region has been investigated in the table below. Consequently, as it can be observed in the Table 4.2, the Pearson Chi-square $(\chi^2 cal) = 926.06$ which is greater than18.307 at 10 degree of freedom with P-value =2.2e-16which is less than 0.05 level of significance, implying strong evidence of heterogeneity for married women contraceptive practice across regional states of Ethiopia.

Insert table 2

Bayesian multilevel intercept model

In this Bayesian intercept model, the intercept can vary across the region after

incorporating covariates of married women contraceptive practice. This means that, the intercept (β_0) is shared by all regions, while the random effect $u_{0j}$is specific to region j and the random effect is assumed to be normal distribution with varianceδ_u^2. Here, the Bayesian random intercept binary logistic regression analysis for married women's contraceptive practice was compared with empty model based on their respective Deviance information criteria. With this context the deviance information criteria for the intercept model is 9777.474 which is smaller than the empty model (10561.12). This suggests that the model with all predictors including the random intercept model is found to be better than the empty model because the DIC for the intercept model is smaller than the empty model DIC.

The overall posterior mean of married women's contraceptive practice is estimated to be-3.433 which is decreased by 2.21 as compared to empty model (Table: 3). Therefore, indicating many variables that are included in this model have impacts on married women not to practice contraceptive.

The variance component for random intercept is found to be significant because the lower limit of credible interval is greater than zero, indicating strong evidence of the variations across regions for married women's contraceptive practice.

The results revealed that, place of resident, age of women, religion, women education level, husband's education level, knowledge of family planning, wealth index, women work status, husband work status, are found to be significant, indicating strong effects on married women's contraceptive practice and also contributing to married women's contraceptive practice variations among regional state in Ethiopia (Table: 3).However, the impacts of desire for more child, number of living children and mass media exposure of women are found to be insignificant, suggesting no evidence for the effects of those factors on married women's contraceptive practice.

Women living in rural areas have a 42.9 % (OR: 0.571, 95% cred.int (-0.763361 - 0.367230) reduced likelihood of practicing contraceptive as compared with women living in urban areas. This is may be since family planning service distribution and access is not more in rural area than urban area. The odds of practicing contraceptive for the women age group of 20-24 is 43.5% (OR 1.435:95% Credible interval:(0.0733,0.6307)) times more than the reference age group 15-49. It is also observed that the odds of contraceptive practice for the women age group of 25-29 is 55% times more than the women age group of 15-19. Similarly, the odds of contraceptive practice for married women in the age group 30-34 is 57.95% times more than the age group 15-19.Furthermore, the odds of contraceptive practice for married women in the age group 45-49 is 63.12% times reduced than the women age group of 15-19.This may be due to the fact that the age group 45-49 is the period at which fertility would be terminated. However, the odds of practicing contraceptive for married women in the age group of 35-39 and 40-44 are not significantly different from women age group 15-19.

The odds of contraceptive practice for married women in Muslim religion were 46.5% times reduced as compared to those women in orthodox religion. Similarly, the odds of using contraceptive for married women in other religion were24.4% times reduced than women in orthodox religion. However, the odds of contraceptive practice for married women in protestant and catholic religions were statistically found to be insignificant.

The odds of contraceptive practice for married women having husbands with primary education level is0.386 (OR: 1.38597 credible interval (0.176190 0.479801) times more than women having husbands with no education level. However, the odds of contraceptive practice for married women having husbands with secondary and higher education level were not statistically significant. The odds of contraceptive practice of women having primary education level were0.251 (OR: 1.250783 credible interval (0.073829 0.376264)) times more than illiterate women. It is also observed that the odds of contraceptive practice for women having secondary education level were 0.33 (OR: 1.331239 credible interval (0.045796-0.526080) times more than illiterate women. Furthermore, the odds of contraceptive practice for women having higher education level were 0.51 (OR: 1.511224, credible interval (0.120940 0.719250)) times more than illiterate women.

The odds of contraceptive practice for married women whose wealth index status were categorized under middle were 0.852 (OR: 1.852322 credible interval (0.434229 0.782276)) times more than women whose wealth index status were poor. Similar with this the odds of contraceptive practice for married women whose wealth index status were categorized under richwere2.489 (OR: 2.489147 credible interval (0.746276 1.074613)) times more than women whose wealth index status were poor.

The odds of contraceptive practice for married women who have work were 0.42912(OR: 1.535905 credible interval (0.244180 0.613486)) times more than women who haven't work. Likewise, the odds of contraceptive practice for married women whose husbands have work were 0.131 (OR: 1.131009, credible interval (0.001718 0.238799)) times more than women whose husbands have no work. In a similar manner, the odds of contraceptive practice for married women who have knowledge about family planning were 5.012877 (OR: 5.012877, credible interval (0.854463 2.453304)) times more than women who haven't knowledge about family planning.

Insert table 3

Bayesian multilevel logistic regression model comparisons

Here the comparisons of Bayesian multilevel models such as multilevel empty model, random intercept model, and random coefficient model were conducted based on Deviance information criterion which is mostly used as model comparison in Bayesian analysis. Therefore, as it is shown in the Table 4 below the Bayesian random intercept model is appropriately fitting the variations of married women's contraceptive practice among regional states of Ethiopia for 2016 EDHS data sets as compared to empty and random slope model.

Insert table 4

Model comparison of Bayesian and classical multilevel logistic regressions

In this section, researcher has compared the random intercept model which was selected in the Bayesian analysis with the classical random intercept model based on the parameters' numerical value of standard error in both approaches. Considering the standard errors of the estimated coefficients for comparison of both approaches (Bayesian and classical) is very important method and hence the model with the smaller standard error is the appropriately model for fitting the data. Consequently, the estimated coefficients and standard errors of both approaches have been presented in the Table 5 below. But the full classical random intercept model is presented in Appendix A. Hence, the result

in the Table 6 indicated that all estimated coefficients' standard errors in Bayesian random intercept model are smaller than the classical random intercept model.

Insert table 5

Intra class correlation

Here researcher can usually interpret the variation of intercept δ_u^2 between cluster(in this case region) by considering the ICC which goes from 0 indicates perfect independence of residuals or the observations do not depend on cluster membership and 1 indicates perfect interdependence of residuals or the observations only vary between clusters (Sommet, 2017).It is usually expressed as :-

$$ICC = \frac{\delta_u^2}{\delta_u^2 + \delta_e^2}$$

Where δ_u^2 is the varianceof the between cluster and δ_e^2 the variance of the residual. But, in the context of logistic regression, there is no direct estimation or calculation of the residuals on the first level. Therefore, δ_e^2 is the logistic distribution variance which always can be given the value$\frac{\pi^2}{3}$ which is 3.29. The intra region correlation coefficient for this study was estimated $\hat{\rho} = \frac{0.7319}{0.7319+3.29}$=0.182 .This indicated that about 18.2% of the total variability in married women contraceptive practices due to the fact that differences across regions and the remaining unexplained81.8% accounts the between married women differences.

Comparison of married women's contraceptive practice across Survey years

This section presents changes in contraceptive practice during the period of the two EDHS years 2011 and 2016. Looking at the overall change, Ethiopia has shown an increasing in contraceptive practice among married women over the two survey years, from 24.8% in 2011 to 30.97% in 2016. According to the results in table 4.8 below shows an increasing pattern in contraceptive practice in most categories of the predictors have been observed from 2011 to 2016.

In terms of women age, all categories of age groups showed an increasing pattern in contraceptive practice. Regarding place of residence, women living in rural areas have increased in using contraceptive by 7.25% from the 2011 EDHS. In contrast, a little decrease in contraceptive practice has been observed among those women living in urban areas.

An increase in contraceptive practice has also been observed in all categories of women educational levels. Women who were categorized under illiterate and primary education level 6.65 and 5 percentage point change in using contraceptive respectively as compared to similar categories in 2011 EDHS. Regarding living children, an increasing pattern in using contraceptive has been investigated in all categories. That means 17% women who have no child were practicing contraceptive in 2011 but it increases to 31.72% in 2016. Likewise, women who have children more than three have increased contraceptive practice from 21% in 2011 to 30.04% in 2016

Regarding regional state of Ethiopia, all regions of Ethiopia except Addis Ababa city administrative have shown an in increasing pattern in contraceptive practice across the two surveys year. For instance, Tigray region increases from 21.1% in 2011 to 35.56 % in 2016 in contraceptive practice. Similarly, Afar region also increases from 6.4% in 2011 to 7.75% in 2016 in contraceptive practice. Furthermore, married women in Amhara

region have from 31.7 in 2011 to 48.31 in 2016 in contraceptive practice.

Generally, from the result in the table 4.8 below it has been observed that all categories of women's age, rural residence, women education, husband education, number of living children, desire for more children, mass media exposure, and all regions except Addis Ababa have increased contraceptive practice as compared to the 2011 EDHS.

Insert table 6

Checking Convergence

In this section the convergence of an MCMC algorithm would be an important issue for the correct estimation of the posterior distribution of interest. The convergence cannot always be diagnosed as clearly as in optimization methods which are assumed to be the problem of MCMC methods. For this reason, both the length of the burn in period and the size of the MCMC output that was used for the posterior analysis could be specified by the user. The next most important problem is specification of the thinning interval, that is, the numbers of iterations researcher needs to discard until two successive observations become independent. With this regard, Metropolis-Hasting algorithm was implemented with 60000 iterations, 10000 burn-in terms discarded, and 50 thinning intervals to make observations independent or low autocorrelation. Therefore, different methods such as trace plot, autocorrelation, and density plot for monitoring convergence have been presented below.

Trace plots: This is the graph which could be plotted the iterations versus the generated values. In this graph convergence can be attained if all values are within a zone without strong periodicities (up and down periods). Therefore, the trace plots in the **figure1**below are all straight line which did not show up and down periods. Furthermore, the density plots in **figure1**arealmost similar with normal plot. This is an indication that all posterior estimates were converged.

Insert figure 1

Autocorrelation: Here the requirement is that the chain should not display high autocorrelation. It is observed when there are trends in the data. Autocorrelation means that a next value can be potentially influenced by the previous value. In case of strong autocorrelations, the model estimates (posterior means or modes) are assumed to be unreliable or not correct. The acceptance autocorrelation according to the rule of thumb is the value less than 0.1(Natalia Levshina, 2015). Also, convergence of posterior estimate has been checked using effective sample size that is all the effective sample sizes of the estimates are greater than 200. This is an indication of efficient posterior estimate. It has been presented in Table 5 (see appendix C).

Assessing Accuracy of the Bayesian model Estimate

In order to assess the accuracy of Bayesian model estimate, the Monte carlo standard error was compared with the standard deviation. The model is accurate if the Monte carlo standard error is less than 5% times its standard deviation. Thus, with this study, the Monte carlo standard error of all covariates for the Bayesian random intercept model was less than 5% times of its standard deviation. Therefore, since the convergence and accuracy criteria were attained, then it is possible to say that the posterior estimate of the Bayesian random intercept model was accurate.

Discussions of the Results

This study has been conducted to identify predictors that are associated to married women's contraceptive practice and to identify cross regional variation based on the 2016 geo-referenced data of Ethiopian Demographic Health Survey. For the analysis of the data, Bayesian multilevel logistic regression and classical multilevel logistic regression were used. First researcher has fitted the Bayesian multilevel empty, intercept and coefficient models. With this regard, the Bayesian random intercept model was found better in fitting the data appropriately based up on their deviance information criteria compared to the empty and random coefficient model.

The model that are selected in the Bayesian frame work has been compared with the classical model based on their respective standard error. Consequently, the Bayesian model found to be better than the classical model because the standard errors of predictors in this model were smaller than the classical model. The results obtained from Bayesian model have been discussed as follow. According to the results of Bayesian random intercept binary logistic regression model revealed that the overall mean of married women's contraceptive practice varied across the regions. Based on Chi-square test of association, all the predictor variables included in the analysis except number of living children and women's mass media exposure have significant association with married women's contraceptive practice. From the Bayesian intercept model predictors such as place of residence, Age of women, women's education level, husband's education level, work status of women, work status of husband, wealth index, religion and knowledge of family planning were found to be significant variables for women contraceptive practice.

Here in the model the Bayesian random intercept model has shown that the random intercept is significantly different from zero indicating that reproductive age of married women contraceptive practice varies from region to region. This study seems to agree with the studies using classical multilevel model applied to the same case (Hailu, 2015).

Place of residence of women has significant contribution for women's contraceptive practice. Consequently, those women living in rural area are less likely to practice contraceptive compared to women living in urban area. This result is similar with the previous findings (Balew,2015; Worku, 2015).

From the result, women's age has significant impact on their status of contraceptive practice. The highest probability of contraceptive practice has been observed more in the age groups of 20-24 and 25-29. In contrast, the minimum number of contraceptive practices were observed in the age group of 45-49 and this may be due to the fact that women could stop fertility at this age group. This result was supported by similar findings by (Hailu, 2015; Haq, 2017).

Likewise, the study has shown women in Muslim and other religion has negative impact towards the use of contraceptive and this result also seems to agree with finding of study done in Ethiopia as in(Hailu, 2015; Tiruneh,2015).The case might be happened due to some unobserved culture and the belief that children are gifts of God. This assumption has been investigated in Muslim and other religions by using structured questioner in India for the purpose of identifying religious decision towards contraceptive practice (Iyer, 2010).

In addition, the finding of this study has also shown women education level is significant factor that affect the status

women's contraceptive practice. The result indicates that women whose education levels are primary, secondary, and higher tend to have higher probability of contraceptive practice than those who have no education. Moreover, an increasing pattern in contraceptive practice has been observed when their education levels increases. This finding was also supported by similar findings (Medhany2017; N-B Kandala,2015; Eshete, 2015).

Likewise, the result of this study has also shown that husband's education level is another important factor for women's contraceptive practice. In this result women whose husbands are educated are more likely to use contraceptive than whose husbands are not educated. This might be due to supportive idea provided by their husbands on behalf of contraceptive. The result has been confirmed with similar findings investigated previously by (Amu, 2016).

According to the result, occupation of women has also the significant determinant for the status of contraceptive practice. Consequently, employed women were more likely to practice contraceptive than women who were not employed. This logic might be occurred since women who have work able to access contraceptive rather than their counter parts because of improvement in their economy. The result of this finding seems to agree with the previous study of similar case (Endriyas, 2017; G.M., 2017).

In the same manner, husband's occupational status was found to be important determinant for women to use contraceptive. Therefore, the result of Bayesian intercept logistic regression model shows that women whose husbands have work are more likely to use contraceptive than women whose husbands have not work. This finding is consistent with the results of the study in Bangladesh (Md. Shahidul, 2013).

The result from the final model has also shown that wealth index has significantly affected the status of women's contraceptive practice. It revealed that the odds of using contraceptive for women whose economic status is categorized under middle were 1.8522 times more than women whose economic status is poor. In addition, the odds of using contraceptive for women whose economy is categorized under rich was 2.4890 times more than those women whose economy was poor at the time of survey. Here, an increasing pattern in using contraceptive has been observed when their economy increases. This result has been confirmed with the previous studies like (Alvergne, 2017;Azmoude, 2017).

The odds of contraceptive practice among women who had knowledge of family planning are about 5.013 higher than the odds among women who had no knowledge of family planning during the survey time. Means that a reproductive woman who had knowledge about family planning uses contraceptive highly than those not know about family planning and this supports the study done by (Gebremedhin,2018).

This study has also examined the overall change of contraceptive practice among married women and major factors positively or negatively contributing to this change for the last five years. Consequently, most determinants such as women's age, rural residence, women education, husband education, number of living children, desire for more children, mass media exposure, and all regions except Addis Ababa have increased contraceptive practice as compared to the last five years survey data. Due to positive contributions from these determinants, the overall contraceptive practice among married women increased by more than six

percent as compared to 2011 survey. This finding seems to agree a study by(Worku, 2015) on trend of modern contraceptive practice among young married women.

In Bayesian analysis the posterior inference was implemented with Metropolis-Hasting algorithm with 60000 iterations, 10,000 samples as burn in and 50 thinning intervals to make the sequence sampling independent or low autocorrelation with **MCMCglmm** packages in R software. For convergence check researcher has implemented four methods such as trace plot, density plot, autocorrelation, and effective sample size. With these four methods convergences of the posterior estimate were correctly attained.

Conclusions and Recommendations

Conclusions

This study was generally aimed to identify determinant of married women's contraceptive practice among reproductive ages of 15-49 using 9403 samples data that were collected in 2016 EDHS. To address the objectives of the study, both Bayesian and classical multilevel logistic regression has been fitted. Using the standard model comparison technique that the smaller the standard error the better the model is, Bayesian model was appropriately fitted the data well as compared to the classical model.

The determinants that found to be significant under the best model were place of residence, women's age; women's educational level, husband's education level, women occupation, husband's occupation, Religion, wealth index, and knowledge of family planning. Similarly, the variance of the random component of the intercept term is found to be significant implying that the presence of married women's contraceptive practice variations across regional states. The model has also certified that there was higher variation of between women's contraceptive practice than that of the between region variation.

Finally, to compare the change in the women's contraceptive practice across survey years, the results of this study has been compared to previous study which is based on 2011 survey data. The contraceptive practice was increased across survey years and almost all the variables have contributed for this increment.

Recommendations

Based on the findings of the study, the following recommendations are made for ministry of health specifically family planning workers, policy makers, and individuals interested to any sub-work of this study.

Since regions have significant effect on married women's contraceptive practice, the regional states have to take remedial measures on family planning policy and design strategies to improve facility towards the major factors that affecting women's contraceptive practice and contributing for reducing variations of women's contraceptive among regional states based on the following points:

- Supporting women and their husbands to upgrade their educational level.
- Women must be encouraged to the culture of practicing contraceptive and awareness about it has to be given.
- Further studies should be conducted to identify other factors that affect and contribute to women's contraceptive practice variations among regions.
- In this study, only the overall variation of contraceptive practice between regions was identified. But identifying which region is

highly practicing contraceptive and which is not might be important for family planning workers in terms of acting. Therefore, future studies should incorporate spatial modeling to identify the hotspot areas.

- In this study, the estimation method used for Bayesian model was MCMC which is based on iteration technique. However, there is also other recent, deterministic and very fast estimation method called Integrated Nested Laplace Approximation (INLA) method. Hence, researchers should strongly recommend so that to compare the MCMC and INLA for better estimation of the posterior marginal.

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Table 1: Cross tabulation of married women's contraceptive practice and its Determinants

Variables name	Category	Current contraceptive practice		Total	Pearson chi-square (p-value)
		Not practice	practice		
		Count (%)	Count (%)		
Region	Tigray	587(64.43)	324(35.56)	911	931.718(0.000)
	Afar	750(92.25)	63(7.75)	813	
	Amhara	566(51.69)	529(48.31)	1095	
	Oromia	895(70.47)	375(29.52)	1270	
	Somali	903(95.76)	40(4.24)	943	
	Beni.Gum.	551(70.37)	232(29.63)	783	
	SNNPR	706(59.28)	485(40.72)	1191	
	Gambela	477(71.95)	186(28.05)	663	
	Harari	395(70.41)	166(29.59)	561	
	Addis Ababa	266(43.32)	348(56.68)	614	
	Dire dawa	395(70.66)	164(29.34)	559	
	Total	6491(69.03)	2912(30.97)	9403	
Place of resident	Urban	1244(53.69)	1073(46.31)	2317	338.478(0.000)
	Rural	5247(74.05)	1839(25.95)	7086	
Women's age	15-19	467(76.06)	147(23.94)	614	120.012(0.000)
	20-24	1101(65.65)	576(34.35)	1677	
	25-29	1399(65.07)	751(34.93)	2150	
	30-34	1188(66.74)	592(33.26)	1780	
	35-39	1048(69.13)	468(30.87)	1516	
	40-44	723(72.81)	270(27.19)	993	
	45-49	565(83.95)	108(16.05)	673	
Husband education	No education	3393(78.82)	912(21.18)	4305	389.430(0.000)
	primary	1853(62.26)	1123(37.74)	2976	
	secondary	682(58.89)	476(41.11)	1158	
	higher	547(56.74)	417(43.26)	964	
Desire for child	Not want	2138(70.58)	891(29.42)	3029	6.171(0.013)
	Want	4337(68.04)	2037(31.96)	6374	
Number of living children	No child	648(68.28)	301(31.72)	949	5.308(0.151)
	1_2 child	2075(67.63)	993(32.37)	3068	
	3_4 child	1751(69.76)	759(30.24)	2510	
	+5 child	2017(70.13)	859(29.87)	2876	
Mass media exposure	No	4482(69.45)	1972(30.55)	6454	1.651(0.199)
	Yes	2009(68.12)	940(31.88)	2949	
Husband occupation	Has work	5349(66.92)	2644(33.08)	7993	111.018(0.000)
	Has no work	1142(80.99)	268(19.01)	1410	
Women occupation	Has work	2548(62.48)	1530(37.52)	4078	144.493(0.000)
	Has no work	3943(74.05)	1382(25.95)	5325	
Wealth index	Poor	3525(82.98)	723(+17.02)	4248	752.237(0.000)

	Middle	860(65.05)	462(34.95)	1322	
	Rich	2106(54.94)	1727(45.06)	3833	
Women Education level	No education	4234(76.74)	1283(23.25)	5517	449.309(0.000)
	primary	1565(61.18)	993(38.82)	2558	
	secondary	442(53.77)	380(46.22)	822	
	higher	234(46.25)	272(53.75)	506	
Knowledge family planning	No	402(97.81)	9(2.19)	411	166.508(0.000)
	Yes	6089(67.72)	2903(32.28)	8992	
Religion	Orthodox	1841(54.82)	1517(45.18)	3358	711.562(0.000)
	Catholic	35(60.34)	23(39.65)	58	
	protestant	1089(63.46)	627(36.53)	1716	
	Muslim	3418(82.38)	731(17.62)	4149	
	Other	108(88.52)	14(11.48)	122	

Source: Researchers' computations based on primary data

Table 2: Chi-Square Tests of Heterogeneity of MWCP between Regional States of Ethiopia

Chi-square test			
Statistics	Value	D.f	P-value
Pearson Chi-square	926.06	10	2.2e-16
N of Valid Cases9403			

Table 3 : 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
		---	---	---	---	---	---
	Ref(Ortho)						
Religion	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
	Muslim	-0.6247	0.0845	0.0027	-0.7938	-0.6223	-0.4552
	Others	-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
NOLC	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
WWS	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
MME	Ref (No)	---	---	---	---	---	---
	Yes	0.0152	0.0652	0.0021	-0.1127	0.0146	0.1410
KFP	Ref (No)	---	---	---	---	---	---
	Yes	1.6120	0.4052	0.0128	0.8545	1.5971	2.4533
Random effect							
var(δ_u^2)		0.7319	0.3926	0.0124	0.2856	0.6433	1.7660
			DIC= 9777.474				

Note:δ_u^2 regions variance, DIC (deviance information criteria)

Table 4: Bayesian multilevel model comparisons

Model comparison statistics	Empty model	Random intercept model	Random coefficient model
DIC	10561.12	9777.474	10023.345

Table 5: Model comparison of Bayesian random intercept and classical random intercept model

Covariates	Category estimated	BRIM		CRIM		SE Comparison
		Post.mean	$S.E_B$	β	$S.E_C$	
Intercept	β_0	-3.4330	0.0164	-3.0127	0.4408	$S.E_B < S.E_C$
Place of residence	Rural	-0.5611	0.0032	-0.4720	0.0863	$S.E_B < S.E_C$
Women's age	20-24	0.3768	0.0044	0.3068	0.1207	$S.E_B < S.E_C$
	25-29	0.4423	0.0043	0.3690	0.1221	$S.E_B < S.E_C$
	30-34	0.2755	0.0046	0.2272	0.1250	$S.E_B < S.E_C$
	35-39	0.1561	0.0046	0.1305	0.1277	$S.E_B < S.E_C$
	40-44	-0.1005	0.0052	-0.0787	0.1375	$S.E_B < S.E_C$
	45-49	-0.9974	0.0059	-0.8604	0.1609	$S.E_B < S.E_C$
Religion	Catholic	-0.0355	0.0110	-0.0100	0.3037	$S.E_B < S.E_C$
	Protestant	-0.1852	0.0032	-0.1515	0.0857	$S.E_B < S.E_C$
	Muslim	-0.6247	0.0027	-0.5243	0.0729	$S.E_B < S.E_C$
	Others	-1.4105	0.0111	-1.1850	0.3089	$S.E_B < S.E_C$
Husband education level	Primary	0.3264	0.0024	0.2831	0.0654	$S.E_B < S.E_C$
	secondary	0.0891	0.0035	0.0841	0.0969	$S.E_B < S.E_C$
	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	$S.E_B < S.E_C$
NOLC	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	$S.E_B < S.E_C$
WWS	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	$S.E_B < S.E_C$
MME	YES	0.0152	0.0021	1.4716	0.3565	$S.E_B < S.E_C$
KFP	YES	1.6120	0.0128	0.0118	0.0559	$S.E_B < S.E_C$

Note**: BRIM** is Bayesian random intercept model; **CRIM** is classical random intercept model

Table 6: Percentage distributions of married women's contraceptive practice by selected characteristics in 2011 and 2016

Variables	category	EDHS2011 survey year. N=9324	EDHS 2016 survey year. N=9403
Women's age	15-19	19.5	23.94
	20-24	27	34.34
	25-29	6.2	34.93
	30-34	28	33.26
	35-39	26.7	30.87
	40-44	19.4	27.19
	45-49	10.7	16.05
Residence	Urban	47.7	46.31
	Rural	17.7	25.95
Women's education	No education	16.6	23.25
	Primary	33.8	38.82
No.of living children	0	17	31.72
	1_2	32.3	32.37
	>=3	21	30.04
Husband's education	No education	15	21.18
	Primary	29.5	37.74
Desire for more child	No	29	29.42
	Yes	21.4	31.96
Knowledge of FP	No	16.7	2.19
	Yes	39.6	32.28
Mass media exposure	No	13.4	30.55
	Yes	22.3	31.88
Region	Tigray	21.1	35.56
	Afar	6.4	7.75
	Amhara	31.7	48.31
	Oromia	26	29.52
	Somalia	3.3	4.24
	Ben-Gumuz	23.6	29.63
	SNNP	10.6	40.72
	Gambela	23.3	28.05
	Harari	31.6	29.59
	Addis Ababa	70.4	56.68
	Dire Dawa	24.8	29.34
overall married women's contraceptive practice		24.8	30.97

Source of EDHS 2011 result is (Eskezia.Y, 2012)

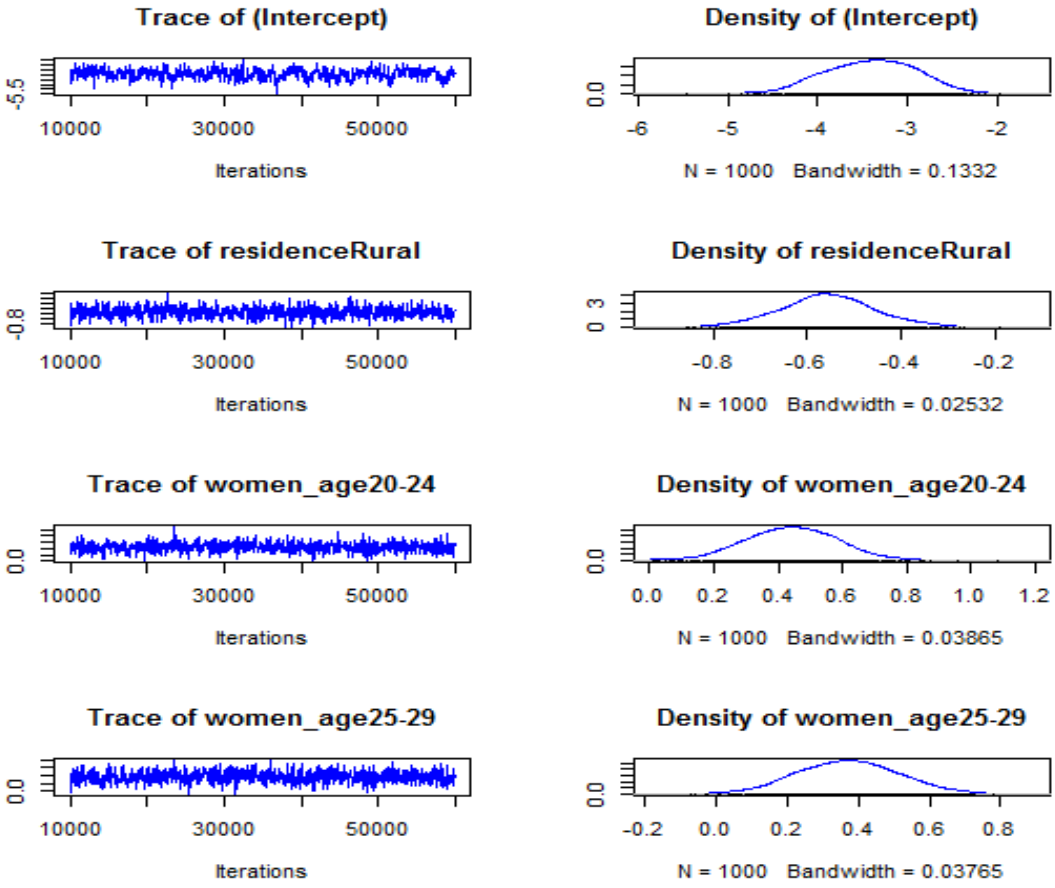

Figure 1: Trace and density plot for convergence check