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Prevalence and determinants of children ever born among ever-married women: evidence from clustered data in Bangladesh

Atikur Rahman[1], Zakir Hossain[2*], M Lutfor Rahman[3], Enamul Kabir[4]

1. Department of Statistics, Jahangirnagar University, Savar, Dhaka, Bangladesh
E-mail: arahman@juniv.edu
2. Department of Statistics, University of Dhaka, Dhaka, Bangladesh
*Corresponding author's E-mail: zakir.hossain@du.ac.bd
3. Institute of Statistical Research and Training, University of Dhaka, Dhaka, Bangladesh
E-mail: lutfor@isrt.ac.bd
4. School of Sciences, University of Southern Queensland, Toowoomba, Australia
E-mail: Enamul.Kabir@usq.edu.au

Abstract

Objective: To investigate the prevalence of number of children ever born (CEB) and its associated determinants among women aged 15-49 years in Bangladesh.

Study design and setting: We used clustered data extracted from the last two Bangladesh Demographic and Health Surveys (BDHS 2014 and BDHS 2017-18). A two-stage stratified sampling was used in both surveys. Mixed logistic regression modelling approach for binary responses was adapted to accommodate clustering effects via the generalized linear mixed model framework.

Participants: The study is based on 15924 ever-married women in BDHS 2017-18 (14119 in BDHS 2014) of Bangladesh.

Results: As per the latest BDHS 2017-18, 42.1% of reproductive women had 3 or more children. Age at first marriage ($p<0.001$), age at first birth ($p<0.001$), place of residence ($p<0.001$), exposure of media ($p<0.001$), religion ($p<0.001$), education of women ($p<0.001$) and husband ($p<0.001$), husband's desire more child ($p<0.001$), women empowerment ($p<0.001$) and wealth index ($p<0.001$) were found to be statistically significant determinants of the number of CEB among ever-married women.

Conclusion: The CEB appears to be higher among women who were married before 18 years, Muslim, illiterate, living in rural areas, had first birth before 20 years, non-exposure of media, and husband's desire for more children.

Keywords: Children ever born, Ever-married women, Clustered data, Random effects, GLMM, BDHS.

Strengths and limitations of this study:

- Clustering effects were considered through mixed modelling approach to avoid misleading inferences and hence for valid interpretation of the results.

- Analysing the two most recent nationally representative data sets assisted to give a wide comparative picture of society in Bangladesh and provided significant determinants of children ever born among ever-married women.
- Due to the use of secondary datasets, we were limited in case of our freedom to choose exposure variables for the statistical analysis.

Introduction

The number of children ever born (CEB) is defined to be the number of live births among ever-married women aged 15-49 years in Bangladesh[1]. The CEB is one of the important determinants of population dynamics, as it decides the size, structure and composition of the population in any country of the world. It is not only responsible for population growth but is also the key factor in determining the changes in age composition of the population[2, 3].

The frequency of CEB among women is a measure of childbearing experience throughout their lives. It was reported that the childbearing decisions of women were mainly influenced by their education and urbanization[4]. It was also noted that the mother's age group, place of residence, administrative division and mass-media exposure were found to be significantly associated with the number of children among ever-married women[5]. The women who completed their secondary or higher levels of education were less likely to have more children than others[4, 6, 7]. Also, age at marriage and wealth index of Bangladeshi women both had a significant negative effect on their number of CEB[8]. Contraceptive usage among Bangladeshi women also played a more important role in reducing fertility trends than other proximate determinants[9, 10]. The key responsible factors for childbearing among women in Bangladesh were their employment status as well as food security[11]. There was a son preference among women who had only daughters, so they were more likely to have a higher number of CEB compared with those women having sons already[12].

The number of children among women in Bangladesh increased with their age and wealth index; and it declined with their own and husbands' increasing levels of education[1, 13]. Delayed marriage, usage of contraceptive methods, induced abortion and successive birth interval were potential demographic determinants for the lower birth rates[14]. It was reported that women's age at first birth, use of contraceptive methods, education of both women and their husband, religion and wealth index were significantly associated with their number of CEB[15].

The total population of Bangladesh is projected to be 192.78 million in 2053[16], which sounds alarming for the government to ensure the basic needs, such as food, clothing, shelter, education and health care. Therefore, the relevant authorities have been examining ways to control the

population growth rate since 2012. In this context, the government has attempted to control the number of live births by advertising the fertility slogan 'No more than two children, better if one', which was further modified in 2019 to 'Whether it is a boy or girl, two children are enough' among ever-married women in Bangladesh[17].

Geographical clusters are there in Bangladesh Demographic and Health Surveys (BDHS) 2014 and 2017-18. In the data, women are in clusters which result in possible correlation among subjects, i.e. correlated responses occurred due to clustering. The clustering effect has been completely overlooked in previous studies for analyzing CEB data among Bangladeshi ever-married women[1, 15]. Analyzing CEB data while overlooking the clustering effect may produce misleading inferences and provide incorrect interpretations of the analytical results. Therefore, by taking the fertility slogan as well as clustering effects into account, this study endeavors to investigate the determinants of CEB among ever-married women in Bangladesh using clustered data from the BDHS 2014 and BDHS 2017-18. In the current study, analytical errors have been remedied through MLR modelling approach and incorporating the random effects in addition to the fixed effects via the generalized linear mixed model (GLMM) framework. This study also aims to compare the analytical results obtained from two latest consecutive BDHS surveys.

Materials and methods

Data and study design

We used clustered data to investigate the potential determinants of CEB in Bangladesh, derived from the latest country-wise representative BDHS 2017-18[18] and BDHS 2014[19]. The BDHS 2017-18 utilized a two-stage stratified sampling design in which each of the eight (seven in BDHS 2014) administrative divisions were treated as stratum. At the first stage, 675 (600 in BDHS 2014) enumeration areas (EAs) were chosen using the probability proportional to size (PPS) of EAs, where 250 (207 in BDHS 2014) and 425 (393 in BDHS 2014) EAs were selected from urban and rural regions, respectively. A complete listing of households was then prepared in all the chosen EAs and used as the sampling frame at the second stage. This stage of sampling was then conducted through a systematic sampling design which selected 30 households per EAs on average. Finally, the survey selected 20250 (18000 in BDHS 2014) households in total and 20100 (17893 in BDHS 2014) women of reproductive age group 15-49 years were interviewed. The detailed information about the survey data is available at https://dhsprogram.com/data/available-datasets.cfm.

Participants and variables included in the study

To investigate the potential determinants of CEB in Bangladesh, we considered 15924 (14119 in BDHS 2014) ever-married women of reproductive age 15-49 years after deleting missing cases in this study. The number of CEB among Bangladeshi women was considered as the binary response variable. More precisely, a binary indicator of CEB, coded as 0 = 1 to 2; and 1 = 3 or more children was used as the outcome variable. The various socio-economic, demographic and cultural attributes were considered as exposure variables such as women's age at first marriage, age at first birth, administrative division, type of place of residence, religion, household headship, education of women and their husband, husband's desire for more children, women's empowerment, use of contraceptive methods, wealth index, membership of non-government organizations (NGOs) and exposure to mass media.

For the purpose of analysis, the required information about these all variables was not found in a straightforward way from the current survey data. In this case, we combined associated variables in order to create new variables of interest such as exposure to media, NGO membership and women's empowerment. Those women were treated as empowered once they had the power to take a decision independently in at least one of these areas: visiting their own family members or relatives, buying major household goods, personal and children health care. A woman was also considered to have NGO membership if she had involvement with any of these organizations: Bangladesh Rural Advancement Committee (BRAC), Grameen Bank, Proshika, Association of Social Advancement (ASA), Bangladesh Rural Development Board (BRDB) or Mother Club. However, data on these variables were missing in the latest BDHS 2017-18. Women were considered to be exposed to mass-media if they watched television or listened to the radio or read magazines or newspapers at least once every week. The variable 'religion' measured the respondents' religious affiliation, and these were grouped into two categories (Muslim and non-Muslim). Those women were considered as Muslim, affiliated with Islam; and others (Hindu, Buddhist and Christian) were treated as non-Muslim.

Models

To model the binary responses of CEB clustered data used in this study, a start can be made with the logistic regression (LR) in the context of a generalized linear model (GLM) framework[20, 21]. However, a GLM has limitations in modelling clustered data as this cannot accommodate the correlation among subjects (women) because of its assumption of independence. In this case, the MLR in the context of the GLMMs set-up is a further extension by introducing random effects to the linear predictor of a GLM that models the possible correlation among subjects[22].

Let y_{ij} be the binary response and $\boldsymbol{x}_{ij}$, a $p \times 1$ vector of fixed covariates for j^{th} woman at i^{th} cluster (EA), where $j = 1,\ 2, \ldots, n_i$ and $i = 1,\ldots,k$. If $\boldsymbol{y}_i^T = (y_{i1},\ldots,y_{in_i})$is a vector of correlated responses from the i^{th} cluster then to analyze such correlated data, random effects can be added into the regression model to account for the correlation of the CEB data due to clustering. The MLR model, the most popular GLMM, is a common choice for analyzing the binary response data. In the GLMM framework, this model considers the *logit* link and the model specification can be written as

$$g(\mu_{ij}) = logit\ (\mu_{ij}) = log\left(\frac{\mu_{ij}}{1 - \mu_{ij}}\right) = \boldsymbol{x}_{ij}^T\boldsymbol{\beta} + u_i,$$

where g is the *logit* link function, $\mu_{ij} = E(y_{ij}|\ u_i)$ is the conditional expectation, u_i is the random effect for the i^{th} cluster and $\boldsymbol{\beta} = (\beta_1,\beta_2,\ldots,\beta_p)^T$ is the $p \times 1$ column vector of regression parameters. The random effect u_i is assumed to be normally distributed with zero mean and variance σ_u^2.

As the joint distributions of both the vector of responses and random effects are fully specified, we use the likelihood-based iterative weighted least squares (IWLS) estimation algorithm. Under this framework, our goal is to estimate whether $\boldsymbol{\beta}$ and σ_u^2, can be obtained by maximizing the likelihood function[22]

$$L(\boldsymbol{\beta},\sigma_u^2) = \int_{-\infty}^{\infty}\left\{\prod_{i=1}^{k}\prod_{j=1}^{n_i} f(y_{ij}|x_{ij},u_i)\right\}du_i.$$

The intra-cluster correlation coefficient (ρ) can be computed by using the variance component σ_u^2 as[23]

$$\rho = \frac{\sigma_u^2}{\sigma_u^2 + \frac{\pi^2}{3}}.$$

In addition, we conducted the likelihood-ratio test (LRT) for testing σ_u^2associated with random effects in a GLMM by using the chi-square(χ^2)test statistic[24].

AIC[25] is a commonly used criterion for the purpose of model selection, which is likelihood-based with asymptotic properties of the maximum likelihood estimator (MLE). The model for which AIC is minimum, is considered to be the best model for the data analysis and is given by

$$AIC = -2l(\hat{\boldsymbol{\beta}};D) + 2p,$$

where $l(\hat{\boldsymbol{\beta}};D)$ is the log-likelihood, $\hat{\boldsymbol{\beta}}$ is the vector of estimated model parameters, $D = (y_{ij},x_{ij})$ is the data set and p is the dimension of $\boldsymbol{\beta}$.The odds ratio (OR) is calculated for interpretation of

results by exponentiating the individual regression coefficient as $OR_l = e^{\hat{\beta}_l}$ where $\hat{\beta}_l; l = 1,...,p$ is the l^{th} estimated regression parameter.

Patient and public involvement

Patient and public involvement were not directly associated in this study. The secondary data from BDHS 2017-18 and BDHS 2014 were used (freely available online) where questionnaires of these surveys were based on the MEASURE DHS model questionnaires. The country representative surveys were conducted in eight administrative divisions of Bangladesh involving women of reproductive age group**.**

Results

Table 1 (right panel: BDHS 2017-18) shows that almost three quarters of women (74.9%) married before their legal recommended age of first marriage, which is at least 18 years, in Bangladesh. Most of the women (80.7%) had their first birth at 20 years or below. The survey participants were selected covering all eight administrative divisions or regions in Bangladesh. The division-wise percentages of women were 14.6%, 11.0%, 14.6%, 13.1%, 12.6%, 12.3%, 10.7% and 11.0% from Dhaka, Barisal, Chittagong, Khulna, Rajshahi, Rangpur, Sylhet, and Mymensingh, respectively. 63.8% of women were selected from rural and 36.2% from urban areas. The vast majority of participants were Muslim women (90.0%) while only 10.0% women were non-Muslim. The majority (88.2%) of women were living in male-headed households and only 11.8% women in female-headed households.

Table 1**:** Socio-economic, demographic and cultural variables of ever-married women along with frequency and percentage (%) distributions.

Variables	BDHS 2014 (n=14119)		BDHS 2017-18 (n=15924)	
	Number of women	Percentage (%)	Number of women	Percentage (%)
Age at first marriage				
<18	10859	76.9	11932	74.9
18 and above	3260	23.1	3992	25.1
Age at first birth				
≤20	11651	82.5	12851	80.7
>20	2468	17.5	3073	19.3
Division				
Dhaka	2448	17.3	2323	14.6
Barisal	1739	12.3	1752	11.0
Chittagong	2318	16.4	2328	14.6
Khulna	2015	14.3	2082	13.1
Rajshahi	2003	14.2	2013	12.6
Rangpur	1987	14.1	1961	12.3
Sylhet	1609	11.4	1711	10.7

Mymensingh	-	-	1754	11.0
Place of residence				
Rural	9364	66.3	10154	63.8
Urban	4755	33.7	5770	36.2
Religion				
Non Muslim	1325	9.4	1591	10.0
Muslim	12794	90.6	14333	90.0
Household headship				
Female	1310	9.3	1885	11.8
Male	12809	90.7	14039	88.2
Women education				
No education	3181	22.5	2381	15.0
Primary	4225	29.9	5150	32.3
Secondary	5442	38.5	6338	39.8
Higher	1271	9.0	2055	12.9
Husband education				
No education	3944	27.9	3415	21.4
Primary	3977	28.2	5104	32.1
Secondary	4086	28.9	4698	29.5
Higher	2112	15.0	2707	17.0
Husband desire more child				
No	12465	88.3	14020	88.0
Yes	1654	11.7	1904	12.0
Women empowerment				
No	10283	72.8	13349	83.8
Yes	3836	27.2	2575	16.2
Contraceptive use				
No	5138	36.4	5659	35.5
Yes	8981	63.6	10265	64.5
Wealth index				
Poor	5229	37.0	6087	38.2
Middle	2868	20.3	3103	19.5
Rich	6022	42.7	6734	42.3
Exposure of media				
Non-exposure	6626	46.9	7182	45.1
Exposure	7493	53.1	8742	54.9
NGO membership				
No	10459	74.1	-	-
Yes	3660	25.9	-	-

A significant percentage (15.0%) of the women who participated in the study were illiterate i.e., having no educational attainment, and only 12.9% of the women had higher education. Among the respondents, 32.3% and 39.8% of the women had primary and secondary level of education, respectively. In addition, 21.4% of their husbands were illiterate and 17.0% had higher education. The proportion of husbands having primary (32.1%) and secondary (29.5%) levels of education was almost the same. Of the total respondents, 12.0% of husbands desired more children and 88.0% had a negative attitude towards having more children. Table 1 also shows that most of the women were not empowered (83.8%) and only 16.2% women were found to be

empowered. Of all the respondents, 64.5% of women used contraceptive methods and 35.5% used no methods. The proportion of women from rich families was higher (42.3%) than poor (38.2%) and middle class (19.5%) families. More than fifty percent (54.9%) women had the mass-media exposure in Bangladesh. The data on NGO membership were not found in the BDHS 2017-18, although this variable was available in BDHS 2014. The majority of women were not involved with any NGO activities (74.1%) while the rest (25.9%) had an involvement with such activities (left panel: BDHS 2014).

Table 2 summarizes the frequency and percentage distributions for the number of CEB among Bangladeshi women of reproductive age 15-49 years. Among ever-married women of reproductive age in the latest BDHS 2017-18, 42.1% (43.3% in BDHS 2014) of women had three or more CEB in Bangladesh. It follows that 57.9% (56.7% in BDHS 2014) women of reproductive age met the criterion of the fertility slogan in Bangladesh 'Not more than two children, one is better'.

Table 2: Frequency and percentage distributions of children ever born (CEB) among women of their reproductive age group 15-49 years

	BDHS 2014			BDHS 2017-18		
	Women with CEB			Women with CEB		
Distribution	1 or 2	3 or more	Total	1 or 2	3 or more	Total
Frequency	8009	6110	14119	9223	6701	15924
Percentage (%)	56.7	43.3	100	57.9	42.1	100

The results obtained from bivariate analysis are summarized in Table 3. In the BDHS 2017-18, among ever-married women in the reproductive age group (15-49 years), 47.0% of whose first married before 18 years had 3 or more CEB and this figure was substantially smaller (27.5%) for women who married at 18 years or above. As expected that the proportion of women whose first marriages were before 18 years having 3 or more CEB than who married at 18 years or later. Age at first marriage of Bangladeshi women was significantly associated ($p<0.001$) with their higher frequency of CEB.

Table 3: Frequency (%) distribution of ever-married women by their children ever born (CEB) along with p-value of the chi-square (χ^2) test

Variables	BDHS 2014			BDHS 2017-18		
	n (%) by CEB		p-value	n (%) by CEB		p-value
	1 or 2	3 or more		1 or 2	3 or more	
Age at first marriage			<0.001			<0.001
<18	5707 (52.6)	5152 (47.4)		6329 (53.0)	5603 (47.0)	
18 and above	2302 (70.6)	958 (29.4)		2894 (72.5)	1098 (27.5)	
Age at first birth			<0.001			<0.001
≤20	6207 (53.3)	5444 (46.7)		6891 (53.6)	5960 (46.4)	
>20	1802 (73.0)	666 (27.0)		2332 (75.9)	741 (24.1)	
Division			<0.001			<0.001

Dhaka	1458 (59.6)	990 (40.4)		1459 (62.8)	864 (37.2)	
Barisal	921 (53.0)	818 (47.0)		955 (54.5)	797 (45.5)	
Chittagong	1179 (50.9)	1139 (49.1)		1198 (51.5)	1130 (48.5)	
Khulna	1276 (63.3)	739 (36.7)		1353 (65.0)	729 (35.0)	
Rajshahi	1268 (63.3)	735 (36.7)		1288 (64.0)	725 (36.0)	
Rangpur	1178 (59.3)	809 (40.7)		1174 (59.9)	787 (40.1)	
Sylhet	729 (45.3)	880 (54.7)		851 (49.7)	860 (50.3)	
Mymensingh	-	-		945 (53.9)	809 (46.1)	
Place of residence			<0.001			<0.001
Rural	4948 (52.8)	4416 (47.2)		5509 (54.3)	4645 (45.7)	
Urban	3061 (64.4)	1694 (35.6)		3714 (64.4)	2056 (35.6)	
Religion			<0.001			<0.001
Non-Muslim	872 (65.8)	453 (34.2)		1111 (69.8)	480 (30.2)	
Muslim	7137 (55.8)	5657 (44.2)		8112 (56.6)	6221 (43.4)	
Household headship			0.416			0.511
Female	757 (57.8)	553 (42.2)		1105 (58.6)	780 (41.4)	
Male	7252 (56.6)	5557 (43.4)		8118 (57.8)	5921 (42.2)	
Women Education			<0.001			<0.001
No education	893 (28.1)	2288 (71.9)		608 (25.5)	1773 (74.5)	
Primary	2032 (48.1)	2193 (51.9)		2337 (45.4)	2813 (54.6)	
Secondary	3954 (72.7)	1488 (27.3)		4487 (70.8)	1851 (29.2)	
Higher	1130 (88.9)	141 (11.1)		1791 (87.2)	264 (12.8)	
Husband education			<0.001			<0.001
No education	1515 (38.4)	2429 (61.6)		1224 (35.8)	2191 (64.2)	
Primary	2157 (54.2)	1820 (45.8)		2735 (53.6)	2369 (46.1)	
Secondary	2732 (66.9)	1354 (33.1)		3145 (66.9)	1553 (33.1)	
Higher	1605 (76.0)	507 (24.0)		2119 (78.3)	588 (21.7)	
Husband desire more child			<0.001			<0.001
No	7252 (58.2)	5213 (41.8)		8404 (59.9)	5616 (40.1)	
Yes	757 (45.8)	897 (54.2)		819 (43.0)	1085 (57.0)	
Women empowerment			<0.001			<0.001
No	5927 (57.6)	4356 (42.4)		7848 (58.8)	5501 (41.2)	
Yes	2082 (54.3)	1754 (45.7)		1375 (53.4)	1200 (46.6)	
Contraceptive use			<0.001			0.654
No	2786 (54.2)	2352 (45.8)		3291 (58.2)	2368 (41.8)	
Yes	5223 (58.2)	3758 (41.8)		5932 (57.8)	4333 (42.2)	
Wealth index			<0.001			<0.001
Poor	2527 (48.3)	2702 (51.7)		3060 (50.3)	3027 (49.7)	
Middle	1570 (54.7)	1298 (45.3)		1776 (57.2)	1327 (42.8)	
Rich	3912 (65.0)	2110 (35.0)		4387 (65.1)	2347 (34.9)	
Exposure of media			<0.001			<0.001
Non-exposure	3108 (46.9)	3518 (53.1)		3453 (48.1)	3729 (51.9)	
Exposure	4901 (65.4)	2592 (34.6)		5770 (66.0)	2972 (34.0)	
NGO membership			<0.001			
No	6167 (59.0)	4292 (41.0)		-	-	-
Yes	1842 (50.3)	1818 (49.7)				

Among total women of reproductive age, the proportion of women who had their first birth at 20 years or less having 3 or more children was higher (46.4%) than their counterparts (24.1%). Age at first birth of Bangladeshi women was found to be statistically significant ($p<0.001$) for their number of CEB. The regional variation among women was strongly associated ($p<0.001$) with their number of CEB in Bangladesh. The percentage of women having 3 or more CEB was the highest in Sylhet division and the corresponding value was to be the lowest in Khulna region. The percentage of women, among reproductive age groups, having 3 or more CEB was higher in rural areas (45.7%) compared to women from urban areas (35.6%). Type of place of residence ($p<0.001$) of women was also significantly associated with their frequency of CEB in

Bangladesh. From Table 3 (right panel: BDHS 2017-18), it can be seen that 43.4% of Muslim women aged 15-49 had 3 or more children, whereas the corresponding values were 30.2% for non-Muslim women. The religion of women ($p<0.001$) in Bangladesh was strongly associated with their number of CEB. The percentages of women having 3 or more children from male-headed (42.2%) and female-headed (41.4%) households are similar. The gender-based household headship was found to be statistically insignificant ($p=0.511$) for the number of CEB among Bangladeshi women.

The educational attainment of both women ($p<0.001$) and their husbands ($p<0.001$) was strongly associated with their number of CEB. The decreasing trend among women of having 3 or more CEB was observed with their own as well as their husbands' increasing levels of education. However, the proportion of women having 3 or more CEB was found to be higher among women whose husbands desired more children (57.0%) than their counterparts (40.1%). The intention of the husbands to have more children ($p<0.001$) was also significantly associated with the number of CEB among Bangladeshi women.

Women's empowerment ($p<0.001$) was strongly associated with their number of CEB. The percentage of reproductive women having 3 or more CEB was slightly higher among those who were empowered (46.6%) than who were not (41.2%). The proportion of women having 3 or more CEB was observed to lessen with the increasing levels of wealth index and this index of women ($p<0.001$) was strongly associated with their number of CEB in Bangladesh. Mass-media exposure of women was found to be statistically significant ($p<0.001$) for their frequency of CEB in Bangladesh. The women exposed to mass-media were found to be less likely to have 3 or more CEB than women who were not exposed.

In the BDHS 2017-18, the use of contraceptive methods was found to be statistically insignificant ($p=0.654$), though it was significant ($p<0.001$) in BDHS 2014, among women of reproductive age group 15-49 years. It is evident from the BDHS 2014, the percentage of women having 3 or more children was found to be higher among women with NGO membership than their counterparts. NGO membership of women was strongly associated ($p<0.001$) with their frequency of CEB.

To find potential determinants of higher number of CEB among Bangladeshi women, we used multivariate analysis, considering selected variables that were found to be statistically significant for the number of CEB in bivariate analysis (Table 3). We fitted both LR and MLR models in the context of GLMs and GLMMs framework, respectively. The results are

summarized including estimated variance component($\hat{\sigma}^2$), intra-cluster correlation(ρ), LRT and AIC values in Table 4.

Table 4: Model selection criterion (AIC) for logistic regression (LR) and mixed logistic regression (MLR), estimated variance component($\hat{\sigma}^2$), intra-cluster correlation (ρ)along with chi-square (χ^2) and p-values of the likelihood-ratio test (LRT).

Model	BDHS 2014					BDHS 2017-18				
	$\hat{\sigma}^2$	ρ	χ^2	p-value	AIC	$\hat{\sigma}^2$	ρ	χ^2	p-value	AIC
LR	-	-	-	-	16310.08	-	-	-	-	18220.85
MLR	0.12	0.04	64.02	<0.001	16248.06	0.12	0.03	61.72	<0.001	18157.13

It was observed that AIC values were substantially lower for MLR (BDHS 2017-18: AIC=18157.13, BDHS 2014: AIC=16248.06) than LR (BDHS 2017-18: AIC=18220.85, BDHS 2014: AIC=16310.08) model. In addition, the value of $\hat{\sigma}^2$ for the random effects associated with MLR was 0.12. The contribution of random effects in the MLR model was found to be statistically significant (p-value<0.001) for modelling CEB data among women in Bangladesh. More precisely, it follows that the between women's variability obtained from different clusters was strongly associated with the number of CEB among Bangladeshi women. It can also be seen that the intra-cluster correlation coefficient values were 0.03 (BDHS 2017-18) and 0.04 (BDHS 2014) for CEB clustered data of women aged 15-49 years. Thus, to analyse the factors that are associated with CEB for this clustered data, the MLR is the most appropriate modelling technique to be used compared to the LR.

The results obtained from multivariable analysis by fitting the MLR to CEB clustered data are summarized in Table 5. In the BDHS 2017-18, the women of reproductive age who married at their legal age 18 years or higher were less likely (OR=0.74, 95% CI: 0.666 to 0.825) to have 3 or more CEB than those who married below 18 years. Age at first marriage of women was strongly associated with their higher number of CEB (p=<0.001).

Table 5: Estimates (Est.), standard errors (SE), *p*-value and odds ratio (OR) along with 95% CI for OR obtained from fitting the mixed logistic regression (MLR) model to children ever born (CEB) clustered data in Bangladesh

Variable	BDHS 2014					BDHS 2017-18				
	Est.	SE	*P*-value	OR	95 % CI	Est.	SE	*P*-value	OR	95 % CI
Constant	0.555	0.110	<0.001	1.74	(1.403, 2.161)	0.881	0.110	<0.001	2.41	(1.946, 2.993)
Age at first marriage										
<18 (ref.)	-	-	-	-	-	-	-	-	-	-
18 and above	-0.303	0.057	<0.001	0.74	(0.661, 0.826)	-0.299	0.054	<0.001	0.74	(0.666, 0.825)
Age at first birth										
≤20 (ref.)	-	-	-	-	-	-	-	-	-	-
>20	-0.484	0.064	<0.001	0.62	(0.544, 0.698)	-0.616	0.060	<0.001	0.54	(0.480, 0.607)
Division										
Dhaka (ref.)	-	-	-	-	-	-	-	-	-	-
Barisal	0.425	0.092	<0.001	1.53	(1.278, 1.832)	0.404	0.093	<0.001	1.50	(1.248, 1.798)
Chittagong	0.53	0.084	<0.001	1.70	(1.442, 2.003)	0.624	0.085	<0.001	1.87	(1.579, 2.205)

Khulna	-0.154	0.088	0.078	0.86	(0.772, 1.018)	-0.045	0.088	0.61	0.96	(0.804, 1.137)
Rajshahi	-0.218	0.088	0.013	0.80	(0.678, 0.955)	-0.187	0.089	0.036	0.83	(0.696, 0.988)
Rangpur	-0.044	0.089	0.622	0.96	(0.804, 1.139)	0.108	0.091	0.236	1.11	(0.932, 1.333)
Sylhet	0.547	0.093	<0.001	1.73	(1.440, 2.075)	0.548	0.093	<0.001	1.73	(1.441, 2.077)
Mymensingh	-	-	-	-	-	0.273	0.093	0.003	1.31	(1.096, 1.576)
Place of residence										
Rural (ref.)	-	-	-	-	-	-	-	-	-	-
Urban	-0.275	0.056	<0.001	0.76	(0.681, 0.848)	-0.238	0.052	<0.001	0.79	(0.712, 0.872)
Religion										
Non Muslim (ref.)	-	-	-	-	-	-	-	-	-	-
Muslim	0.332	0.077	<0.001	1.39	(1.199, 1.620)	0.385	0.072	<0.001	1.47	(1.277, 1.690)
Women education										
No education (ref.)	-	-	-	-	-	-	-	-	-	-
Primary	-0.896	0.055	<0.001	0.41	(0.366, 0.455)	-0.840	0.059	<0.001	0.43	(0.384, 0.485)
Secondary	-1.962	0.063	<0.001	0.14	(0.124, 0.159)	-1.854	0.064	<0.001	0.16	(0.138, 0.178)
Higher	-2.907	0.121	<0.001	0.05	(0.043, 0.069)	-2.610	0.102	<0.001	0.07	(0.060, 0.090)
Husband education										
No education (ref.)	-	-	-	-	-	-	-	-	-	-
Primary	-0.265	0.053	<0.001	0.77	(0.692, 0.852)	-0.364	0.052	<0.001	0.70	(0.628, 0.769)
Secondary	-0.346	0.060	<0.001	0.71	(0.629, 0.795)	-0.603	0.058	<0.001	0.55	(0.488, 0.613)
Higher	0.078	0.085	0.356	1.08	(0.916, 1.277)	-0.379	0.080	<0.001	0.68	(0.585, 0.800)
Husband desire more child										
No (ref.)	-	-	-	-	-	-	-	-	-	-
Yes	0.377	0.061	<0.001	1.46	(1.295, 1.641)	0.468	0.057	<0.001	1.60	(1.428, 1.784)
Women empowerment										
No (ref.)	-	-	-	-	-	-	-	-	-	-
Yes	0.215	0.045	<0.001	1.24	(1.136, 1.353)	0.171	0.050	<0.001	1.19	(1.075, 1.310)
Wealth index										
Poor (ref.)	-	-	-	-	-	-	-	-	-	-
Middle	0.281	0.057	<0.001	1.32	(1.184, 1.481)	0.224	0.054	<0.001	1.25	(1.125, 1.392)
Rich	0.444	0.063	<0.001	1.56	(1.379, 1.764)	0.473	0.057	<0.001	1.61	(1.435, 1.796)
Exposure of media										
Non exposure (ref.)	-	-	-	-	-	-	-	-	-	-
Exposure	-0.268	0.049	<0.001	0.77	(0.695, 0.842)	-0.349	0.044	<0.001	0.71	(0.647, 0.768)
NGO membership										
No (ref.)	-	-	-	-	-	-	-	-	-	-
Yes	0.310	0.046	<0.001	1.36	(1.247, 1.492)					
Contraceptive use										
No (ref.)	-	-	-	-	-	-	-	-	-	-
Yes	0.083	0.042	0.046	1.09	(1.001, 1.179)	-	-	-	-	-

Note: OR=1 for the reference category

Age at first birth of women (p<0.001) was found to be highly significant in relation to having a higher number of CEB. Women who had their first child above 20 years were also less likely (OR=0.54, 95% CI: 0.480 to 0.607) to have 3 or more CEB than their counterparts (BDHS 2017-18). It can be observed that women aged 15-49 years from Barisal (p<0.001, OR=1.50, 95% CI: 1.248 to 1.798), Chittagong (p<0.001, OR=1.87, 95% CI: 1.579 to 2.205), Sylhet (p<0.001, OR=1.73, 95% CI: 1.441 to 2.077) and Mymensingh (p=0.003, OR=1.31, 95% CI: 1.096 to 1.576) were statistically highly significant and more likely to have 3 or more CEB than those from Dhaka division. The women from urban areas were less likely (OR=0.79, 95% CI: 0.712 to 0.872) to have 3 or higher CEB than rural women. The place of residence was found to be statistically significant (p<0.001) among women of their reproductive age group in relation to whether they had 3 or more CEB.

As expected, the religious status of women in Bangladesh was strongly associated (p<0.001) with their number of CEB. More precisely, the Muslim women were 1.47 (OR=1.47, 95% CI: 1.277 to 1.690) times more likely to have 3 or more CEB than non-Muslim women. The educational status among women aged 15-49 years (p<0.001) also showed significant effects on the number of CEB in Bangladesh. The proportions were 57%, 84%, and 93% less likely to have 3 or more CEB for mothers who had primary (OR=0.43, 95% CI: 0.384 to 0.485), secondary (OR=0.16, 95% CI: 0.138 to 0.178) or higher (OR=0.07, 95% CI: 0.060 to 0.090) education, respectively in comparison to mothers with no educational attainment. In the BDHS 2017-18, it can be seen that the increasing levels of education of husbands were also less likely to have 3 or more CEB than those women with an illiterate husband. However, the higher educational attainment of husband was found to be statistically insignificant (p=0.356) in the BDHS 2014.

Furthermore, women whose husbands wanted more children (p<0.001, OR=1.60, 95% CI: 1.428 to 1.784) were more likely to have 3 or more CEB than their counterparts. We also observed from Table 5 that the women's empowerment (p<0.001) was strongly associated with their number of CEB in Bangladesh. However, it is surprising that the empowered women (OR=1.19, 95% CI: 1.075 to 1.310) were 1.19 times more likely to have higher CEB than those who were not empowered. It may happen because of the religious beliefs among Muslim women in Bangladesh. Wealth index of women (p<0.001) was strongly associated with their number of CEB in Bangladesh.

Mass-media exposure (p<0.001) among reproductive women was strongly associated with their number of CEB. It was observed that the proportion of having 3 or more CEB among women who were exposed to media was 29% (OR=0.71, 95% CI: 0.647 to 0.768) lower compared to their counterparts. In addition, the variables: NGO membership (p<0.001) and use of contraceptive methods (p=0.046) were found to be statistically significant in the multivariable analysis for the BDHS 2014 data.

Discussion and conclusion

This study attempted to estimate the number of CEB and to find out its potential determinants among ever-married women using the mixed logistic regression (MLR) model taking into account the clustering effects and keeping in mind the fertility slogan 'Whether it is a boy or girl, two children are enough' in Bangladesh. We used the latest clustered CEB data extracted from the BDHS 2014 and BDHS 2017-18.

Our study findings revealed that among women of reproductive age group 15-49 years, the proportion of 3 or more CEB was 42.1%. Age at first marriage, age at first birth, administrative division, place of residence, religion, educational status of women and their husbands were the potential determinants of CEB among ever-married women. Moreover, the intention of having more children measured by husband, wealth index, mass-media exposure and women's empowerment among Bangladeshi women of reproductive age were also found to be significantly associated with their number of CEB[1, 5, 6, 11, 15]. However, the use of contraceptive methods was not found to be significant in the current study though previous studies had found it to be important[9, 10, 26].

More precisely, age at first marriage and first birth, women and their husbands' educational status and place of residence had negative effects, while religion, husband desires more child, wealth index and women's empowerment had a positive effect on their number of CEB. The educated women[6] who married at 18 years or above, had their first child after 20 years, those living in urban areas, or exposed to mass-media were less likely to have higher frequency of CEB. The number of children among women was negatively related to their levels of education[7, 13, 27] and similar scenarios were also observed in our study. One reason may be that educated women are more conscious about their pregnancy, may reject under-age marriages, and can consider the effective use of contraception. However, Muslim women were more likely to have more children because of their religious beliefs.

Based on the study findings, we recommend that effective programs should be devised, focusing on creating awareness among illiterate Muslim women who often bound or forced to be married and had their first child at an early age, so that they would be more conscious about their higher frequency of CEB and the consequences of life-threatening pregnancy complications. These programs would need to be the subject of further research. Effective programs in Bangladesh should control the number of CEB and to reduce infant and maternal morbidity as well as mortality.

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Author Contributions

AR, ZH and EK conceptualized the idea and designed the study, AR and ZH analysed the data and wrote the draft manuscript; MLR and EK provided intellectual comments and jointly contributed in revising the manuscript with AR and ZH. All authors approved the final version of the manuscript.

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No conflict of interest exits among the authors.

Patient and public involvement

Patient consent for publication

Not applicable.

Availability of Data

We used secondary data from the Demographic and Health Surveys (DHS) Program. The data are available online at https://dhsprogram.com/data/available-datasets.cfm.

Ethics statement

This article does not include any data of human participants conducted by any of the authors. The Bangladesh Demographic and Health Survey (BDHS) was approved by ICF Macro Institutional Review Board and the National Research Ethics Committee of the Bangladesh Medical Research Council. Written consent was given by participants in relation to this survey before the interview. All identification of the survey participants was disidentified before publishing the data. In this study, we used the secondary data that are freely available on the DHS website: https://dhsprogram.com/data/available-datasets.cfm.

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Determinants of children ever born among ever-married women in Bangladesh: evidence from the Demographic and Health Survey 2017-18

Atikur Rahman[1], Zakir Hossain[2*], M Lutfor Rahman[3], Enamul Kabir[4]

1. Department of Statistics, Jahangirnagar University, Savar, Dhaka, Bangladesh
E-mail: arahman@juniv.edu
2. Department of Statistics, University of Dhaka, Dhaka, Bangladesh
*Corresponding author's E-mail: zakir.hossain@du.ac.bd
3. Institute of Statistical Research and Training, University of Dhaka, Dhaka, Bangladesh
E-mail: lutfor@isrt.ac.bd
4. School of Sciences, University of Southern Queensland, Toowoomba, Australia
E-mail: Enamul.Kabir@usq.edu.au

Abstract

Objective: To investigate the prevalence of the number of children ever born (CEB) and its associated determinants among women aged 15-49 years in Bangladesh.

Study design and setting: We used clustered data extracted from the last two Bangladesh Demographic and Health Surveys (BDHS 2014 and BDHS 2017-18). A two-stage stratified sampling was used in both surveys. Mixed logistic regression modelling approach for binary responses was adapted to accommodate clustering effects via the generalized linear mixed model framework.

Participants: The study is based on 15924 ever-married women in BDHS 2017-18 (14119 in BDHS 2014) of Bangladesh.

Results: As per the latest BDHS 2017-18, 42.1% of reproductive women had 3 or more children. Age at first marriage ($p<0.001$, OR=0.74, 95% CI: 0.666-0.825), age at first birth ($p<0.001$, OR=0.54, 95% CI: 0.480-0.607), place of residence ($p<0.001$, OR=0.79, 95% CI: 0.712-0.872), exposure of media ($p<0.001$, OR=0.71, 95% CI: 0.647-0.768), religion ($p<0.001$, OR=1.47, 95% CI: 1.277-1.690), husband's desire more child ($p<0.001$, OR=1.60, 95% CI: 1.428-1.784), women empowerment ($p<0.001$, OR=1.19, 95% CI: 1.075-1.3) and wealth index ($p<0.001$, OR=1.61, 95% CI:0.435-1.796) were found to be statistically significant determinants of the number of CEB among ever-married women. The number of CEB among women was negatively associated with their own educational status ($p<0.001$) and husbands level of education ($p<0.001$).

Conclusion: The CEB appears to be higher among women who were married before 18 years, Muslim, illiterate, living in rural areas, had first birth before 20 years, non-exposure of media, and husband's desire for more children.

Keywords: Children ever born, Ever-married women, Clustered data, Random effects, GLMM, BDHS.

Strengths and limitations of this study:

- Clustering effects were considered through a mixed modelling approach to avoid misleading inferences and hence for valid interpretation of the results.
- Analysing the two most recent nationally representative data sets assisted to give a wide comparative picture of society in Bangladesh and provided significant determinants of children ever born among ever-married women.
- Due to the use of secondary datasets, we were limited in case of our freedom to choose exposure variables for the statistical analysis.

Introduction

The number of children ever born (CEB) is defined to be the number of live births among ever-married women aged 15-49 years in Bangladesh[1]. The CEB is one of the important determinants of population dynamics, as it decides the size, structure and composition of the population in any country of the world. It is not only responsible for population growth but is also the key factor in determining the changes in the age composition of the population[2, 3].

The frequency of CEB among women is a measure of childbearing experience throughout their lives. It was reported that the childbearing decisions of women were mainly influenced by their education and urbanization[4]. It was also noted that the mother's age group, place of residence, administrative division and mass-media exposure were found to be significantly associated with the number of children among ever-married women[5]. The women who completed their secondary or higher levels of education were less likely to have more children than others[4, 6, 7]. Also, age at marriage and wealth index of Bangladeshi women both had a significant negative effect on their number of CEB[8]. Contraceptive usage among Bangladeshi women also played a more important role in reducing fertility trends than other proximate determinants[9, 10]. The key responsible factors for childbearing among women in Bangladesh were their employment status as well as food security[11]. There was a son preference among women who had only daughters, so they were more likely to have a higher number of CEB compared with those women having sons already[12].

The number of children among women in Bangladesh increased with their age but it declined with their own and husbands' increasing levels of education and wealth index[1, 13, 14]. Delayed marriage, usage of contraceptive methods, induced abortion and successive birth intervals were potential demographic determinants for the lower birth rates[15]. It was reported that women's age at first birth, use of contraceptive methods, education of both women and their husband, religion and wealth index were significantly associated with their number of CEB[16].

The total population of Bangladesh is projected to be 192.78 million in 2053[17], which sounds alarming for the government to ensure the basic needs, such as food, clothing, shelter, education and health care. Therefore, the relevant authorities have been examining ways to control the population growth rate since 2012. In this context, the government has attempted to control the number of live births by advertising the fertility slogan 'No more than two children, better if one', which was further modified in 2019 to 'Whether it is a boy or girl, two children are enough' among ever-married women in Bangladesh[18].

Geographical clusters are there in Bangladesh Demographic and Health Surveys (BDHS) 2014 and 2017-18. In the data, women are in clusters which result in possible correlation among subjects, i.e. correlated responses occurred due to clustering. The clustering effect has been completely overlooked in previous studies for analyzing CEB data among Bangladeshi ever-married women[1, 16]. Analyzing CEB data while overlooking the clustering effect may produce misleading inferences and provide incorrect interpretations of the analytical results. Therefore, by taking the fertility slogan as well as clustering effects into account, this study endeavors to investigate the determinants of CEB among ever-married women in Bangladesh using clustered data from the BDHS 2014 and BDHS 2017-18. In the current study, analytical errors have been remedied through the mixed logistic regression (MLR) modelling approach and incorporating the random effects in addition to the fixed effects via the generalized linear mixed model (GLMM) framework. This study also aims to compare the analytical results obtained from two latest consecutive BDHS surveys.

Materials and methods

Data and study design

We used clustered data to investigate the potential determinants of CEB in Bangladesh, derived from the latest country-wise representative BDHS 2017-18[**Error! Reference source not found.**] and BDHS 2014[0]. The BDHS 2017-18 utilized a two-stage stratified sampling design in which each of the eight (seven in BDHS 2014) administrative divisions were treated as stratum. At the first stage, 675 (600 in BDHS 2014) enumeration areas (EAs) were chosen using the probability proportional to size (PPS) of EAs, where 250 (207 in BDHS 2014) and 425 (393 in BDHS 2014) EAs were selected from urban and rural regions, respectively. A complete listing of households was then prepared in all the chosen EAs and used as the sampling frame at the second stage. This stage of sampling was then conducted through a systematic sampling design which selected 30 households per EAs on average. Finally, the survey selected 20250 (18000 in BDHS 2014) households in total and 20100 (17893 in BDHS 2014) women of reproductive age group 15-49

years were interviewed. The detailed information about the survey data is available at https://dhsprogram.com/data/available-datasets.cfm.

Participants and variables included in the study

To investigate the potential determinants of CEB in Bangladesh, we considered 15924 (14119 in BDHS 2014) ever-married women of reproductive age 15-49 years after deleting missing cases in this study. The study also excludes women who are at zero parity following the fertility slogan 'No more than two children, better if one' in Bangladesh. The number of CEB among Bangladeshi women was considered as the binary response variable. More precisely, a binary indicator of CEB, coded as 0 = 1 to 2; and 1 = 3 or more children was used as the outcome variable. The various socio-economic and demographic attributes were considered as exposure variables such as women's age at first marriage, age at first birth, administrative division, type of place of residence, religion, household headship, education of women and their husband, husband's desire for more children, women's empowerment, use of contraceptive methods, wealth index, membership of non-government organizations (NGOs) and exposure to mass media.

For the purpose of analysis, the required information about these variables was not found in a straightforward way from the current survey data. In this case, we combined associated variables in order to create new variables of interest such as exposure to media, NGO membership and women's empowerment. Women empowerment is constructed if a woman reported making a decision on her own on any of the three conditions: visiting their family members or relatives, buying major household goods, personal and children health care. A woman was also considered to have NGO membership if she had involvement with any of these organizations: Bangladesh Rural Advancement Committee (BRAC), Grameen Bank, Proshika, Association of Social Advancement (ASA), Bangladesh Rural Development Board (BRDB) or Mother Club. However, data on these variables were missing in the latest BDHS 2017-18 data because the NGO activities are significantly reducing in Bangladesh. One reason could be that the government provides more facilities than NGOs. Women were considered to be exposed to mass-media if they watched television or listened to the radio or read magazines or newspapers at least once every week. The variable 'religion' measured the respondents' religious affiliation, and these were grouped into two categories (Muslim and non-Muslim). Those women were considered as Muslim, affiliated with Islam; and others (Hindu, Buddhist and Christian) were treated as non-Muslim.

Models

To model the binary responses of CEB clustered data used in this study, a start can be made with the logistic regression (LR) in the context of a generalized linear model (GLM) framework[0, 22]. However, a GLM has limitations in modelling clustered data as this cannot accommodate the correlation among subjects (women) because of its assumption of independence. In this case, the MLR in the context of the GLMMs set-up is a further extension by introducing random effects to the linear predictor of a GLM that models the possible correlation among subjects[23].

Let y_{ij} be the binary response and $\boldsymbol{x}_{ij}$, a $p \times 1$ vector of fixed covariates for j^{th} woman at i^{th} cluster (EA), where $j = 1, 2, ..., n_i$ and $i = 1,...,k$. If $\boldsymbol{y}_i^T = (y_{i1},... ,y_{in_i})$is a vector of correlated responses from the i^{th} cluster then to analyze such correlated data, random effects can be added into the regression model to account for the correlation of the CEB data due to clustering. The MLR model, the most popular GLMM, is a common choice for analyzing the binary response data. In the GLMM framework, this model considers the *logit* link and the model specification can be written as

$$g(\mu_{ij}) = logit\,(\mu_{ij}) = log\left(\frac{\mu_{ij}}{1 - \mu_{ij}}\right) = \boldsymbol{x}_{ij}^T\boldsymbol{\beta} + u_i,$$

where g is the *logit* link function, $\mu_{ij} = E(y_{ij}|\, u_i)$ is the conditional expectation, u_i is the random effect for the i^{th} cluster and $\boldsymbol{\beta} = (\beta_1,\beta_2,... ,\beta_p)^T$ is the $p \times 1$ column vector of regression parameters. The random effect u_i is assumed to be normally distributed with zero mean and variance σ_u^2.

As the joint distributions of both the vector of responses and random effects are fully specified, we use the likelihood-based iterative weighted least squares (IWLS) estimation algorithm. Under this framework, our goal is to estimate whether $\boldsymbol{\beta}$ and σ_u^2, can be obtained by maximizing the likelihood function[23]

$$L(\boldsymbol{\beta},\sigma_u^2) = \int_{-\infty}^{\infty}\left\{\prod_{i=1}^{k}\prod_{j=1}^{n_i} f(y_{ij}|x_{ij},u_i)\right\}du_i.$$

The intra-cluster correlation coefficient (ρ) can be computed by using the variance component σ_u^2 as[24]

$$\rho = \frac{\sigma_u^2}{\sigma_u^2 + \frac{\pi^2}{3}}.$$

In addition, we conducted the likelihood-ratio test (LRT) for testing σ_u^2 associated with random effects in a GLMM by using the chi-square (χ^2) test statistic[25].

AIC[26] is a commonly used criterion for the purpose of model selection, which is likelihood-based with asymptotic properties of the maximum likelihood estimator (MLE). The model for which AIC is minimum, is considered to be the best model for the data analysis and is given by

$$AIC = -2l(\hat{\boldsymbol{\beta}};D) + 2p,$$

where $l(\hat{\boldsymbol{\beta}};D)$ is the log-likelihood, $\hat{\boldsymbol{\beta}}$ is the vector of estimated model parameters, $D = (y_{ij},x_{ij})$ is the data set and p is the dimension of $\boldsymbol{\beta}$.The odds ratio (OR) is calculated for interpretation of results by exponentiating the individual regression coefficient as $OR_l = e^{\hat{\beta}_l}$ where $\hat{\beta}_l; l = 1,...,p$ is the l^{th} estimated regression parameter.

Patient and public involvement

Patient and public involvement were not directly associated in this study. The secondary data from BDHS 2017-18 and BDHS 2014 were used (freely available online) where questionnaires of these surveys were based on the MEASURE DHS model questionnaires. The country representative surveys were conducted in eight administrative divisions of Bangladesh involving women of reproductive age group**.**

Results

Table 1 (right panel: BDHS 2017-18) shows that almost three quarters of women (74.9%) married before their legal recommended age of first marriage, which is at least 18 years, in Bangladesh. Most of the women (80.7%) had their first birth at 20 years or below. The survey participants were selected covering all eight administrative divisions or regions in Bangladesh. The division-wise percentages of women were 14.6%, 11.0%, 14.6%, 13.1%, 12.6%, 12.3%, 10.7% and 11.0% from Dhaka, Barisal, Chittagong, Khulna, Rajshahi, Rangpur, Sylhet, and Mymensingh, respectively. 63.8% of women were selected from rural and 36.2% from urban areas. The vast majority of participants were Muslim women (90.0%) while only 10.0% women were non-Muslim. The majority (88.2%) of women were living in male-headed households and only 11.8% women in female-headed households.

Table 1**:** Socio-economic, demographic and cultural variables of ever-married women along with frequency and percentage (%) distributions.

Variables	BDHS 2014 (n=14119)		BDHS 2017-18 (n=15924)	
	Number of women	Percentage (%)	Number of women	Percentage (%)
Age at first marriage				

<18	10859	76.9	11932	74.9
18 and above	3260	23.1	3992	25.1
Age at first birth				
≤20	11651	82.5	12851	80.7
>20	2468	17.5	3073	19.3
Division				
Dhaka	2448	17.3	2323	14.6
Barisal	1739	12.3	1752	11.0
Chittagong	2318	16.4	2328	14.6
Khulna	2015	14.3	2082	13.1
Rajshahi	2003	14.2	2013	12.6
Rangpur	1987	14.1	1961	12.3
Sylhet	1609	11.4	1711	10.7
Mymensingh	-	-	1754	11.0
Place of residence				
Rural	9364	66.3	10154	63.8
Urban	4755	33.7	5770	36.2
Religion				
Non Muslim	1325	9.4	1591	10.0
Muslim	12794	90.6	14333	90.0
Household headship				
Female	1310	9.3	1885	11.8
Male	12809	90.7	14039	88.2
Women education				
No education	3181	22.5	2381	15.0
Primary	4225	29.9	5150	32.3
Secondary	5442	38.5	6338	39.8
Higher	1271	9.0	2055	12.9
Husband education				
No education	3944	27.9	3415	21.4
Primary	3977	28.2	5104	32.1
Secondary	4086	28.9	4698	29.5
Higher	2112	15.0	2707	17.0
Husband desire more child				
No	12465	88.3	14020	88.0
Yes	1654	11.7	1904	12.0
Women empowerment				
No	10283	72.8	13349	83.8
Yes	3836	27.2	2575	16.2
Contraceptive use				
No	5138	36.4	5659	35.5
Yes	8981	63.6	10265	64.5
Wealth index				
Poor	5229	37.0	6087	38.2
Middle	2868	20.3	3103	19.5
Rich	6022	42.7	6734	42.3
Exposure of media				
Non-exposure	6626	46.9	7182	45.1
Exposure	7493	53.1	8742	54.9
NGO membership				
No	10459	74.1	-	-
Yes	3660	25.9	-	-

A significant percentage (15.0%) of the women who participated in the study were illiterate i.e., having no educational attainment, and only 12.9% of the women had higher education. Among the respondents, 32.3% and 39.8% of the women had primary and secondary levels of education, respectively. In addition, 21.4% of their husbands were illiterate and 17.0% had higher education. The proportion of husbands having primary (32.1%) and secondary (29.5%) levels of education was almost the same. It is observed that 88% men do not desire to have more children or do not support or want more children. Table 1 also shows that most of the women were not empowered (83.8%) and only 16.2% women were found to be empowered. Of all the respondents, 64.5% of women used contraceptive methods and 35.5% used no methods. The proportion of women from rich families was higher (42.3%) than poor (38.2%) and middle class (19.5%) families. More than fifty percent (54.9%) women had the mass-media exposure in Bangladesh. The data on NGO membership were not found in the BDHS 2017-18, although this variable was available in BDHS 2014. The majority of women were not involved with any NGO activities (74.1%) while the rest (25.9%) had an involvement with such activities (left panel: BDHS 2014).

Table 2 summarizes the frequency and percentage distributions for the number of CEB among Bangladeshi women of reproductive age 15-49 years. Among ever-married women of reproductive age in the latest BDHS 2017-18, 42.1% (43.3% in BDHS 2014) of women had three or more CEB in Bangladesh. It follows that 57.9% (56.7% in BDHS 2014) women of reproductive age met the criterion of the fertility slogan in Bangladesh 'Not more than two children, one is better'.

Table 2: Frequency and percentage distributions of children ever born (CEB) among women of their reproductive age group 15-49 years

	BDHS 2014			BDHS 2017-18		
	Women with CEB			Women with CEB		
Distribution	1 or 2	3 or more	Total	1 or 2	3 or more	Total
Frequency	8009	6110	14119	9223	6701	15924
Percentage (%)	56.7	43.3	100	57.9	42.1	100

The results obtained from bivariate analysis are summarized in Table 3. In the BDHS 2017-18, among ever-married women in the reproductive age group (15-49 years), 47.0% of whose first married before 18 years had 3 or more CEB and this figure was substantially smaller (27.5%) for women who married at 18 years or above. As expected that the proportion of women whose first marriages were before 18 years having 3 or more CEB than who married at 18 years or later. Age at first marriage of Bangladeshi women was significantly associated ($p<0.001$) with their higher frequency of CEB.

Table 3: Frequency (%) distribution of ever-married women by their children ever born (CEB) along with p-value of the chi-square (χ^2) test

Variables	BDHS 2014			BDHS 2017-18		
	n (%) by CEB		p-value	n (%) by CEB		p-value
	1 or 2	3 or more		1 or 2	3 or more	
Age at first marriage			<0.001			<0.001
<18	5707 (52.6)	5152 (47.4)		6329 (53.0)	5603 (47.0)	
18 and above	2302 (70.6)	958 (29.4)		2894 (72.5)	1098 (27.5)	
Age at first birth			<0.001			<0.001
≤20	6207 (53.3)	5444 (46.7)		6891 (53.6)	5960 (46.4)	
>20	1802 (73.0)	666 (27.0)		2332 (75.9)	741 (24.1)	
Division			<0.001			<0.001
Dhaka	1458 (59.6)	990 (40.4)		1459 (62.8)	864 (37.2)	
Barisal	921 (53.0)	818 (47.0)		955 (54.5)	797 (45.5)	
Chittagong	1179 (50.9)	1139 (49.1)		1198 (51.5)	1130 (48.5)	
Khulna	1276 (63.3)	739 (36.7)		1353 (65.0)	729 (35.0)	
Rajshahi	1268 (63.3)	735 (36.7)		1288 (64.0)	725 (36.0)	
Rangpur	1178 (59.3)	809 (40.7)		1174 (59.9)	787 (40.1)	
Sylhet	729 (45.3)	880 (54.7)		851 (49.7)	860 (50.3)	
Mymensingh	-	-		945 (53.9)	809 (46.1)	
Place of residence			<0.001			<0.001
Rural	4948 (52.8)	4416 (47.2)		5509 (54.3)	4645 (45.7)	
Urban	3061 (64.4)	1694 (35.6)		3714 (64.4)	2056 (35.6)	
Religion			<0.001			<0.001
Non-Muslim	872 (65.8)	453 (34.2)		1111 (69.8)	480 (30.2)	
Muslim	7137 (55.8)	5657 (44.2)		8112 (56.6)	6221 (43.4)	
Household headship			0.416			0.511
Female	757 (57.8)	553 (42.2)		1105 (58.6)	780 (41.4)	
Male	7252 (56.6)	5557 (43.4)		8118 (57.8)	5921 (42.2)	
Women Education			<0.001			<0.001
No education	893 (28.1)	2288 (71.9)		608 (25.5)	1773 (74.5)	
Primary	2032 (48.1)	2193 (51.9)		2337 (45.4)	2813 (54.6)	
Secondary	3954 (72.7)	1488 (27.3)		4487 (70.8)	1851 (29.2)	
Higher	1130 (88.9)	141 (11.1)		1791 (87.2)	264 (12.8)	
Husband education			<0.001			<0.001
No education	1515 (38.4)	2429 (61.6)		1224 (35.8)	2191 (64.2)	
Primary	2157 (54.2)	1820 (45.8)		2735 (53.6)	2369 (46.1)	
Secondary	2732 (66.9)	1354 (33.1)		3145 (66.9)	1553 (33.1)	
Higher	1605 (76.0)	507 (24.0)		2119 (78.3)	588 (21.7)	
Husband desire more child			<0.001			<0.001
No	7252 (58.2)	5213 (41.8)		8404 (59.9)	5616 (40.1)	
Yes	757 (45.8)	897 (54.2)		819 (43.0)	1085 (57.0)	
Women empowerment			<0.001			<0.001
No	5927 (57.6)	4356 (42.4)		7848 (58.8)	5501 (41.2)	
Yes	2082 (54.3)	1754 (45.7)		1375 (53.4)	1200 (46.6)	
Contraceptive use			<0.001			0.654
No	2786 (54.2)	2352 (45.8)		3291 (58.2)	2368 (41.8)	
Yes	5223 (58.2)	3758 (41.8)		5932 (57.8)	4333 (42.2)	
Wealth index			<0.001			<0.001
Poor	2527 (48.3)	2702 (51.7)		3060 (50.3)	3027 (49.7)	
Middle	1570 (54.7)	1298 (45.3)		1776 (57.2)	1327 (42.8)	
Rich	3912 (65.0)	2110 (35.0)		4387 (65.1)	2347 (34.9)	
Exposure of media			<0.001			<0.001
Non-exposure	3108 (46.9)	3518 (53.1)		3453 (48.1)	3729 (51.9)	
Exposure	4901 (65.4)	2592 (34.6)		5770 (66.0)	2972 (34.0)	
NGO membership			<0.001			
No	6167 (59.0)	4292 (41.0)		-	-	-
Yes	1842 (50.3)	1818 (49.7)				

Among total women of reproductive age, the proportion of women who had their first birth at 20 years or less having 3 or more children was higher (46.4%) than their counterparts (24.1%). Age at first birth of Bangladeshi women was found to be statistically significant (p<0.001) for their number of CEB. The regional variation among women was strongly associated (p<0.001) with their number of CEB in Bangladesh. The percentage of women having 3 or more CEB was the highest in Sylhet division and the corresponding value was to be the lowest in Khulna region. The percentage of women, among reproductive age groups, having 3 or more CEB was higher in rural areas (45.7%) compared to women from urban areas (35.6%). Type of place of residence (p<0.001) of women was also significantly associated with their frequency of CEB in Bangladesh. From Table 3 (right panel: BDHS 2017-18), it can be seen that 43.4% of Muslim women aged 15-49 had 3 or more children, whereas the corresponding values were 30.2% for non-Muslim women. The religion of women (p<0.001) in Bangladesh was strongly associated with their number of CEB. The percentages of women having 3 or more children from male-headed (42.2%) and female-headed (41.4%) households are similar. The gender-based household headship was found to be statistically insignificant (p=0.511) for the number of CEB among Bangladeshi women.

The educational attainment of both women (p<0.001) and their husbands (p<0.001) was strongly associated with their number of CEB. The decreasing trend among women of having 3 or more CEB was observed with their own as well as their husbands' increasing levels of education. However, the proportion of women having 3 or more CEB was found to be higher among women whose husbands desired more children (57.0%) than their counterparts (40.1%). The intention of the husbands to have more children (p<0.001) was also significantly associated with the number of CEB among Bangladeshi women.

Women's empowerment (p<0.001) was strongly associated with their number of CEB. The percentage of reproductive women having 3 or more CEB was slightly higher among those who were empowered (46.6%) than who were not (41.2%). The proportion of women having 3 or more CEB was observed to lessen with the increasing levels of wealth index and this index of women (p<0.001) was strongly associated with their number of CEB in Bangladesh. Mass-media exposure of women was found to be statistically significant (p<0.001) for their frequency of CEB in Bangladesh. The women exposed to mass-media were found to be less likely to have 3 or more CEB than women who were not exposed.

In the BDHS 2017-18, the use of contraceptive methods was found to be statistically insignificant (p=0.654), though it was significant (p<0.001) in BDHS 2014, among women of reproductive age group 15-49 years. It is evident from the BDHS 2014, the percentage of women

having 3 or more children was found to be higher among women with NGO membership than their counterparts. NGO membership of women was strongly associated (p<0.001) with their frequency of CEB.

To find potential determinants of higher number of CEB among Bangladeshi women, we used multivariate analysis, considering selected variables that were found to be statistically significant for the number of CEB in bivariate analysis (Table 3). We fitted both LR and MLR models in the context of GLMs and GLMMs framework, respectively. The results are summarized including estimated variance component $(\hat{\sigma}^2)$, intra-cluster correlation (ρ), LRT and AIC values in Table 4. The problem of multicollinearity in the model was also checked by computing the variance inflation factor (VIF) and observed no significant correlation among the explanatory variables (1<VIF<2)[27].

Table 4: Model selection criterion (AIC) for logistic regression (LR) and mixed logistic regression (MLR), estimated variance component$(\hat{\boldsymbol{\sigma}}^{\boldsymbol{2}})$, intra-cluster correlation $(\boldsymbol{\rho})$along with chi-square $(\boldsymbol{\chi}^{\boldsymbol{2}})$ and p-values of the likelihood-ratio test (LRT).

Model	BDHS 2014					BDHS 2017-18				
	$\hat{\sigma}^2$	ρ	χ^2	p-value	AIC	$\hat{\sigma}^2$	ρ	χ^2	p-value	AIC
LR	-	-	-	-	16310.08	-	-	-	-	18220.85
MLR	0.12	0.04	64.02	<0.001	16248.06	0.12	0.03	61.72	<0.001	18157.13

It was observed that AIC values were substantially lower for MLR (BDHS 2017-18: AIC=18157.13, BDHS 2014: AIC=16248.06) than LR (BDHS 2017-18: AIC=18220.85, BDHS 2014: AIC=16310.08) model. In addition, the value of $\hat{\sigma}^2$ for the random effects associated with MLR was 0.12. The contribution of random effects in the MLR model was found to be statistically significant (p-value<0.001) for modelling CEB data among women in Bangladesh. More precisely, it follows that the between women's variability obtained from different clusters was strongly associated with the number of CEB among Bangladeshi women. It can also be seen that the intra-cluster correlation coefficient values were 0.03 (BDHS 2017-18) and 0.04 (BDHS 2014) for CEB clustered data of women aged 15-49 years. Thus, to analyse the factors that are associated with CEB for this clustered data, the MLR is the most appropriate modelling technique to be used compared to the LR.

The results obtained from multivariable analysis by fitting the MLR to CEB clustered data are summarized in Table 5. In the BDHS 2017-18, the women of reproductive age who married at their legal age 18 years or higher were less likely (OR=0.74, 95% CI: 0.666 to 0.825) to have 3 or more CEB than those who married below 18 years. Age at first marriage of women was strongly associated with their higher number of CEB (p=<0.001).

Table 5: Estimates (Est.), standard errors (SE), *p*-value and odds ratio (OR) along with 95% CI for OR obtained from fitting the mixed logistic regression (MLR) model to children ever born (CEB) clustered data in Bangladesh

Variable	BDHS 2014					BDHS 2017-18				
	Est.	SE	*P*-value	OR	95 % CI	Est.	SE	*P*-value	OR	95 % CI
Constant	0.555	0.110	<0.001	1.74	(1.403, 2.161)	0.881	0.110	<0.001	2.41	(1.946, 2.993)
Age at first marriage										
<18 (ref.)	-	-	-	-	-	-	-	-	-	-
18 and above	-0.303	0.057	<0.001	0.74	(0.661, 0.826)	-0.299	0.054	<0.001	0.74	(0.666, 0.825)
Age at first birth										
≤20 (ref.)	-	-	-	-	-	-	-	-	-	-
>20	-0.484	0.064	<0.001	0.62	(0.544, 0.698)	-0.616	0.060	<0.001	0.54	(0.480, 0.607)
Division										
Dhaka (ref.)	-	-	-	-	-	-	-	-	-	-
Barisal	0.425	0.092	<0.001	1.53	(1.278, 1.832)	0.404	0.093	<0.001	1.50	(1.248, 1.798)
Chittagong	0.53	0.084	<0.001	1.70	(1.442, 2.003)	0.624	0.085	<0.001	1.87	(1.579, 2.205)
Khulna	-0.154	0.088	0.078	0.86	(0.772, 1.018)	-0.045	0.088	0.61	0.96	(0.804, 1.137)
Rajshahi	-0.218	0.088	0.013	0.80	(0.678, 0.955)	-0.187	0.089	0.036	0.83	(0.696, 0.988)
Rangpur	-0.044	0.089	0.622	0.96	(0.804, 1.139)	0.108	0.091	0.236	1.11	(0.932, 1.333)
Sylhet	0.547	0.093	<0.001	1.73	(1.440, 2.075)	0.548	0.093	<0.001	1.73	(1.441, 2.077)
Mymensingh	-	-	-	-	-	0.273	0.093	0.003	1.31	(1.096, 1.576)
Place of residence										
Rural (ref.)	-	-	-	-	-	-	-	-	-	-
Urban	-0.275	0.056	<0.001	0.76	(0.681, 0.848)	-0.238	0.052	<0.001	0.79	(0.712, 0.872)
Religion										
Non Muslim (ref.)	-	-	-	-	-	-	-	-	-	-
Muslim	0.332	0.077	<0.001	1.39	(1.199, 1.620)	0.385	0.072	<0.001	1.47	(1.277, 1.690)
Women education										
No education (ref.)	-	-	-	-	-	-	-	-	-	-
Primary	-0.896	0.055	<0.001	0.41	(0.366, 0.455)	-0.840	0.059	<0.001	0.43	(0.384, 0.485)
Secondary	-1.962	0.063	<0.001	0.14	(0.124, 0.159)	-1.854	0.064	<0.001	0.16	(0.138, 0.178)
Higher	-2.907	0.121	<0.001	0.05	(0.043, 0.069)	-2.610	0.102	<0.001	0.07	(0.060, 0.090)
Husband education										
No education (ref.)	-	-	-	-	-	-	-	-	-	-
Primary	-0.265	0.053	<0.001	0.77	(0.692, 0.852)	-0.364	0.052	<0.001	0.70	(0.628, 0.769)
Secondary	-0.346	0.060	<0.001	0.71	(0.629, 0.795)	-0.603	0.058	<0.001	0.55	(0.488, 0.613)
Higher	0.078	0.085	0.356	1.08	(0.916, 1.277)	-0.379	0.080	<0.001	0.68	(0.585, 0.800)
Husband desire more child										
No (ref.)	-	-	-	-	-	-	-	-	-	-
Yes	0.377	0.061	<0.001	1.46	(1.295, 1.641)	0.468	0.057	<0.001	1.60	(1.428, 1.784)
Women empowerment										
No (ref.)	-	-	-	-	-	-	-	-	-	-
Yes	0.215	0.045	<0.001	1.24	(1.136, 1.353)	0.171	0.050	<0.001	1.19	(1.075, 1.310)
Wealth index										
Poor (ref.)	-	-	-	-	-	-	-	-	-	-
Middle	0.281	0.057	<0.001	1.32	(1.184, 1.481)	0.224	0.054	<0.001	1.25	(1.125, 1.392)
Rich	0.444	0.063	<0.001	1.56	(1.379, 1.764)	0.473	0.057	<0.001	1.61	(1.435, 1.796)
Exposure of media										
Non exposure (ref.)	-	-	-	-	-	-	-	-	-	-
Exposure	-0.268	0.049	<0.001	0.77	(0.695, 0.842)	-0.349	0.044	<0.001	0.71	(0.647, 0.768)
NGO membership										
No (ref.)	-	-	-	-	-	-	-	-	-	-
Yes	0.310	0.046	<0.001	1.36	(1.247, 1.492)					
Contraceptive use										
No (ref.)	-	-	-	-	-	-	-	-	-	-
Yes	0.083	0.042	0.046	1.09	(1.001, 1.179)	-	-	-	-	-

Note: OR=1 for the reference category

Age at first birth of women (p<0.001) was found to be highly significant in relation to having a higher number of CEB. Women who had their first child above 20 years were also less likely (OR=0.54, 95% CI: 0.480 to 0.607) to have 3 or more CEB than their counterparts (BDHS 2017-18). It can be observed that women aged 15-49 years from Barisal (p<0.001, OR=1.50, 95% CI: 1.248 to 1.798), Chittagong (p<0.001, OR=1.87, 95% CI: 1.579 to 2.205), Sylhet (p<0.001, OR=1.73, 95% CI: 1.441 to 2.077) and Mymensingh (p=0.003, OR=1.31, 95% CI: 1.096 to 1.576) were statistically highly significant and more likely to have 3 or more CEB than those from Dhaka division. The women from urban areas were less likely (OR=0.79, 95% CI: 0.712 to 0.872) to have 3 or higher CEB than rural women. The place of residence was found to be statistically significant (p<0.001) among women of their reproductive age group in relation to whether they had 3 or more CEB.

As expected, the religious status of women in Bangladesh was strongly associated (p<0.001) with their number of CEB. More precisely, the Muslim women were 1.47 (OR=1.47, 95% CI: 1.277 to 1.690) times more likely to have 3 or more CEB than non-Muslim women. The educational status among women aged 15-49 years (p<0.001) also showed significant effects on the number of CEB in Bangladesh. The proportions were 57%, 84%, and 93% less likely to have 3 or more CEB for mothers who had primary (OR=0.43, 95% CI: 0.384 to 0.485), secondary (OR=0.16, 95% CI: 0.138 to 0.178) or higher (OR=0.07, 95% CI: 0.060 to 0.090) education, respectively in comparison to mothers with no educational attainment. In the BDHS 2017-18, it can be seen that the increasing levels of education of husbands were also less likely to have 3 or more CEB than those women with an illiterate husband. However, the higher educational attainment of husband was found to be statistically insignificant (p=0.356) in the BDHS 2014.

Furthermore, women whose husbands wanted more children (p<0.001, OR=1.60, 95% CI: 1.428 to 1.784) were more likely to have 3 or more CEB than their counterparts. We also observed from Table 5 that the women's empowerment (p<0.001) was strongly associated with their number of CEB in Bangladesh. However, it is surprising that the empowered women (OR=1.19, 95% CI: 1.075 to 1.310) were 1.19 times more likely to have higher CEB than those who were not empowered. It may happen because of the religious beliefs among Muslim women in Bangladesh. Wealth index of women (p<0.001) was strongly associated with their number of CEB in Bangladesh.

Mass-media exposure (p<0.001) among reproductive women was strongly associated with their number of CEB. It was observed that the proportion of having 3 or more CEB among women who were exposed to media was 29% (OR=0.71, 95% CI: 0.647 to 0.768) lower

compared to their counterparts. In addition, the variables: NGO membership ($p<0.001$) and use of contraceptive methods ($p=0.046$) were found to be statistically significant in the multivariable analysis for the BDHS 2014 data. Though it is expected that the women with NGO membership will have lower fertility than others[28] surprisingly, we observed the opposite direction in our analysis. They may claim more financial benefits from NGOs by referencing their higher number of children.

Discussion and conclusion

This study attempted to estimate the number of CEB and to find out its potential determinants among ever-married women using the mixed logistic regression (MLR) model taking into account the clustering effects and keeping in mind the fertility slogan 'Whether it is a boy or girl, two children are enough' in Bangladesh. We used the latest clustered CEB data extracted from the BDHS 2014 and BDHS 2017-18.

Our study findings revealed that among women of reproductive age group 15-49 years, the proportion of 3 or more CEB was 42.1%. Naturally, the women who married in their teens (before 18 years) and gave their first birth before 20 years had a significantly higher number of children than others. Age at first marriage and the first birth of women were found to be significant determinants of CEB[5,8,16]. The study findings revealed that the women who married at the age of 18 years or later and had their first child after the age of 20 were less likely to have a higher number of CEB, similar results were also found in previous studies[8,16,29,302930]. In our study, it is observed that urban women were less likely to have more children than women from rural areas of Bangladesh[5,31]. Notably, urban women were comparatively more concerned about using contraceptive methods whereas in rural areas there is a lack of accessibility of contraceptive methods, and also rural women tend to marry at an early age. The religious status of women was also found to be strongly associated with a higher number of children in Bangladesh. Muslim women were more likely to have higher children than their counterparts[11,16,32].

The number of CEB among ever-married women is inversely related to their levels of education and similar scenarios were observed in our study. The educated women were less likely to have more children than others[1,4,6,16,31,33**Error! Reference source not found.**2934-37]. One reason may be that educated women are more conscious about their pregnancy, may reject underage marriage, and can consider the effective use of contraception. Husband's formal education also turned out to be a potential determinant of fertility in Bangladesh. Moreover, the intention of having more children measured by husband, wealth index and mass-media exposure

among Bangladeshi women were also found to be significantly associated with their number of CEB[1,5,6,11,16]. In this study, we observed that the empowered women had a significantly higher frequency of CEB, however, some previous studies reported both positive and inverse relationships[38-4141]. The usage of contraceptive methods was statistically insignificant while this was found to be significant in the literature[9,10,42**Error! Reference source not found.**]. Based on the study findings, we recommend that effective programs should be devised, focusing on creating awareness among illiterate Muslim women who are often bound or forced to be married and had their first child at an early age, so that they would be more conscious about their higher frequency of CEB and the consequences of life-threatening pregnancy complications. These programs would need to be the subject of further research. Effective programs in Bangladesh surely control the number of CEB, reduce infant and maternal morbidity as well as mortality.

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Author Contributions

AR, ZH and EK conceptualized the idea and designed the study, AR and ZH analysed the data and wrote the draft manuscript; MLR and EK provided intellectual comments and jointly contributed to revising the manuscript with AR and ZH. All authors approved the final version of the manuscript.

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Conflict of Interest

No conflict of interest exits among the authors.

Patient consent for publication

Not applicable.

Availability of Data

We used secondary data from the Demographic and Health Surveys (DHS) Program. The data are available online at https://dhsprogram.com/data/available-datasets.cfm.

Ethics statement

This article does not include any data of human participants conducted by any of the authors. The Bangladesh Demographic and Health Survey (BDHS) was approved by ICF Macro Institutional

Review Board and the National Research Ethics Committee of the Bangladesh Medical Research Council. Written consent was given by participants in relation to this survey before the interview. All identification of the survey participants was disidentified before publishing the data. In this study, we used the secondary data that are freely available on the DHS website: https://dhsprogram.com/data/available-datasets.cfm.

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STROBE Statement—Checklist of items that should be included in reports of ***cross-sectional studies***

	Item No	Recommendation	Page number
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	1
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	2 and 3
Objectives	3	State specific objectives, including any prespecified hypotheses	3
Methods			
Study design	4	Present key elements of study design early in the paper	3
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	3 and 4
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	4
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	4
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	4
Bias	9	Describe any efforts to address potential sources of bias	
Study size	10	Explain how the study size was arrived at	4
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	4
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	5 and 6
		(*b*) Describe any methods used to examine subgroups and interactions	5 and 6
		(*c*) Explain how missing data were addressed	4
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	5 and 6
		(*e*) Describe any sensitivity analyses	5 and 6
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	6 and 7
		(b) Give reasons for non-participation at each stage	
		(c) Consider use of a flow diagram	
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	6 and 7
		(b) Indicate number of participants with missing data for each variable of interest	
Outcome data	15*	Report numbers of outcome events or summary measures	8

Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	12
		(*b*) Report category boundaries when continuous variables were categorized	12
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	12
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	9
Discussion			
Key results	18	Summarise key results with reference to study objectives	14
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	14
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	15
Generalisability	21	Discuss the generalisability (external validity) of the study results	15
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	15

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.