DETERMINANTS OF FERTILITY IN SIERRA LEONE: A LOGISTIC REGRESSION MODEL APPROACH

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Original Article

ABSTRACT

Background: Fertility levels in Sierra Leone have been on the decline from approximately 5.1 children in 2008 to 4.2 children in 2019, it is still high compared to many countries. This has potentially negative consequences to the economic growth and development of a country. The objective of this study is to assess selected socioeconomic and demographic variables that influence fertility in Sierra Leone.

Method: This is a population-based study using the 2019 Sierra Leone Demographic and Health Survey (SDHS) dataset. The background variables selected for this analysis were: region of residence; educational status; wealth index and age. The roles of each of these determinants in declining fertility (total children ever born) were established. We performed logistic regression to explain the observed socio-economic disparities in fertility using the IBM SPSS Statistics version 25, and statistical significance was pegged at p>0.05.

Results: Data of 9,519 women between the ages of 15 to 49 years, who have at least one child were extracted for this study. In the analysis, we found that women educational level, Wealth Index, Region and age in 5-years group had significant effect on the total number of children ever born $(CEB \geq 5)$. Women with no formal education were more likely to be more fertile $(CEB \geq 5)$ compared to those with higher level of education (OR = 5.410, 95% CI 4.216-6.941). The likelihood of high fertility $(CEB \geq 5)$ was OR=2.594(95% CI 2.301, 2.924, p<0.001) times higher among poor women than rich women. Also, women who lived in the North Western region were more likely to have more children compared to those who lived in Western region (OR = 1.194, 95% CI 1.063-1.341, p<0.000).

Conclusion: This study concludes that women in high-socioeconomic status are less likely to have more children in Sierra Leone. On the other hand, women in the North western tend to have more children. As a policy measure, it is suggested that priority be given to women's educational attainment and the socio-economic wellbeing of women in Sierra Leone.

Keywords: Fertility Levels, Binary Logistic Regression Model, SLDHS-2019 Data, Total Fertility.

INTRODUCTION

Fertility is the major determinant of high population growth and population growth could hinder a country's economic performance as this may put pressure on the already limited infrastructure and government funds (Ashraf *et al.* 2014). Many households with smaller family sizes are more likely to benefit from demographic dividends. However, factors generally associated with increase fertility include religiosity(Hayford and Morgan 2008), intention to have children(Dommermuth *et al.* 2014), and maternal support(Schaffnit and Sear 2014). Factors associated with decreased fertility include wealth, education(Rai *et al.* 2013), female labor participation (Bloom *et al.* 2009), urban residence (Sato 2007), and cost of housing(Li *et al.* 2006).

In Sierra Leone, total fertility rate (TFR) have decrease from 4.9 in 2013 to 4.2 in 2019 (Statistics Sierra Leone 2019). According to the Sierra Leone Demographic Health Survey 2019 (SLDHS-2019), age-specific fertility is low among women age 15-19 (102 births per 1,000 women), peaks among women age 20-24 (196 births per 1,000 women), and declines thereafter, to 21 births per 1,000 women among those in the 45-49 age group (Statistics Sierra Leone 2019). It shows that in Sierra Leone fertility is higher in the middle-ages than the lower and higher ages. In the last three SLDHS (2008, 2013, and 2019), the age-specific fertility rate has been highest among women age 20-29,(Statistics Sierra Leone 2019). There has also been a similar decline among women in rural areas from 5.8 to 5.7 and 5.1, in 2008, 2013 and 2019 respectively and urban areas (from 3.8 to 3.5 and 3.1) during the same period(Statistics Sierra Leone 2019). By region the TFR is highest in the North West and Southern provinces

(5.0 children per woman for each province) and lowest in the Western Area province (2.9 children per woman)(Statistics Sierra Leone 2019). By district, the TFR is highest in Moyamba and Karene (5.4 children per woman for each district) and lowest in Western Area Urban (2.5 children per woman) (Statistics Sierra Leone 2019). The total fertility rate declines with increasing education, from 5.0 among women with no education to 2.0 among women with more than a secondary education. Fertility also decreases with increasing household wealth. Women in the lowest wealth quintile give birth to 5.6 children on average, as compared with 2.6 children among women in the highest quintile (Statistics Sierra Leone 2019). These analyses are based on descriptive methods.

However, previous research has used advanced statistical methods to understand the connection between fertility and its socio-economic demographic factors. In (Muhoza *et al.* 2014) the authors fitted a logistic regression to investigate the effects of wealth, education, religious affiliation and place of residence on the desired family size and excess fertility in East Africa. Their findings showed that wealthy and higher educated people have fertility desires close to replacement level, regardless of religion, while poor, uneducated people, particularly those in Muslim communities, have virtually uncontrolled fertility. Desalegn (Dana 2018) used binary logistic regression model to Ethiopians DHS data and found that age at first marriage, residence, woman's education level, region, use of contraceptives determined the total number of children ever born to a woman in Ethiopia. Adhikari (Adhikari 2010) used bivariate and multivariate regression model to show that the age at

first marriage, perceived ideal number of children, place of residence, literacy status, religion, mass media exposure, use of family planning methods, household headship, and experience of child death were the most important variables that explained the variance in fertility at Nepalese. In (Zhao *et al.* 2020) the authors consider bivariate and binary logistic regression to showed that age, severity of Intrauterine adhesion increased menstrual volume, and hysteroscopic adhesiolysis procedures were the dominant factors affecting reproductive outcomes and may be regarded as potential predictors for evaluating Intrauterine adhesion prognosis.

There is a lack of knowledge on the determinants of fertility levels among women of childbearing age in Sierra Leone. To fill this gap, therefore, this study mainly examines the socioeconomic factors associated with fertility in Sierra Leone using the Sierra Leone DHS- 2019. The study provides a better knowledge of the relationship between socioeconomic disparities as well as demographic characteristics and fertility levels in Sierra Leone and, consequently offers appropriate policy directions for fertility regulation programs in the country.

METHODOLOGY

Data Sources

Data for this study was obtained from the 2019 Sierra Leone Demographic and Health Survey (SLDHS) (Statistics Sierra Leone 2019) online data. This is a cross sectional study implemented by Statistics Sierra Leone. The 2019 SLDHS offers an updated estimate of fundamental demographic and health information covered by the early surveys since its inception. The survey targeted women aged 15-49 and men aged 15-59. The sampling procedure follows a two-stage cluster sampling approach. Selection of sample points or clusters was done in the first stage and these yielded 578 clusters.

Dependent Variable

The outcome variable for this study is fertility measured by aggregating detailed information on full birth history of each woman. The outcome variable (fertility) was:

$$Total\ Children\ Ever\ Born\ (CEB) = \begin{cases} 1, & High{:}\ if\ CEB \geq 5 \\ 0, & Low{:}\ if\ otherwise \end{cases}$$

Independent Variables

Fertility was modeled as a function of various socioeconomic and demographic variables that define communities which are the focus point of this research. Education and wealth status were used as proxies for socio-economic status. Whilst varied indicators are used for measuring socio-economic status, these two indicators (education and wealth) have dominated in the literature over time. Education as used in the DHS; focuses on highest level of education that a person has completed. We used education of both the women and their partners. This is categorized into no education, primary, secondary and higher. Wealth quintile on the other hand, is measured as an ordinal variable ranging from poorest to richest. We also considered some critical socio-demographic characteristics of the sampled women. These are age and region.

Logistic Regression Model

Logistic regression is a widely used multidimensional method for modeling dichotomous results. It is suitable for models covering decision-making issues, which is why it is often used in statistical analyzes appearing in the economics and finance literature. The regression model serves two purposes: (1) it can predict the result variable for new values of predictive variables, and (2) it can help answer

questions about the studied phenomenon, because the coefficient of each predictive variable clearly describes the relative contribution of this variable to the result variable, automatically controlling the influence of other predictive variables.

Let (y, x) be the observed data with $y = (y_i, 1 \leq i \leq n)$ and n vector of binary responses, $x = (x_{ij}, 1 \leq i \leq n, 1 \leq j \leq p)$ and $n \times p$ matrix of covariates, where x_{ij} takes its values in $\mathfrak{R}$. The logistic regression model for binary classification can be written as

$$P(y_i = 1 \mid x_i; \beta) = \frac{\exp(\beta + \sum_{j=1}^{p} \beta_j x_{ij})}{1 + \exp(\beta + \sum_{j=1}^{p} \beta_j x_{ij})}, \quad i = 1, \cdot$$

Where $x_{i1}, \cdots, x_{ip}$ are the covariates for individual i and $\beta_0, \beta_1, \cdots, \beta_p$ unknown parameters. We assume that $x_i = (x_{i1}, \cdots, x_{ip})$ is normally distributed $x_i \sim N(\mu, \Sigma), \ i = 1, \cdots, n.$

Let $\theta = (\mu, \Sigma, \beta)$ be the set of parameters of the model. Then the likelihood for the complete data can be written as

$$\ell\ell(\theta; x; y) = \sum_{i=1}^{n} \ell\ell(\theta; x_i, y_i)$$

$$= \sum_{i=1}^{n} (\log(p(y_i \mid x_i; \beta)) + \log(p(x_i; \mu, \Sigma)))$$

The logistic regression uses a logistic function to model a binary dependent variable. In the logistic model, the log-odds for the value labeled "1" is a linear combination of one or more explanatory variables. The corresponding probability of the value labeled "1" can vary between 0 and 1. We therefore modelled the log odds of high fertility

$$\log\left(\frac{p_i}{1 - p_i}\right) = \beta_0 + \beta_1 x_{1i} + \beta_2 x_{2i} + \cdots + \beta_k x_{ki},$$

where p is the probability of bearing at least five children, i is the index of ith woman, and k is the index for the kth predictor such as household wealth, age, educational level, region e.t.c. All the analysis was done using SPSS 26.

Results

The distribution of children ever born to women by education level is given in Figure 1. The data show that the pattern of childbearing was similar across age groups but difference exists by education level. The women who had high fertility (bearing at least five children) was higher among women with no education than women with higher education. Predominantly, most women aged 15-19 years in the two educational level had no children but consistently higher proportion of such women was found among women with higher education than women with no education and this pattern dominates other age groups.

The distribution of children ever born to women by wealth index is presented in Figure 2. The children ever born (CEB) was consistently higher among the poor women than their counterparts who are rich across the age group of women.
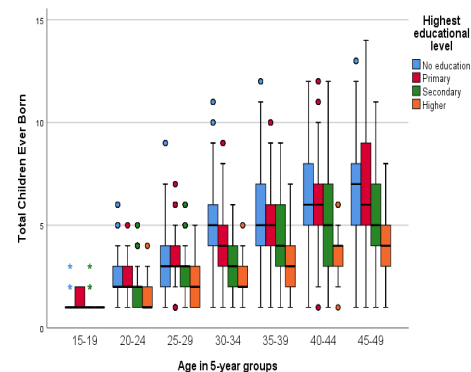

Figure 1. Box plot distribution of women according to children ever born by Education Level
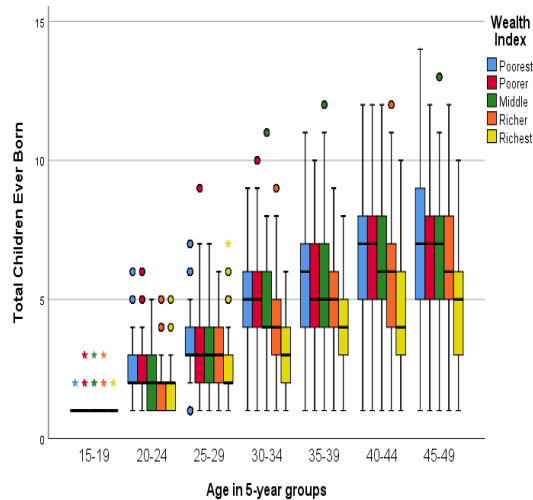
Figure 2. Box plot distribution of women according to children ever born by wealth index.
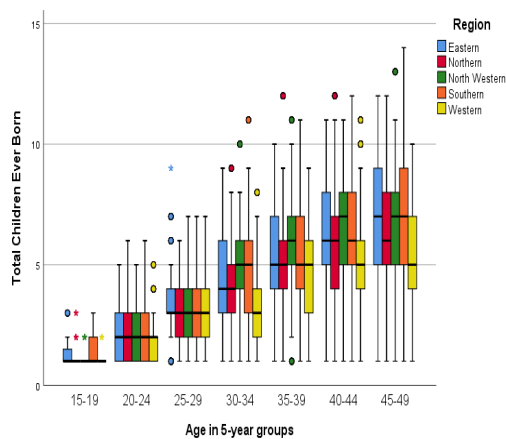

Figure 3. Box plot distribution of women according to children ever born by region

Table 1. Logistic regression results on Fertility (CEB) and selected Socio-economic demographic factors.

Variable	Frequency	Percentage	OR (95% CI)	Wald χ^2	p-value
Education Level					
No Education	28821	71.1	5.410 (4.216, 6.941)	176.222	<0.001
Primary	4797	11.8	4.613 (3.566, 5.966)	135.655	<0.001
Secondary	6045	14.9	2.466 (1.907, 3.179)	47.72	<0.001
Higher	880	2.2	Ref.	-	-
Wealth Index					
Poor	9392	23.6	2.421(2.146, 2.731)	206.473	<0.001
Poorer	10372	25.6	2.594(2.301, 2.924)	242.931	<0.001
Middle	9172	22.6	2.637(2.343, 2.148)	258.792	<0.001
Richer	7108	17.5	1.925(1.724, 2.148)	136.308	<0.001
Richest	4499	11.1	Ref.	-	-
Age					
15-19	687	1.7	0.000(0.00,0.000)	0.000	0.999
20-24	2966	7.3	0.007(0.005, 0.009)	1288.426	<0.001
25-29	6081	15.0	0.057(0.520, 0.061)	3187.0009	<0.001
30-34	6855	16.9	0.203(0.186, 0.221)	1355.911	<0.001

35-39	9860	24.3	0.478(0.440, 0.518)	318.134	<0.001
40-44	6860	16.9	0.797(0.727, 0.873)	23.745	<0.001
45-49	7235	17.8	Ref.	-	-
Region					
Eastern	8586	21.2	1.066(0.952, 1.193)	1.225	0.268
Northern	9911	24.4	0.611(0.547, 0.683)	75.428	<0.001
North-Western	7188	17.7	1.194(1.063, 1.341)	8.917	<0.001
Southern	10152	25.0	1.018(0.909, 1.139	0.094	<0.001
Western	4706	11.6	Ref.	-	

Table 1 presents the socio-demographic and other characteristics of respondents. The percentage distribution of women by region revealed that 25.0% of the women reside in Southern region, while 24.4%, 21.2%, 17.7% and 11.6% reside in Northern, Eastern, Northwestern and Western region, respectively. Also, 25.6% of the women are in the poorest wealth quintile whereas 23.2%, 22.6%, 17.5% and 11.1% are within the poorer, middle, richer and richest wealth quintiles, respectively. Besides, 71.1% of the women have no education while 14.9%, 11.8% and 2.2% have primary, secondary and higher education, respectively. As also revealed in Table 1, all the socio-demographic and other selected variables (age, education, wealth index, residence) were statistically significantly associated with fertility.

The Results of Binary Logistic Regression as displayed in Table 1 below presents the socio-economic and demographic predictors of fertility among women of reproductive age in Sierra Leone, while controlling potential covariates. The relationship between fertility desire and Selected explanatory variables were examined using the odds ratios. This model revealed a positive, statistically significant, higher odds ratio for women with no formal education (OR = 5.410, 95% CI 4.216, 6.941, p<0.001) were more likely to have more children compared to those with higher level of education. Also, fertility was higher among poor women compared to rich women (OR = 2.594, 95% CI 2.301, 2.924, p<0.001). In addition, this study found statistically significant odds ratio for children ever born was higher among women who lived-in North-western region compared to those who lived in Western region (OR = 1.194, 95% CI 1.063, 1.341, p<0.001). Similarly, children ever born was less among women aged 45-49 compared to those aged 15-19 (OR = 0.04, 95% CI 0.02-009, p<0.001).

Ref = Reference category; OR = odds ratio;

***p < 0.001, χ^2 =Chi-Squared.

DISCUSSION AND CONCLUSION

This study assessed the association between socio-economic and demographic factors of fertility among women of reproductive age in Sierra Leone using logistic regression model. Our findings showed that women in the richest wealth quintile and those with higher level of education are less likely to have more children, whilst those without a formal education have higher overall fertility. Several researchers, including Bongaarts (2003) and Lee (2016) have demonstrated a significant negative association between women's educational level and fertility.

Education is predicted to increase women's participation in skilled jobs, which lowers fertility (Kimura 2007) and increases their likelihood of knowing about, having access to, and effectively using contraceptives (Bongaarts 2010). However, because these women may have spent a significant portion of their reproductive years in college, highly educated women are more likely to delay having children.

Additionally, fertility is found to have a significant negative relationship with household wealth status. According to our findings, women from wealthy household had much lower fertility than women from poorer households, who have significantly higher fertility. The relationship between fertility and wealth has been debated extensively in the literature. However, this appears to depend on the geographical context or development status of the place under consideration. Studies in affluent regions reveal a favorable correlation between wealth and fertility (Stulp and Barrett 2015), but those in underdeveloped nations show a negative association (Adhikari 2010; Ndahindwa *et al.* 2014). The reason why women from low-income households in developing nations like Sierra Leone have significantly higher fertility than women from similar households in affluent nations is unknown. Residence is another factor that affects fertility, with rural women notably having greater fertility levels than their urban counterparts. This evidence confirms findings from certain research in Asia (Adhikari 2010) and Africa (Alaba 2007; White *et al.* 2008) and the need to learn more about the patterns of fertility in Sierra Leone's rural and urban areas. Additionally, the study provides some evidence of significant regional differences in fertility rates in the country. The Northern, Southern, Eastern, and North-Western Compared to women in the Western region, all showed higher fertility level.

In modern societies those who are in high socioeconomic strata tend to interpret more children as additional burden which can strain their resources including time as opposed to those in the low socio-economic status who wish to have more children with the notion that the children will serve as their old age security. In addition, due to the various economic activities of those in high socio-economic status, they might not have more children as opposed to those who are in the low socio-economic status. Another plausible explanation by (Channon and Sarah 2019) is that in contemporary era, women have competing life goals. They maintained that for highly educated women, it is sometimes problematic for them to combine many children and life goals such as occupying certain managerial position that will not allow certain amount of maternity leave within a given period. To reach the desired objective, we must raise the educational levels of women as a complementing factor. This might also apply to other nations, especially those in sub-Saharan Africa, which has high fertility rates, rapid population expansion, and low levels of female education. As this study's findings indicate, a key policy goal for achieving the intended fertility and population growth rates will be to improve women's educational performance, and maintain present policies to reduce fertility rates.

In conclusion, women in high-socioeconomic status are less likely to have more children in Sierra Leone. In addition, women in the North western tend to have more children. Also the Sierra Leone Government should prioritize improving women's educational attainment and

household economic wellbeing. A comprehensive sexual and reproductive health programs can focus on delaying sexual debut or promoting abstinence among adolescents.

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