Determinants of fertility in Ethiopia

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Abstract

Background: The most important elements to determine the rate of population growth is fertility. Fertility is the main element to affect the welfare of mother. The survival of a child can be affected by high fertility and shorter birth intervals.
Methods: For this study, the linear mixed model was used to determine factors affecting fertility status of women in Ethiopia. The 2011 Ethiopian demographic and health survey data was used for this study.
Results: From the result, materials used for roof, wall and floor were found to have a significant relation to fertility level of women in the last five years. Moreover, family size and births in the last five years were found to have a significant relationship.
Conclusion: Significant variation in fertility level was observed among rural and urban residents of Ethiopia. To reduce the gap of fertility between rural and urban population, it is important to modernize different factors. These factors could be access to education, media, and providing employment opportunities in the modern economic sector. Besides this, it is important to develop and maintain the access of family planning services.

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Introduction

To examine changes of a population over time, fertility is the most important factor in population dynamics. It contributes for the change and structure of the population In sub-Saharan countries, fertility rate is high compared to the rest of the world[1-3]. In Ethiopia the situation is similar, i.e., there is high fertility and rapid population growth rate.The country's population in 2013 was estimated to be more than 80 million[4]. According to the 2011 Ethiopian demographic and health survey, the total fertility rate at national level was 4.8 children per woman[5]. This value indicates that much effort should be made to attain the targets set in the national population policy of Ethiopia by 2015. For high fertility rate, the main reasons might be early age at first marriage, desire for more children and extremely low contraceptive use. There are some of the major reasons behind such high fertility rate[6,7].

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Because agriculture is the major economic sector in Ethiopia, most families want to have large number of children. This is because, they are considered as an economic asset rather than liabilities. For most of rural areas,the children assist their parents in farming activities, i.e., the economic importance of children are over lifetime. Similar to many countries in sub-Saharan Africa, having many children is considered as an advantage and gift of God in a number of Ethiopian rural communities[8,9].

Through years, the Ethiopian government developed several strategies to reduce fertility levels since 1993. The plan of the government is to reduce total fertility rate from the then 7.7 children per woman to 4.0 by 2015. Therefore, it is important to identify socio-economic, demographic and geographic factors which could contribute for the level of fertility in Ethiopia[10].

Materials and methods

Data Source

The Ethiopian demographic and health survey (DHS) is conducted within five years of period (2000, 2005 and 2011). This survey is administered at the household level. For this study, the 2011 Ethiopian demographic and health survey was used. The survey consist 624 selected enumeration areas. Complete household listing was carried out in each of the 624 EAs. For the survey, sample of 17,817 households was selected. To estimate at the national level, all data of the survey were weighted. Therefore, interviews were conducted with 9, 096 15-49 aged women and 6,033 15-59 aged men. Therefore, the 2011 EDHS sample was designed to provide estimates for the health and demographic variables of interest for Ethiopia as a whole; urban and rural area of Ethiopia and 11 geographical areas[4,5,11].

Variable of interest

Response variables:- The outcome of interest is the births in last five years. This information is obtained by asking the mother how many live births she had in the past five years.

Independent variables:- The independent predictor variables consisted of baseline socio- economic, demographic and geographic variables, which were collected from each household. The socio-economic variables were the following: main source of drinking water; time taken to collect water; toilet facilities; main construction material of the rooms' walls, main construction material of the room's roof and main construction material of the room's floor and type of fuel for cooking geographic variables were region and type of place of residence, and demographic variables were age of respondents, religion, literacy, family size, total children ever born and age of respondents at 1st birth.

Statistical methods

For this study, the linear mixed model was used. This method first developed for applications in animal genetics and breading research[12-14]. The linear mixed model consists of fixed and random effects. A fixed effect refers to the levels of the factors used in the experiment. The random effect is used if the levels in the study are randomly selected and the interest in the effect of the population of the levels of a factor or factors.[15].
Therefore, the general linear mixed model (LMM) for the response can be written

$$y_i = X_i\beta + Z_i u_i + \varepsilon_i,\ i = 1,2,\ldots,k \qquad (1)$$

where
β is a $p \times 1$ vector of fixed effects;
y_i is an $n \times 1$ vector of observed responses;
X_i is an $n \times p$ design matrix associated with β;
u_i is a $q_i \times 1$ vector of independent random effects with a $N(0, I_{q_i}\sigma_i^2)$ distribution;
Z_i is an $n \times q_i$ design matrix associated with u_i, where u_i is a $q_i \times 1$ vector of independent random variables with a N(0, σ_i^2) distribution, $i = 1,2,\ldots,k$,
ε_i is an $n \times 1$ vector of random errors from a N(0, $I_n\sigma_e^2$), and u_i and ε_i are mutually independent.

The random effects vectors u_i are assumed to be independent and normally distributed with mean vector 0 and variance – covariance **G**, i.e. $u = [u1' \| u2' \| \ldots \| uk'] \sim N(0, G)$, where **G** is a block diagonal with the ith block $\sigma_i^2 I_{qi}$, and the error vectors εi are assumed to be independent and normally distributed with mean vector **0** and variance – covariance matrix R_i, i.e. $\varepsilon_i \sim N(0, R_i)$, for i = 1, 2, . . ., k. Here, **G** and R_i are $q \times q$ (where, $q=q_1 + q_2 + \ldots + q_k$) and $n \times n$ matrices respectively. Under the assumption of normality and independence for u_i and ε_i, the marginal distribution of the response y_i is normal with mean Xβ and variance – covariance matrix V_i where $V_i = \sigma_e^2 I_n + ZGZ' = \sigma_e^2 I_n + \sum_{i=1}^{r} \sigma^2 Z_i Z_i'$[16,17]. Estimation of σ_e^2 and the σ_i^2 is done using either the analysis of variance (ANOVA) method, or the maximum likelihood and the restricted/residual maximum likelihood methods under the assumption of normality and independence for u_i and ε_i. The methods are described in the next section. Further literature for linear mixed model can be found in different books[13,14,16-24].

Result

For this study, the effect of socio-economic, demographic and geographic factors on fertility status of women was investigated. To obtain the required result, linear mixed model approach was used. The result is presented in Table 1. The null model likelihood ratio test (LRT) for the analysis is given by Chi-square value 28.08 (P-value < 0.0001). This is highly significant for this model, indicating that the compound symmetry (CS) covariance matrix is preferred to the diagonal matrix of the ordinary least squares null model. From the result it was observed that all socio-economic, demographic and geographic factors were found to have significant effect on the fertility status of the mother for the last five years except time to reach water source. The results for the random effects that the effect of cluster was significant (p-value = 0.03). Therefore, the estimated value 0.06 was found to be significant.

The usual model error assumptions for these models were checked using the residual plots in Figures 1. From the figures, the first plot is of the predicted values against studentized residuals. These plots show that the studentized residuals vary between -1 and 1. The next two plots are a histogram and q-q plot of studentized residuals, and intended to show the normality of the studentized residuals. These plots show that the usual assumptions of the linear mixed model were not seriously violated by the data.

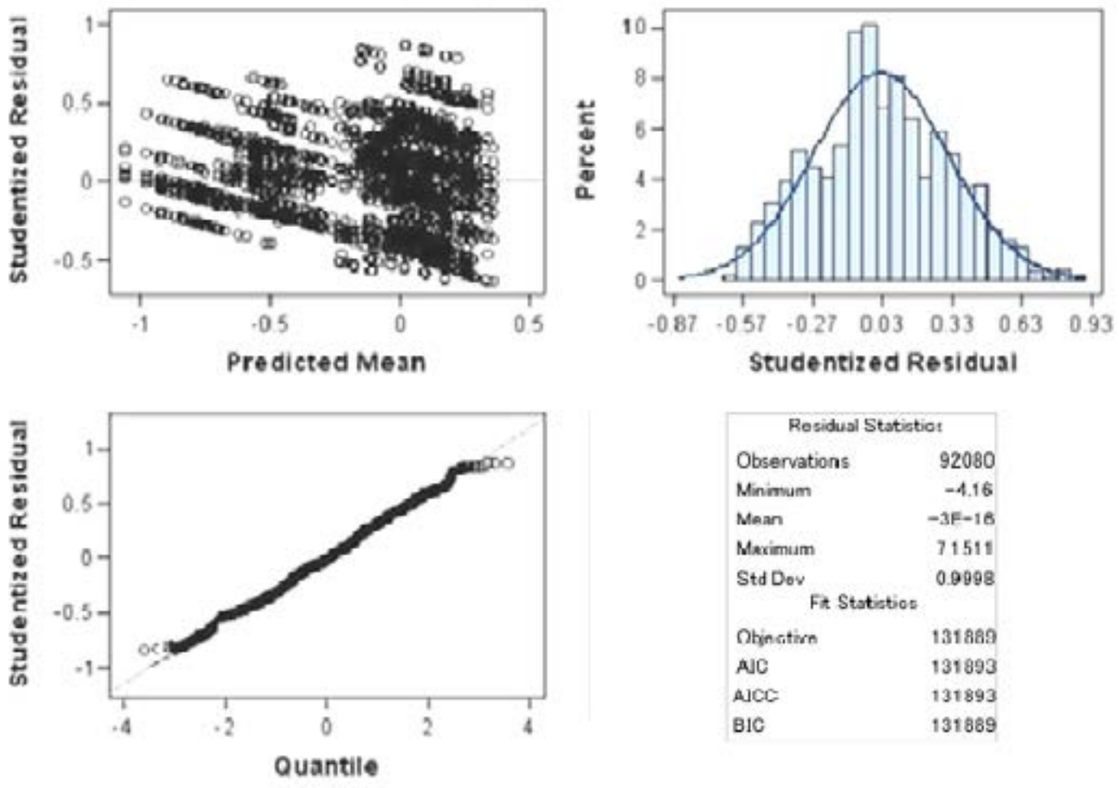

Figure 1: Plots of studentized Residuals

Table 1 shows that fertility status of a woman is different among the eleven administrative regions. As the result indicates, the highest fertility is found in Somali region (10.9%) followed by Dire Dawa administrative region (0.6%) compared to Tigray region. The lowest fertility rate was observed in Addis Ababa administrative region (-0.83), followed by Harari, Benishangul-Gumuz, Amhara, Oromiya, SNNP, Gambela and Afar regions compared to Tigray region. Similarly, women who live in rural area have 4.9% higher fertility compared to women who live in urban areas.

Table 1: Socio-economic, demographic and geographic factors

Effect	Estimate	t Value	P - value	Lower	Upper
Intercept	0.599	18.57	<.0001	0.536	0.662
Region (Ref. Tigray)					
Affar	-0.012	-1.13	0.2568	-0.032	0.008
Amhara	-0.038	-5.21	<.0001	-0.052	-0.024
Oromiya	-0.029	-3.87	0.0001	-0.043	-0.014
Somali	0.109	9.93	<.0001	0.087	0.130
Benishangul-Gumuz	-0.055	-6.73	<.0001	-0.071	-0.039
SNNP	-0.027	-3.16	0.0016	-0.043	-0.010
Harari	-0.071	-7.86	<.0001	-0.089	-0.054
Gambela	-0.016	-11.40	<.0001	-0.088	-0.012
Addis Ababa	-0.083	-8.25	<.0001	-0.103	-0.063
Dire Dawa	0.006	0.63	0.5262	-0.012	0.024
Place of residence (Ref. Urban)					
Rural	0.049	7.88	<.0001	0.038	0.062
Religion (Ref Traditional)					
Catholic	-0.118	-5.62	<.0001	-0.159	-0.077
Muslim	0.017	1.05	0.2927	-0.014	0.048
Orthodox	-0.047	-2.92	0.0035	-0.078	-0.015
Protestant	-0.019	-1.21	0.2271	-0.049	0.012
Educational level (Ref. Higher education)					
Secondary	0.028	4.74	<.0001	0.033	0.079
No education	0.073	8.41	<.0001	0.056	0.090
Primary	0.056	3.29	0.0010	0.011	0.044
Main source of drinking water (Ref. Unprotected)					
Protected water	-0.026	-5.88	<.0001	-0.034	-0.017
Tap Water	-0.034	-7.08	<.0001	-0.044	-0.025
Toilet facility (Ref. Pit latrine)					
Flush toilet	-0.027	-3.00	0.0027	-0.044	-0.009
No facility	0.039	0.88	0.3794	-0.049	0.129
Type of cooking fuel (Ref. Wood charcoal)					
Electricity	0.028	1.87	0.0615	-0.001	0.058
Gas/LPG	-0.043	-4.20	<.0001	-0.063	-0.023
No food to cook	0.234	4.71	<.0001	0.137	0.331
Main floor material (Ref. wood and related material)					
Carpet	-0.048	-2.23	0.0254	-0.091	-0.006
Cement	-0.068	-3.41	0.0007	-0.107	-0.029
Natural floor	-0.032	-1.67	0.0944	-0.070	0.006
Main roof material (Ref. Thatch/plastic/wood)					
Finished roofing	-0.025	-5.89	<.0001	-0.033	-0.017
No roof	0.079	7.27	<.0001	0.058	0.100
Main wall material (Ref. No walls)					
Cane/Wood etc.	0.110	9.23	<.0001	0.087	0.134
Finished walls	0.161	12.10	<.0001	0.135	0.188
Family size	-0.004	-3.71	0.0002	-0.006	-0.002
Age of respondents at first sex	0.015	31.49	<.0001	0.014	0.016
Current age of respondents	-0.021	-71.20	<.0001	-0.021	-0.020
Time to collect water	0.0041	1.79	0.0742	-1.11E-6	0.0024

The association between fertility in the last five years and religion shows that muslim women have 1.7% higher fertility compared to women with traditional beliefs. But, women who are Catholic (-0.118) have lowest fertility followed by Orthodox (-0.047) and Protestant (-0.019) compared to traditional religion. On the other hand, women who have no education have higher fertility (7%) followed by primary (5%) and secondary (2%) compared to women who attended higher education. From the result, it was found that main source of water and births in the last five years were found to have significant relation. As the result indicates, women who use tap water have lowest fertility (-0.034) followed by protected water (-0.026) compared to women who use

unprotected water. Women who have no food to cook (23.4%) have more children compared to women who use wood/charcoal for cooking. Similarly, women who used electricity for cooking (2.8%) have more children compared to women who use wood/charcoal for cooking.

Regarding materials used for roof, wall and floor, from the result it was found that births in the last five years were found to have significant relation to material used for wall, roof and floor. This result is presented in Table 1. Furthermore, from the result it were found that family size and births in the last five years found to have significant relationship. Therefore, as family size in the household increases, births for last five years decrease by 0.4%. But, as age of respondents at first sex increases, births in the last five years increase by 1.5%. In contrary, for one year increase in the current age of respondent, the birth in the last five years decreases by 2.1%.

Discussion

The most important challenge is how to manage with ageing and possible population declines in most countries. In addition to this, it is important to assist programmes to reduce the rate fertility in countries where population growth continues to be high. Therefore, to maintain the fertility status of Ethiopia, it is important to increase age at first marriage. This can be achieved by enhancing women's status through providing them with better employment and educational opportunities[27,28]. Besides this it is important to expand family planning services and information, communication and education to limit family size of the country. Because of this, the government is implementing the population program so that fertility would decline over time. At national level, fertility has shown a declining trend. But, fertility is still high to some regions. Therefore, from the result, it was observed that there are clear regional differences in fertility levels and trends in Ethiopia.

From the result it was observed that some of the regions like Addis Ababa have very low fertility which is below replacement level of fertility. But, other regions like Oromiya, Somali, and SNNP regions have high total fertility rates. For this high fertility, there might be cultural and traditional barriers to effectively utilize modern birth control methods. Other factors could be low status of women and gender inequality including poor health service coverage. For some regions, it was difficult to implement programs that would contribute to fertility transition in each region. Besides regions, high fertility was observed in rural areas than urban areas. Religion also has influence on the status of fertility since Muslim respondents have more children as compared to others. Moreover, women who are less educated have more kids. Based on the economic status of the woman, women who have better facilities tend to have lower fertility. This implies that in areas where traditional social and economic systems continue, the level of fertility is still high. Therefore, for essential change in fertility level, it is important to breakdown the traditional social system. In addition to this, it is important to have transformation of the economy. These changes have to be implemented from changes in the family system, i.e., the persistence of agrarian economy that favours large family size. These families maintained high fertility levels.

Conclusion

Therefore, from the result, significant variation in fertility level was observed among rural and urban residents of Ethiopia. To reduce the gap of fertility between rural and urban population, it is important to modernizedifferent factors. These factors could be access to education, media, and providing employment opportunities in the modern economic sector. Besides this, it is important to develop and maintain the access of family planning services.

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