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Influencing Factors of Fertility in Developing Countries: Evidence from 16 DHS Data

By Abdur Rahman[1], Md. Akhtarul Islam[2] and Samia Yeasmin[3]

Abstract

Objective: This study aims to identify factors that have a substantial impact on the fertility performance of the human population in developing countries.

Methods: We have used 16 different countries' demographic and health survey data to complete the study. To address the study objective, binary logistic regression random effect meta-analysis and random effect meta-regression are used.

Results: At the end of the analysis, it is found that Odds Ratio (OR) for variable women's age is 0.06 [0.06; 0.07] for the event high fertility which is least among all other results. OR for education of women and partner be respectively 0.31 [0.25; 0.39] and 0.44 [0.35; 0.56]. OR for age at first marriage was found to be 0.47 [0.40; 0.56] for the event high fertility. On the other hand, per-capita-health-expenditure can explain 57.14% of the total amount of variation for the variable age at first marriage. Additionally, 49.17% of the heterogeneity can be explained by annual population growth for the variable type of place of residence.

Conclusion: In a developing country, women's age is the most important factor to explain fertility performance. After women's age, an increase in education for both partners and women lead to fertility decline. Another unusual factor that influences fertility behavior is the per capita health expenditure of a country. A rise in per capita health expenditure ultimately leads to fertility decline.

Keywords: Fertility, Factors, Developing countries, Meta-analysis

Introduction

Fertility behavior or human population is largely dependent on the complex web of socio-economic, biological and behavioral factors. So to obtain the impact of one particular factor we need to control others (Hakim, A., & Mahmood, N. (1994). In the recent past, it is observed that several developing countries have experienced a faster decline in fertility performances (Bulatao, 1984).

In the past decades' factors playing important roles to explain fertility are shaped by factors such as trends in fertility rates, a changing societal context for childbearing, and the development of data and applied mathematics tools for testing knowledge domain and construction models (Woods, 1994). The declining fertility rate in Southeast Asian countries is caused by several

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factors such as postponed marriage, increasing coverage of quality reproductive health services, declining infant mortality rate, family structure, increasing adult education level particularly for female as well, cultural tradition and religious beliefs (Hirschman & Guest, 1990).

The record of fertility trends within the developing world suggests that when a fertility decline is afoot it typically continues while not important interruption till the replacement level of around 2 births per woman is reached (Bongaarts, 2008). In Pakistan age is the most important variable explaining the variance of fertility, with older women having higher fertility. Also, the rise of age at marriage and an increase in education influences the low fertility of women in Pakistan (Hakim & Mahmood, 1994). Fertility transition undoubtedly can be understood through Economic reasoning (Cleland & Wilson, 1987). There are some unusual criteria for the fertility rate. Like, son preferences are common in parts of Asia and the Middle East. So high fertility is seen there if the first few children are girls for the desire of male children (Bongaarts, 2001). Also, in developing countries, Muslims have higher fertility than other religious groups (Jones, 2006). Very little is known about the potential influence of body weight on fertility (ie, the number of children) in the general population (Jokela et al., 2007). The main objective of this study is to identify factors that have a substantial impact on the fertility performance of the human population in developing countries from 2006 to 2014 DHS data.

Material and methods

Data Sources

This study extracted relevant information from nationally representative secondary data set of 16 Demographic and Health Survey of developing countries. A country is considered to be developing if they are trying economically and socially towards betterment by economic and social maintenances and proper policy implementation (Paul & Bhuimali, 2019).

These countries were taken into consideration based on some criteria such as (a) countries are developing, (b) availability of the variables required to conduct the study, (c) access to the DHS data, etc. From the developing countries found from (list of developing countries, 2019) (d) size of the data is large enough to compute valid effect size that filled our requirements were taken in the study consideration. For all the countries, the Individual Record (IR) data was used, where only ever-married women age 15-49 are included. The unit of analysis is thus women in the study.

The DHS has a standardized procedure and well-defined questionnaire to collect data of a certain territory or country. Therefore, one can compare the estimates found from DHS data without having problems (“DHS”, 2019).

For meta-regression, per-capita-health-expenditure, annual population growth and GDP (gross domestic product) of countries were included in the analysis which was obtained from the World Bank website (“World Bank”, 2019).

Dependent Variable

The study is conducted based on fertility as a dependent variable of interest. This is measured as a two-category dummy variable. That has two distinct categories of fertility as ‘low’ and ‘high’. The dependent variable is formed using the DHS data where the original variable was “Total children ever born”. If the number of total children ever born is between ‘1 to 2’ it is termed as ‘low’ fertility if the number is ‘above 2’ it is termed as ‘high’ fertility.

In the meta-analysis, we have considered high fertility as our event and low fertility as our non-event. And we investigated how the influence of the independent variable is deviating for the event (high fertility) in different countries.

Independent Variables

Considering our study purpose and analyzing numerous works of literature, we have selected one dependent variable and seven independent variables where the fertility level is our dependent variable. And we have the following independent variables: women's current age, women's education level, husband/partner's education level, wealth index, type of place of residence, age at first cohabitation/marriage and body mass index. *Binary Logistic Regression*

This is a statistical method for analyzing a dataset in which there are one or more independent variables that determine an outcome. The binary logistic regression is similar to multiple linear regression except the outcome is measured with a dichotomous variable (where outcomes have two independent levels). Logistic regression generates the coefficients (and its standard errors and significance levels) of a formula to predict a logit transformation of the probability of the presence of the characteristic of interest.

In a logistic regression model, the dichotomous variable is defined as,

$$\boldsymbol{Y} = \begin{cases} \mathbf{1}; & \textbf{\textit{the presence of characteristics}} \\ \mathbf{0}; & \textbf{\textit{absence of characteristics}} \end{cases}$$

Where, the odds are defined as,

$$\mathbf{Odds} = \frac{\mathbf{p}}{\mathbf{1 - p}} = \frac{\textbf{Probability of presence of characteristics}}{\textbf{Probability of absence of characteristics}}$$

Thus, the logit model is defined as,

$$\mathbf{logit(p)} = \boldsymbol{\beta_0} + \boldsymbol{\beta_1}\mathbf{X_1} + \boldsymbol{\beta_2}\mathbf{X_2} + \boldsymbol{\beta_3}\mathbf{X_3} + \cdots + \boldsymbol{\beta_k}\mathbf{X_k}$$

Where the probability of the presence of the characteristic of interest is represented with p. The logit transformation is defined as the log of odds.

$$\mathbf{Log}\left(\frac{\mathbf{p}}{\mathbf{1 - p}}\right) = \mathbf{Logit(p)} = \boldsymbol{\beta_0} + \boldsymbol{\beta_1}\mathbf{X_1} + \boldsymbol{\beta_2}\mathbf{X_2} + \boldsymbol{\beta_3}\mathbf{X_3} + \cdots + \boldsymbol{\beta_k}\mathbf{X_k}$$

In our analysis of BDHS data, fertility is our dependent variable which is a two-category dummy variable. Categories of the dependent variable is defined as: “low fertility” and “high fertility”. So to estimate the impact of the independent variables (women’s age, women’s education, partner’s education, wealth index, type of place of residence, age at first marriage and Body Mass Index) on the dependent variable we used logistic regression (Tranmer & Elliot, 2008).

Random Effect Meta-Analysis

Basically, in a meta-analysis possibly two sources of heterogeneity are presented. One is sampling error or within-study variation. Another is due between studies variability, which can be due to characteristics in the samples, variation in the sample, design quality, etc. Mathematically, observed effect in a random effect meta-analysis can be represented as $Y_i = \mu + \zeta_i + \varepsilon_i$; Y_i is the observed effect, μ represents the grand mean, ζ_i represents the true effect of studies from the grand mean, and ε_i be the deviation between an observed and true effect of the study (Chen & Peace, 2013; Borenstein et al., 2011).

Random Effect Meta-Regression

Meta-regression is used to explain extra heterogeneity (or the residual heterogeneity) where we use study-level moderators or study-level independent variables. Where the study-level moderators are chosen based on the reported effect size as dependent variables. The variance of the effect size in incorporated as the weight in the analysis. And it is often said that meta-regression is similar to multiple regression analysis and the theory of regression can also be used in meta-regression. Thus, the work of meta-regression is to find whether study characteristics (either continuous or discrete) influence the study effect size (dependent variable) by regressing effect size on study characteristics (independent variables). In a meta-regression, we typically use two kinds of meta-regression models: fixed effect meta-regression and random-effect meta-regression (Chen & Peace, 2013).

A meta-regression model can be typically represented as

$$log(effect\ size) = \alpha + \beta \times moderator + \epsilon$$

where effect size is OR/ Risk Ratio/ Risk difference, etc. α be the intercept term, β be the slope or meta-regression co-efficient and ϵ be the random error terms.

In a fixed effect meta-regression model, only within-study variation is taken into account. On the other hand, in a random effect model both within and between studies variations were taken into consideration. Although random effect meta-regression are highly used in practice, it is said that fixed-effects meta-regression is more powerful, but is less reliable if the between-study variation is significant (Borenstein, 2011; Van Houwelingen et al., 2002; Normand, 1999).

Results

Table 1: Baseline characteristics (count (%)) of DHS data

Country	Albania 2008-09	Azerbaijan 2006	Bangladesh 2014	Cambodia 2014	Cameroon 2011	Egypt 2014	Gambia 2013	Jordan 2012	Kenya 2014	Lesotho 2014	Maldives 2009	Nepal 2011	Pakistan 2012-13	Peru 2012	Tanzania 2015-16	Timor 2009-10
Women's Age	Above 25	4931 (65)	5362 (63.5)	12000 (67.2)	10968 (62.4)	8038 (52.1)	17031 (78.3)	5202 (50.8)	9545 (84.1)	18326 (59)	3553 (53.7)	5320 (74.6)	7165 (56.5)	10258 (75.7)	15119 (63.3)	7356 (55.5)
	Up to 25	2653 (35)	3082 (36.5)	5863 (32.8)	6610 (37.6)	7388 (47.9)	4731 (21.7)	5031 (49.2)	1807 (15.9)	12753 (41)	3068 (46.3)	1811 (25.4)	5509 (43.5)	3300 (24.3)	8769 (36.7)	5910 (44.5)
Women Education	Uneducated	32 (0.4)	114 (1.4)	4206 (23.5)	2233 (12.7)	2796 (18.1)	4861 (22.3)	5079 (49.6)	408 (3.6)	4183 (13.5)	81 (1.2)	1941 (27.6)	4876 (38.5)	7625 (56.2)	695 (2.9)	1998 (15.1)
	Educated	7552 (99.6)	8330 (98.6)	13657 (76.5)	15345 (87.3)	12630 (81.9)	16901 (77.7)	5154 (50.4)	10944 (96.4)	26896 (86.5)	6540 (98.8)	5103 (72.4)	7797 (61.5)	5933 (43.8)	23193 (97.1)	11268 (84.9)
Partner's Education	Uneducated	42 (0.8)	50 (0.9)	5062 (28.3)	1339 (10.4)	2035 (19.2)	3551 (16.3)	4599 (65)	269 (2.4)	1457 (13.8)	741 (17.1)	2293 (36.7)	1820 (18.6)	4215 (31.2)	230 (1.4)	1062 (13)
	Educated	5106 (99.2)	5678 (99.1)	12798 (71.7)	11485 (89.6)	8545 (80.8)	18207 (83.7)	2477 (35)	11070 (97.6)	9095 (86.2)	3594 (82.9)	3958 (63.3)	7964 (81.4)	9296 (68.8)	16281 (98.6)	7096 (87)
Wealth Index	Poor	2936 (38.7)	3582 (42.4)	6611 (37)	6107 (34.7)	5345 (34.6)	7971 (36.6)	4395 (42.9)	5591 (49.3)	13232 (42.6)	2321 (35.1)	3428 (48.1)	4742 (37.4)	5072 (37.4)	10357 (43.4)	4310 (32.5)
	Not Poor	4648 (61.3)	4862 (57.6)	11252 (63)	11471 (65.3)	10081 (65.4)	13791 (63.4)	5838 (57.1)	5761 (50.7)	17847 (57.4)	4300 (64.9)	3703 (51.9)	7932 (62.6)	8486 (62.6)	13531 (56.6)	8956 (67.5)
Type of Place of Residence	Rural	3738 (49.3)	3966 (47)	11696 (65.5)	11911 (67.8)	7654 (49.6)	12134 (55.8)	5735 (56)	3318 (29.2)	19465 (62.6)	4419 (66.7)	6090 (85.4)	8973 (70.8)	7207 (53.2)	7882 (33)	9121 (68.8)
	Urban	3846 (50.7)	4478 (53)	6167 (34.5)	5667 (32.2)	7772 (50.4)	9628 (44.2)	4498 (44)	8034 (70.8)	11614 (37.4)	2202 (33.3)	1041 (14.6)	3701 (29.2)	6351 (46.8)	16006 (67)	4145 (31.2)
Age at First Marriage	Above 18	4578 (88.5)	4929 (85)	4271 (23.9)	9132 (70.6)	5180 (46.5)	16037 (73.7)	3437 (46.7)	9003 (79.3)	14051 (62.4)	2974 (67.3)	4574 (64.1)	4131 (42)	7864 (58)	11128 (67.1)	5676 (58)
	Below 18	594 (11.5)	870 (15)	13592 (76.1)	3795 (29.4)	5964 (53.5)	5725 (26.3)	3930 (53.3)	2349 (20.7)	8453 (37.6)	1446 (32.7)	2557 (35.9)	5706 (58)	5694 (42)	5452 (32.9)	4112 (42)
Body Mass Index	Not Normal	3161 (42)	4149 (50.9)	7608 (43)	3761 (32.8)	3117 (39.5)	18139 (84.2)	1794 (39.5)	5386 (74.9)	5984 (41.5)	1672 (49.4)	3016 (53.2)	1915 (31.2)	2382 (50.9)	13426 (56.7)	5031 (38.2)
	Normal	4359 (58)	3998 (49.1)	10075 (57)	7719 (67.2)	4767 (60.5)	3415 (15.8)	2752 (60.5)	1801 (25.1)	8438 (58.5)	1716 (50.6)	2650 (46.8)	4229 (68.8)	2294 (49.1)	10246 (43.3)	8127 (61.8)

Table 2: A logistic regression coefficient showing different influencing factors for the fertility performance of Bangladesh

	B	Odds Ratio	P-value	95% C.I. for OR	
				Lower	Upper
Women's Age	0.162	1.176	0.000	1.169	1.182
Women's Education			0.000		
Up to primary (Ref. Category)					
Up to Secondary	-0.420	0.657	0.000	0.596	0.724
Higher	-1.359	0.257	0.000	0.205	0.322
Partner's Education			0.000		
Up to primary (Ref. Category)					
Up to Secondary	-0.423	0.655	0.000	0.592	0.724
Higher	-0.613	0.542	0.000	0.462	0.636
Wealth Index			0.000		
Poor (Ref. Category)					
Middle	-0.135	0.874	0.017	0.783	0.976
Rich	-0.308	0.735	0.000	0.658	0.821
Type of Place of Residence					
Rural (Ref. Category)					
Urban	-0.260	0.771	0.000	0.702	0.846
Age at first marriage					
Below 18 (Ref. Category)					
18 and above	-0.586	0.557	0.000	0.502	0.617
Body Mass Index			0.024		
Normal (Ref. Category)					
Underweight	0.103	1.109	0.066	0.993	1.238
Overweight	-0.079	0.924	0.111	0.838	1.018
Constant	-4.572	0.010	0.000		

From *Table 2,* we find that all the variables except Body mass index are significant at 5% level of significance. Among them, age is the lonely continuous variable and rests are categorical variables. Apart from women's age, all the odds ratio in favor of high fertility is below 1 indicating a decrease in high fertility. Alone age has an odds ratio greater than 1 which is the indication of a high chance of high fertility with age increase.

Findings of meta-analysis

Table 3: Summary of meta-analysis for different variables level as a treatment to explain the event high fertility

Variable	Pooled OR	95% CI	Q-Statistic	P-value	I^2
Women's age	0.06	[0.06; 0.07]	293.89	< 0:01	95%
Women's education	0.31	[0.25; 0.39]	783.15	< 0:01	98%
Partner's education	0.44	[0.35; 0.56]	847.52	< 0:01	98%
Wealth index	0.58	[0.52; 0.65]	479.94	< 0:01	97%
Type of place of residence	0.62	[0.55; 0.70]	524.36	< 0:01	97%
Age at first marriage	0.47	[0.40; 0.56]	835.78	< 0:01	98%
Body Mass Index	0.74	[0.64, 0.85]	504.12	< 0:01	97%

Table 3 illustrates that, among them women's age has the smallest pooled OR (0.06) [0.06; 0.07] and body mass index has the largest OR (0.74) [0.64, 0.85]. None of the confidence intervals of pooled OR overlap with 1 which is the evidence of statistical significance. Heterogeneity statistics for all the variables are statistically significant at 5% level of significance. The proportion of between-study variance is very close for the entire variable except for women's age where $I^2 = 95\%$ indicates 95% of the total heterogeneity is explainable rest 5% is due to within-study variance and can't be explained.

Findings of meta-regression

Table 4: Summary of Meta-Regression for explaining high fertility for different moderator variables

Variables	Moderator	Heterogeneity explained	Estimated slope	P-value
Women's age	PCHE	34.34%	-0.0019	0.0015
Women's education	PCHE	25.46%	-0.0005	0.0817
Partner's education	PCHE	55.67%	-0.0010	0.0003
Wealth index	APG	40.25%	0.0606	0.0012
Type of place of residence	APG	49.47%	0.0588	0.0053
Age at first marriage	PCHE	57.14%	-0.0008	0.0001
Body Mass Index	PCHE	18.38%	-0.0004	0.0302

*****PCHE= per capita health expenditure, APG= annual population growth

Table 4 explains that the extra amount of heterogeneity is explained for all the variables at a 5% level of significance except variable women's education, which is significant at 10% level of significance. Here, only two moderator variables are included (PCHE and APG) but GDP was also included in the study as a moderator variable that couldn't significantly explain any heterogeneity.

Discussion

The main purpose of the study is to determine factors that influence the fertility performance of women residing in developing countries. From logistic regression, we see that a unit increase in the age of the respondent, the odds in favor of contributing to high fertility increases by 1.176 units or 17.6%. This finding is statistically significant at a 5% level of significance with P-value =0.000. For the meta-analysis, overall pooled OR for variable women's age is 0.06 [0.06; 0.07]. This is the minimum of all other pooled Odds Ratio indicating that women age Up to 25 are 94% less likely to contribute to high fertility than women aged above 25. Previous studies also found the age of women to be a good determinant of fertility (Hakim & Mahmood, 1994; Joffe & Li, 1994; Howe et al., 1985; Stolzenberg & Waite, 1977).

From logistic regression, the odds ratio of respondent and respondent's partners those who have received up to secondary level education are 0.657 and 0.655 times respectively less likely to contribute to high fertility than those who have up to primary education. Meta-analysis proves that pooled OR for women's education is 0.31 [0.25; 0.39] which is the second lowest among all OR indicating 69% less chance of educated women to contribute in high fertility compared to uneducated women. This is also true for the education of partners with OR=0.44 [0.35; 0.56] which is the third lowest among all. Some previous studies also found women's education as a good determinant (Olfa et al., 2011; Adhikari, 2010, Hakim & Mahmood, 1994; Jain, 1981) and some also found both partners and women's education are good determinant [1, 16] (Hakim & Mahmood, 1994; Jain, 1981).

It is also found from the logistic regression that a rich respondent is 0.735 times or 26.5% less likely to contribute to high fertility than a poor respondent (Hakim & Mahmood, 1994; Martin, 1995; Caldwell, 1980). From meta-analysis we get, women from a poor family, contribute more to high fertility than not poor women as pooled OR is 0.58 [0.52; 0.65]. Finding obtained in previous studies are similar to our findings (Hakim & Mahmood, 1994; Martin, 1995; Caldwell, 1980).

Logistic regression analysis suggests a respondent who lives in an urban area is 0.771 times less likely to contribute to high fertility than the respondent from rural areas. Meta-analysis has shown that fertility performance was higher among rural women compared to urban women. As the pooled OR is 0.62 [0.55; 0.70] for urban women which is the 6th lowest. So residing in the urban area reduces fertility which is similar to previous studies findings [1, 19, 20] (Hakim & Mahmood, 1994; Hill, 1990; Jain & Ross, 2012; Adhikari, 2010).

Logistic regression shows that those who were married at age 18 and above are 0.586 times less likely to contribute to high fertility than those who were married before age 18. Meta-analysis suggests that age at first marriage 18 and above, the pooled OR is 0.47 [0.40; 0.56] indications of 53% less chance to contribute in high fertility compared to those married below age 18. Similarities were seen in previous studies (Hakim & Mahmood, 1994; Hill, 1990; Adhikari, 2010; Howe et al., 1985).

From logistic regression for BMI, underweight and overweight respondents are 1.109 times and 0.924 times likely to contribute to high fertility than those who are normal weight. Findings for BMI are found to be insignificant at 5% level of significance.

The meta-analysis revealed that for BMI of women OR is 0.74 [0.64; 0.85] indicating normal-weight women contribute less in high fertility than a not normal-weight woman by 0.74 times or only 26% less. These findings are similar to (Jokela et al., 2007) but opposite of findings in previous studies which found body mass index is not a good parameter of fertility (Vilarino et al., 2011; Howe et al., 1985).

Findings from meta-regression have shown, moderator variable per capita health expenditure alone can explain 57.14%, 55.67%, 34.34%, 25.46% and 18.38% of the total amount of heterogeneity respectively for variables age at first marriage, partner's education, wealth index, women's age, and body mass index. On the other hand, 49.47% and 40.25% of the heterogeneity can be explained by the moderator variable annual population growth for variables wealth index and type of place of residence. Fertility with the health expenditure per capita or annual population growth was never correlated in any of the previous studies.

Conclusions

Following the analysis, researchers have concluded that there are a number of factors affecting fertility for developing countries. Women's age plays the most important role to explain their fertility performance: women with higher age showed higher fertility as the duration of the marriage is long to contribute to high fertility. Similarly, age at first marriage is also an important factor which implies lower fertility with rising age at first marriage. Also, education is one of the most important factors to explain fertility performance for both women and their partners. Urbanization leads to fertility decline as women residing in the urban area are at low risk to contribute to high fertility. Women's wealth index and body mass index are important factors to explain fertility behavior. Additionally, we found that per capita health expenditure of a country is a very important factor to explain the fertility of a country and this in turn influences most other fertility factors impacts.

Acknowledgment

We are obliged to the DHS program from which we have collected data for our study purpose. We are also grateful to the World Bank data source from which we obtained our indicator that assisted us to conduct an additional part of the study.

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