Current Journal of Applied Science and Technology

22(4): 1-8, 2017; Article no.CJAST.35272
Previously known as British Journal of Applied Science & Technology
ISSN: 2231-0843, NLM ID: 101664541

Modeling the Determinants of Fertility Differentials among Women of Child Bearing Age in Ghana

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Authors' contributions

This work was carried out in collaboration between all authors. Author AMA designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors JD and AL managed the analyses of the study and the literature searches. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/CJAST/2017/35272
Editor(s):
(1) Qing-Wen Wang, Department of Mathematics, Shanghai University, P. R. China.
Reviewers:
(1) Mariano Martin-Loeches de la Lastra, University Hospital Denia (Alicante), Spain.
(2) Aluette Merenda, University of Palermo, Italy.
Complete Peer review History: http://www.sciencedomain.org/review-history/20139

Original Research Article

Received 4th July 2017
Accepted 15th July 2017
Published 20th July 2017

ABSTRACT

Aims: To examined the factors which determine fertility levels, their trend, and how they affect fertility.
Study Design: The design used was Survey Design.
Place and Duration of Study: The study used secondary data from the 2010 Population and Housing Census and some excerpt from the 2014 Ghana Demographic Health Survey which were conducted by the Ghana Statistical Service, 2014.
Methodology: The study used multi-factors additive Negative Binomial regression models.
Sample: A total number of 64,140 women between the ages of 15-49 years were used for the analysis.
Results: The study discovered that, higher education and prevalent contraceptive use had a higher inhibiting effect on fertility than the other determinants of fertility. Respondents with no formal education were 65.4% (IRR=1.654, 95% CI: 1.965 - 2.016) more likely to have children as compared to their educated counterparts. Modern contraceptive use is prevalent among women with higher education with most of these women in urban areas.

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Conclusion: To stem fertility related challenges, all stakeholders must intensify campaign for female education and promotion of contraceptive use among females of child bearing age, because fertility affects all aspects of economies both nationally and internationally.

Keywords: Fertility; contraceptive use; education; negative binomial regression.

1. INTRODUCTION

Fertility is the natural capability of producing offspring(s) [1]. Several researches on fertility of Sub-Saharan Africa in the 1990's found fertility rates to be very high [2]. Peasant farming is commonly practiced in sub-Saharan Africa with parents relying on their children as source of labor, thus, making parents view the human capital of their children (quality) as a substitute for their number of children (quantity) [3]. Consequently, fertility has become a global concern. Researchers have proved the existing negative relationship between fertility and economic growth [4] which consequently show that fertility if left uncontrolled would lead to poverty both at the household and national levels.

In 1969, the government of Ghana initiated its first population policy to tackle issues of high fertility rates which was later revised in 1994 after it failed to achieve its target. Currently, Ghana's Total Fertility Rate (TFR) of 4.2 is considered as one of the lowest in Sub-Saharan Africa but very high comparative to the world's TFR levels [2], [5]. Ghana is experiencing a sustained decline in fertility [2]. Total fertility rate declined from a high of 6.4 births per woman in 1988 to 5.2 births in 1993, 4.4 in 1998 and 2003, and 4.0 in 2008. Currently, fertility measures calculated from the 2014 Ghana Demographic and Health Survey (GDHS) indicates that the total fertility rate for Ghana is 4.2 children per woman, a slight increase from 4.0 children per woman in the 2008 GDHS survey. Childbearing peaks during age group 25-29 and drops sharply after age 39 [5]. This means, a good measure for controlling fertility is one that will delay marriage of females in their early and fertile reproduction ages. This will consequently reduce their fertility as they will start reproduction after their peak, hence reducing the number of children a prospective mother can afford within her reproductive life cycle. The decline in fertility rates and mortality rates has not only changed the size of population, but has also changed the age-distribution of male and female population across various countries. These changes in the age distribution of female population are expected to influence the average fertility rates. There are differences in fertility between urban and rural areas of the country and there are also regional and socioeconomic differentials. These marked differentials affect fertility in different ways and requires different measures to shape the population of various countries that will be beneficial to the populace in ways necessary to propel development. Attempts have been made to explain the drop and variations in fertility [6].

Human fertility is a function of a variety of factors which is constantly changing from place to place contingent on conditions specific to the area. A proper understanding of the dynamics of these factors is crucial to policy makers at all levels. The study seeks to explore the extent to which fertility determinants affect the level of fertility among women of child bearing age in Ghana.

2. METHODOLOGY

The data for the study was based on secondary data from the 2010 Population and Housing Census (PHC) and some excerpt from the 2014 Ghana Demographic and Health Survey which were conducted by the Ghana Statistical Service.

2.1 Description of Variables

Children ever born (CEB) was the dependent variable while the independent variables included respondents' location, religion, age, age at first marriage, paid employment status, marital status, marital duration, education attainment, husbands' education attainment, residence, zones, and ethnicity.

2.2 Data Analysis

Descriptive statistics and analysis of variance (ANOVA) was used to analyze the data. Given the count nature of the dependent variable, a generalized linear model (GLM) with a natural logarithmic linear function negative binomial regression, was adopted to assess how the predictor variables influence the level of fertility. Negative Binomial regression has the advantage of fitting nonlinear models over the linear regression models including situations involving

the number of occurrences (counts) of an event [7]. It is a generalization of the Poisson regression model that accounts for over-dispersion by including a disturbance term [7], [8]. It is fitted via a generalized linear model given by,

$$log(\mu_i) = \boldsymbol{x}_i'\boldsymbol{\beta} + offset_i \quad (1)$$

The usual functional form of the negative binomial regression model is given by

Where,

$$\lambda_i = \alpha + \sum_{i=1}^{j} \beta_i \chi_i + \varepsilon \quad (2)$$

λ_i is the expected value of the outcome variable y_i for subject i, $\boldsymbol{\alpha}$ is the constant, $\boldsymbol{B_i}$ are the coefficients and $\boldsymbol{x_i}$ are the independent variables, and $\boldsymbol{\varepsilon}$ is the disturbance term ([7], [8]).

Therefore,

$$\text{Log (No of Children)} = \alpha + \sum_{i=1}^{j} \beta_i \chi_i + \varepsilon \quad (3)$$

Alternatively,

$$\text{No of children} = exp(\alpha + \sum_{i=1}^{j} \beta_i \chi_i + \varepsilon) \quad (4)$$

This means that the Negative Binomial regression model is a generalized linear model with Poisson error and a log link and implies that one-unit increase in a x_i is associated with a multiplication of μ_i by $exp(\beta_i)$.

3. RESULTS

Due to missing values, frequency (N) had different values across some of the variables. The data for this analysis consisted of 64,160 women within the age group 30-34 constituting 14.29% and ages 45-49, 7.3% with about (37.74%) of the respondents coming from the Western region. Over 58.88% live in the urban areas whiles 71.12% have had a form of education (higher or lower) and 28.88% has never had any form of education. About 48.46% were married whilst 36.19% had never been married. Rural areas had more births (twice as much) 2.520 (2.489-2.551) than urban areas 1.615 (1.594-1.636). The table further shows significant differences between the various socio-demographic characteristics.

Variation in CEB increases with increasing age. The upper ranges and median were highest amongst age group 4, 6 and 7 whilst the median for age group 3 and 5 were relatively the same with age group 5 having higher range than age group 3.

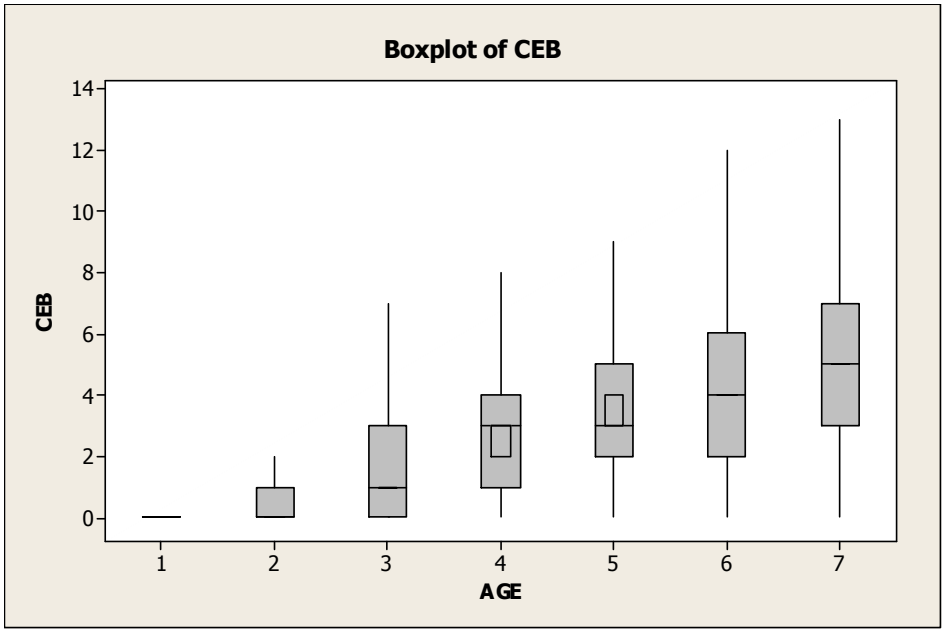

Fig. 1. Distribution of CEB among Ghanaian women PHC, 2010

Table 1. Social-demographic and Reproductive characteristics of respondents and summary of their children ever born (CEB), PHC 2010

Characteristics		Frequency (N)	Percentage (%)	Mean	Std. deviation	Std. error of CEB	95% CI of mean		F	sig
							Lower bound	Upper bound		
Age	15-19	13289	20.23	0.102	0.368	0.003	0.095	0.108	9042.371	0.000
	20-24	12248	19.22	0.676	1.031	0.009	0.658	0.694		
	25-29	11067	17.60	1.608	1.570	0.015	1.578	1.637		
	30-34	8873	14.01	2.699	2.027	0.022	2.656	2.741		
	35-39	7612	11.88	3.634	2.290	0.026	3.582	3.685		
	40-44	6175	9.62	4.369	2.632	0.033	4.303	4.435		
	45-49	4896	7.43	4.760	2.749	0.039	4.683	4.837		
Region	Western	6027	37.74	2.118	2.427	0.031	2.057	2.180	159.083	0.000
	Central	5561	5.48	2.204	2.519	0.034	2.138	2.270		
	Greater Accra	12109	3.15	1.385	1.809	0.016	1.353	1.418		
	Volta	5271	7.42	2.191	2.435	0.034	2.125	2.257		
	Eastern	6596	12.89	2.164	2.419	0.030	2.105	2.222		
	Ashanti	12947	1.47	1.880	2.297	0.020	1.840	1.919		
	Brong Ahafo	5802	6.40	2.234	2.515	0.033	2.169	2.299		
	Northern	5776	3.75	2.488	2.744	0.036	2.417	2.559		
	Upper East	2408	17.10	2.488	2.615	0.053	2.384	2.593		
	Upper West	1663	3.20	2.419	2.762	0.068	2.286	2.551		
Residence	Urban	35773	58.88	1.615	2.061	0.011	1.594	1.636	2355.991	0.000
	Rural	28387	41.12	2.520	2.661	0.016	2.489	2.551		
School attended	Never	17969	28.88	3.292	2.728	0.020	3.252	3.332	7863.116	0.000
	Now	11386	16.46	0.078	0.431	0.004	0.070	0.086		
	Past	34805	54.65	1.990	2.131	0.011	1.968	2.012		
Highest education level	Primary	8509	13.31	2.180	2.410	0.026	2.129	2.232	827.538	0.000
	JSS/JHS	23796	37.57	1.710	2.075	0.013	1.684	1.736		
	SSS/SHS	8801	16.82	0.667	1.333	0.014	0.639	0.695		
	Vocational/technical	1457	3.42	1.439	1.684	0.044	1.353	1.526		
	higher/tertiary	3628	71.12	0.811	1.395	0.023	0.766	0.856		
Marital status	Never married	23572	36.19	0.222	0.743	0.005	0.213	0.232	6694.581	0.000
	Informal/Living together	4434	7.18	2.152	2.107	0.032	2.090	2.215		
	Married	31157	48.46	3.162	2.413	0.014	3.135	3.189		
	Separated	1474	2.48	2.647	2.106	0.055	2.540	2.755		
	Divorced	2137	3.46	3.017	2.186	0.047	2.924	3.110		
	Widowed	1386	2.21	4.078	2.638	0.071	3.939	4.217		

Characteristics		Frequency (N)	Percentage (%)	Mean	Std. deviation	Std. error of CEB	95% CI of mean		F	sig
							Lower bound	Upper bound		
Religion	Catholic	8213	12.32	1.883	2.348	0.026	1.832	1.933	239.670	0.000
	Other Christian	32271	49.26	1.837	2.232	0.012	1.813	1.862		
	Islam	10669	18.53	2.126	2.521	0.024	2.079	2.174		
	Traditionalist	2709	4.33	3.140	2.888	0.055	3.031	3.249		
	Others	10298	15.57	2.268	2.494	0.025	2.220	2.317		
Ethnicity	Akan	75859	37.74	1.915	2.286	0.008	1.899	1.931	7877.416	0.000
	Brong	11014	5.48	2.049	2.309	0.022	2.006	2.092		
	Nzema/Sefwi	6337	3.15	2.152	2.466	0.031	2.091	2.213		
	Ga-Dangbe	14909	7.42	1.835	2.182	0.018	1.800	1.870		
	Ewe	25915	12.89	1.849	2.208	0.014	1.822	1.876		
	Guan	2963	1.47	2.049	2.409	0.044	1.962	2.136		
	Mole-Dagbani	12871	6.40	2.124	2.543	0.022	2.080	2.167		
	Wala	7543	3.75	2.304	2.650	0.031	2.245	2.364		
	All other tribes	34379	17.10	2.233	2.536	0.014	2.206	2.259		
	Foreigners	6434	3.20	2.063	2.369	0.030	2.005	2.121		
Employment status	Employed	42290	66.92	2.611	2.479	0.012	2.587	2.635	4469.123	0.000
	Unemployed	3025	5.03	1.316	1.724	0.031	1.255	1.377		
	Not active	18845	28.04	0.791	1.667	0.012	0.767	0.815		
Employment sector	Public (Government)	1902	2.80	1.450	1.774	0.041	1.370	1.529	222.377	0.000
	Private (Formal)	2000	3.05	1.308	1.832	0.041	1.228	1.388		
	Private (Informal)	39408	62.88	2.725	2.492	0.013	2.701	2.750		
	Semi-Public/Parastatal	31	0.05	1.968	2.331	0.419	1.113	2.823		
	NGOs (Local and International)	146	0.20	1.979	2.344	0.194	1.596	2.363		
	Other International Organisations	12	0.01	0.333	0.651	0.188	-0.081	0.747		

CI = Confidence Interval

To determine the best fit model, six candidate models were fitted and the model with best accuracy measures selected. Below is a table of those models with their deviances.

Table 2. Selecting the best fit model

Model		Deviance
I	Region, employment status, marital status, school attended, highest education level, age, ethnicity	21715.694
II	Region, Residence, marital status, schooling attended, highest education level, employment status, age, religion	21759.210
III	Region,residence, marital status, age, school attended, highest education level, employment status, religion	21862.182
IV	Region, employment status, age, marital status, school attended, highest education level	21777.443
V	Region, residence, age, marital status, school attended, highest education level, employment status	21840.970
VI	Region, marital status, school attended, highest education level, employment status, age, religion, residence, ethnicity	20746.419

Out of the six (6) candidate models of various specifications conditional on the independent variables (X_{ijk}) the number of children (Y_{ijk}) born by the K^{th} woman were modeled using the Negative Binomial Regression. Model VI was selected as the best fit because it had the smallest deviance. Respondents' region, marital status and ethnicity (independently) had significant bivariate relationships with fertility levels but were not significant determinants of fertility in the multiple regression models. The insignificance of marital status and region (geographical location) may be connected with other contextual factors which were not available in the dataset. The reduced model hence becomes;

$$E_j = \exp\begin{pmatrix} 2.129 + \beta_1 age_{1j} + \beta_2 residence_{2j} + \beta_3 educational\ level_{3j} \\ + \beta_4 school\ \ attended_{4j} + \beta_5 employment\ \ status_{5j} \end{pmatrix}$$

Table 3. Negative binomial regression of CEB

Variable	Multiple negative binomial regression	
	IRR (95% CI)	P-value
Age		
15-19	0.040 (0.0370.044)	0.000
20-24	0.159 (0.1500.167)	0.000
25-29	0.340 (0.3230.358)	0.000
30-34	0.570 (0.5410.600)	0.000
35-39	0.760(0.721-0.801)	0.000
40-44	0.901 (0.850.953)	0.000
45-49	1.000	Reference
Residence		
Urban	0.741(0.7200.763)	0.000
Rural	1.000	Reference
Highest education level		
Primary	2.689 (2.545 - 2.841)	0.000
JSS/JHS	2.129 (1.979 - 2.290)	0.000
SSS/SHS	1.755 (1.638 - 1.880)	0.000
Vocational/technical	1.153 (1.072 - 1.240)	0.000
Higher/tertiary	1.000	Reference
School attended		
Never	1.654 (1.965 - 2.016)	0.000
Now	0.263 (0.242 - 0.286)	0.000
Past	1.000	Reference
Employment status		
Employed	1.144(1.100 - 1.190)	0.000
Unemployed	1.029(0.960 - 1.102)	0.042
Not active	1.000	Reference

Intercept= 2.685 (2.456-2.936)

Where β_j *= Vectors of parameter estimates for the various categories of variables*

4. DISCUSSION

The study found that the respondent's age, educational attainment, highest educational level, employment status, marital status, religion, ethnicity and residence location affect fertility levels in Ghana. As expected, respondents' age was a significant determinant of fertility levels as older women had higher fertility levels than younger women. It was also found that, as the level of education increases, the number of children born per woman reduces. Respondents who had secondary or higher education level had lower fertility than the respondents without education or those with primary education. Studies by the United Nations of 26 countries also confirmed that there exists a negative relationship between female education attainment and fertility [9,10]. Longer time spent schooling leads to the deferral or delay in marriage which in turn lowers the chance of giving birth to many children; it comes with exposure which increases the quest for a more comfortable future lifestyle; quality care for wards could be reasons for the mark differential [11]. Also, studies have identified higher education as a factor influencing use of modern contraceptives and fertility is known to be lower among women where prevalence of contraceptive use is high. Respondents' residence location (rural or urban) was significant in both models. Studies have revealed that, rural women tend to have more children than urban women [12]. This is due to the overwhelming low socio-economic conditions in rural areas. With regards to researches by Easterlin synthesis framework [13] or that of Caldwell's wealth-flow theory [14], it is possible to make a good case that the net benefits to parents of having large numbers of children are distinctly lower in urban than in rural places. Rural dwellers often have higher fertility rates which results in large family needed for socioeconomic activities including farming [15]. Children in rural areas therefore typically begin contributing to agricultural production at relatively early ages, whereas this benefit may not be the case in urban areas. There is however a possibility for increasing contraceptive use among rural and less educated women which can in turn lead to further fertility decline [2]. Also, findings from this study shows that, even though with the current TFR of 4.2, Ghana's fertility decline is likely to further decline and complete the transition cycle but at a slow pace. This connotes the findings of researches which asserted that trends of fertility in Africa is declining slowly and lately as compared to other continents [16]. In spite of resource constraints and underdevelopment of the continent, many African countries including Ghana still have high fertility rates exceeding 4.0 [17]. This further stress the limited resources and further worsening the already low standards of life of their populace. This can be explained by a myriad of factors including high levels of infant and child mortality, early and universal marriage; resulting in child bearing which begins early and runs through most of the productive lifespan. Owing to the perceived high infant and child mortality, people tend to have many children with the hope that some children will survive to carry on the family line [18]. For most developing countries to overcome their perennial challenges in all facets of life, conscious efforts must be made to drastically reduce high fertility rates so that the limited resources can better be used in improving their developmental agenda. Reduction in fertility rates can be achieved by increasing the widespread use of contraception, participation of more women in the force, further improvement in women's educational attainment and a continuing inclination towards later age at marriage among women.

The Negative binomial regression model fitted established a non-linear relationship between CEB and the independent variables.

5. CONCLUSION

It is evident from this study that; Negative binomial regression model is an applicable tool for predicting number of children a woman is expected to have. This will ease the yearning of policy makers and researchers for fertility data for up to date planning.

Although causal conclusions cannot be drawn from these results, the study opined that adoption of relevant strategies for continuing to reduce fertility particularly, enforcing socio-economic policies as components of population programmes by the government may prove successful.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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Peer-review history:
The peer review history for this paper can be accessed here:
http://sciencedomain.org/review-history/20139