Two Level Logistic Regression Model of Factors Influencing in Early Childbearing and its Consequences on Nutritional Status of Bangladeshi Mothers: Nationally Representative Data

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Abstract: *Background*: Early marriage and early pregnancy is a social as well as a medical problem in developing countries, which may have an impact on the health and nutritional status of teenage mothers. Therefore, the objective of this study was to determine the influencing factors of early childbearing (ECB) and its consequences on the nutritional status of Bangladeshi mothers.

Methods: Data was extracted from Bangladesh Demographic and Health Survey (BDHS-2014). Women who delivered their first baby before the age of 20 years are considered ECB mothers. Nutritional status was measured by body mass index (BMI). Chi-square test and both univariable and multivariable logistic regressions, and z-proportional test were used in this study.

Results: The prevalence of ECB among currently non-pregnant mothers in Bangladesh was 83%. The logistic regression model provided the following six risk factors of ECB: (i) living location (division) (p<0.01), (ii) respondents' education (p<0.05), (iii) husbands' education (p<0.05), (iv) household wealth quintiles (p<0.01), (v) respondents' age at first marriage (p<0.05), and (vi) number of family members (p<0.05). Still, 17.6% of mothers were undernourished in Bangladesh; among them, 18.5% and 13.4% were ECB and non- ECB mothers respectively. ECB mothers had a greater risk to be undernourished than non-ECB mothers [COR=1.26, 95% CI: 1.11-1.43; p<0.01].

Conclusions: In this study, some modifiable factors were found as predictors of ECB in Bangladesh. ECB mothers were more prone to become under-nourished. These findings can be considered to reduce the number of ECB mothers in Bangladesh consequently improve their nutritional status.

Keywords: Early childbearing mothers, Nutritional status, Socio-demographic factors, Two-level logistic regression model, Bangladesh.

BACKGROUND

The women who delivered children before age 20 years old are usually called early childbearing (ECB) mothers [1]. In the last few decades, the practice of early marriage and early pregnancy were common in Bangladesh despite the substantial development in Human Development Index (HDI) [2]. More than 75 percent of the first-born children were born before women age 20 years and consequently, mortality was 10.4 percent in Bangladesh [3]. It was estimated that more than 50 percent of female adolescents being married before reaching 20 years and thus impacts high maternal, infant and neonatal mortality in Bangladesh [4]. The pregnancy rate among adolescents was higher than adult mothers particularly due to their higher fertility rate, poor reproductive knowledge, inexperience and insufficient use of family planning practice and finally inadequate engagement with care providers [5]. ECB mothers need extra attention to consider their health, babies' growth and development during pregnancy and lactation and long term consequences in developing and under-developed countries including Bangladesh [6, 7]. Adolescent mothers with poor health status due to nutritional deficiencies are at higher risk for various diseases [8, 9]. The pelvic bone of young mothers may be vulnerable which increases the risk of obstructed labour [10]. The risk of pregnancy-related mortality was double before the age of 15 years than the mother's age 15 to 19 years [11, 12]. Poverty is the basic cause

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of nutritional deficiency throughout the world. A study on the African-American community in Chicago reported that adolescent mothers were more likely to be unemployed, lived in poverty and be dependent on social welfare [13]. The cultural, religious, economic and other social factors (i.e. education) also impacts early pregnancy and nutritional deficiency; even some community create pressure to probe fertility on a still-growing body [14-17]. Other studies established that socio-economic factors such as education, wealth index, age at marriage, number of ever-born children, residence, religion, occupation, place and type of delivery are linked to poor health and nutritional status [18-21].

The Government of Bangladesh (GOB) achieved some health-related millennium development goals (MDGs) such as reducing child mortality and improving maternal health. Now, GOB focuses on Sustainable Development Goals (SDGs) to achieve integrated targets by 2030 [22]. In spite of considerable progress, Bangladesh is still facing trouble with malnutrition that adversely affecting the children and their mother's health.

One study found that the mean age of marriage for Bangladeshi women was 15.69 ± 2.97 years which increased the risk of being early mothers [24]. Studies reported that the prevalence of underweight (BMI<18.5 kg/m^2) was higher among poor families in both rural (38.8%) and urban (29.7%) areas [24, 25].

Recently, one study was done on early childbearing among Bangladeshi mothers using the BDHS-2011 dataset. Authors considered only early childbearing mothers and did not compare with non-early childbearing mothers to find the effect of socio-economic and demographic factors on nutritional status [1]. It is needed to identify the risk factors of early childbearing and its effect on their nutritional status and then comparing it with non-early childbearing mothers using nationally representative last dataset.

Therefore, the aim of the present study was to determine the factors influencing ECB, in addition, we also looked at the effect of ECB on nutritional status among mothers in Bangladesh.

Research Questions

There are three research questions in this study; these are (i) what is the prevalence of ECB mothers in Bangladesh? (ii) what factors are related to ECB in Bangladesh? (iii) what is the effect of ECB on nutritional status among mothers in Bangladesh?

METHODS

A total number of 15,015 non-pregnant Bangladeshi women aged 15-49 years who had at least one ever born child were recruited for the present study from Bangladesh Demographic and Health Survey 2014 from March 24, 2014, to August 11, 2014. BDHS collected different characteristics from 17,863 Bangladeshi married women ages ranged from 15 to 49 years. This is a nationally representative survey that covered all administrative divisions of Bangladesh [22].

Sampling

BDHS-2014 utilized two stages of stratified cluster sampling for selecting a sample from Bangladeshi married women aged 15-49 years. With this design, the survey selected 18,000 residential households, which were expected to result in completed interviews with about 18,000 ever-married women. Data from a sample of 17,863 married Bangladeshi women were collected. Outliers and missing values and currently pregnant women were excluded from the data. Finally, we analyzed 15,015 data after excluding outliers and missing values and currently pregnant women.

Outcome Variable

Age at childbearing of mothers was considered as the first outcome variable in this study, and it was classified into two classes as (i) early childbearing (ECB) (delivery first baby before age 20; code =1), (ii) non-early childbearing (non-ECB) (delivery first baby after age 20; code=0) mothers. Nutritional status was the second outcome variable of this study which was measured by body mass index (BMI). BMI was categorized into three categories on the basis of cut-off points; (i) undernutrition (BMI<18.5 kg/m^2) (code, 1) (ii) healthy (normal weight) (18.5≤BMI<25 kg/m^2) (code, 2) and (iii) over nutrition (BMI≥25 kg/m^2) (code, 3) [26].

Independent Variables

Various socio-economic and demographic factors were used as independent variables such as divisions (living location), place of residence, parents' education level, number of family members, household wealth index, total ever born children and age at first marriage. All selected independent variables with their categories and codes are described in Table **1**.

Table 1: Independent Variables with their Categories and Codes

Variable	Categories	Code No	Variable	Categories	Code No
Division (living location)	Barisal	1	Place of residence	Urban	1
	Chittagong	2		Rural	2
	Dhaka	3	Age at first marriage	<18years	1
	Khulna	4		18≥ years	2
	Rajshahi	5	Household wealth index	Poor	1
	Rangpur	6		Middle	2
	Sylhet	7		Rich	3
Respondents' educational level	No education	0	Husbands' education level	No education	0
	Primary	1		Primary	1
	Secondary	2		Secondary	2
	Higher	3		Higher	3
Total ever born children	≤ 2 children	1	Number of family member	≤4 member	1
	3-4 children	2		5-7 member	2
	≥ 5 children	3		≥ 8 member	3

Statistical Analysis

Frequency distribution was used to determine the prevalence of early childbearing mothers in Bangladesh. Z-proportion test was used to find the difference in each category of nutritional status between ECB and non-ECB mothers. The Chi-square test was used for selecting independent factors for multilevel logistic regression models. In our dataset the observations came from several levels of hierarchy, it was possible to obtain a clustering effect in the outcome variable. If we are having a clustering effect, we first need to remove it otherwise we could not get actual results, and could not apply a single-level statistical model for analyzing this type of data set [26]. Two levels of multiple logistic regression analysis were used to remove the clustering effect for getting the effect of socio-economic and demographic factors on ECB mothers in Bangladesh.

The two levels models used in the study were:

Level I: $\eta_{ij} = \beta_{0j} + \beta_{1j}x_{ij}$, $P_{ij} = \exp(\eta_{ij})/1+\exp(\eta_{ij})$, where $y_{ij} = 1$, with probability P_{ij},

$y_{ij} = 0$, with probability $1-P_{ij}$, $\ln(P_{ij}/1-P_{ij}) = \beta_{0j} + \beta_{1j}x_{ij}$

Level II: $\beta_{0j} = y_{00} + u_{0j}$, $\beta_{1j} = y_{10}$, $u_{0j} \sim N(0, \tau_{00})$, $\pi = P(Y = 1| X_1 = x_1; X_2 = x_2;...; X_p = x_p) = e^g(x_i)/1+ e^g(x_i)$, where, $g(x_1) = \beta_0 + \beta_1x_{i1} + \beta_2x_{i2} +...+ \beta_k x_{ik}$; ($i = 1, 2,..., n$).

β_i = unknown logistic regression coefficients ($i = 1, 2,..., n$).

To check the existence of the clustering effect in the outcome variable, we used the median odds ratio (MOR). The following formula is used for calculating MOR value: MOR= $MOR = \exp\left\{ 0.6745\sqrt{2} \sqrt{\sigma_u^2}\right\}$ $= \exp(0.95\sqrt{\sigma_u^2})$, where σ_u^2 is the cluster variance. There is no evidence of clustering effect if MOR=1, but if MOR>1, there is cluster variation of outcome variable [28]. We obtained from our dataset, the MOR=1.372142 > 1, there was a clustering effect of the outcome variable (ECB mothers). We selected a two-level binary logistic regression model for analyzing our data. Level I and II were considered for individual and clusters (EAs) levels respectively. In this study, the magnitude of the standard error (SE) was used to detect the multicollinearity problem, if the magnitude of the SE is less than 0.5, it was judged that there was no evidence of multicollinearity [28]. The goodness of fit of the model was checked by Hosmer and Lemeshow test. Finally, multinomial logistic regression was used to find the effect of early childbearing on the nutritional status of Bangladeshi mothers. For statistical analysis of data, sampling weight was necessary but unfortunately, proportional allocation technique was not used for selecting samples by BDHS-2014. Sampling weights were calculated for univariate, bivariate and multivariate analysis for this study. Statistical significance was accepted at p<0.05. All statistical analyses were performed using SPSS, IBM (version 23.0) and STATA (version 11).

RESULTS

Out of 15,015 mothers, 83% were early at the childbearing (ECB) stage. The highest number of early

childbearing (ECB) mothers (86.0%) was living in the Rangpur division while the lowest number of ECB mothers (77.3%) was in the Sylhet division. A higher number of ECB mothers (86.1%) were living in rural areas than urban (76.9%). It was found that 41.8% of ECB mothers had higher education while 87.3% and 89.2% had no and primary education respectively. 57.6% higher educated husbands' wives were ECB, while 88.4% and 89.7% no and primary educated husbands' wives were ECB respectively. Also, the percentages of ECB mothers were decreasing with increasing their household wealth quintile. ECB mothers married earlier (aged <18 years) than their counterparts. The number and percentages of ECB mothers were increasing with increasing their number of ever born children. Whereas more number (percentage) of ECB mothers (83.75%) lived in a large family (member ≥5). The Chi-square test demonstrated that all selected variables showed significantly associated with ECB mothers in Bangladesh (Table **2**).

The magnitude value of SE for every independent variable in a multivariable two-level logistic model was less than 0.50, there was no evidence of multicollinearity problems among independent variables. After removing the clustering effect of childbearing age, and controlling the effect of other factors on ECB, the two-level model demonstrated that

Table 2: Association between Early Childbearing (ECB) and Household and other Characteristics of Mothers in Bangladesh

Characteristics	Categories	ECB mothers, N (%)	χ^2- value	p-value
Division (living location)	Barisal	1502 (83.7)	70.31	p<0.01
	Chittagong	2022 (83.9)		
	Dhaka	2084 (80.7)		
	Khulna	1836 (84.4)		
	Rajshahi	1812 (84.2)		
	Rangpur	1864 (86.0)		
	Sylhet	1342 (77.3)		
Place of residence	Urban	3882 (76.9)	203.40	p<0.01
	Rural	8580 (86.1)		
Respondents' educational level	No education	3108 (87.3)	1724.35	p<0.01
	Primary	4058 (89.2)		
	Secondary	4758 (84.7)		
	Higher	538 (41.8)		
Household wealth index	Poor	5010 (88.9)		
	Middle	2675 (87.5)		
	Rich	4777 (75.6)		
Age at first marriage	<18years	10893 (93.4)	3990.98	p<0.01
	18≥ years	1569 (88.4)		
Husbands' educational level	No education	3842 (88.4)	1204.04	p<0.01
	Primary	3796 (89.7)		
	Secondary	3595 (83.6)		
	Higher	1229 (57.6)		
Total ever born children	≤ 2 children	6346 (77.8)	348.12	p<0.01
	3-4 children	4300 (88.3)		
	≥ 5 children	1816 (91.3)		
Number of family member	≤ 4 member	5102 (81.5)	18.73	p<0.01
	5-7 member	5478 (84.4)		
	≥ 8 member	1882 (83.1)		

Table 3:   Effects of Demographic and Socioeconomic Factors on Early Childbearing among Mothers in Bangladesh

Variable	SE	p-value	AOR	95% CI of AOR	
				Lower	Upper
Division (living location)					
Chittagong Vs Sylhet[R]	0.17	0.001	1.56	1.26	1.95
Dhaka Vs Sylhet[R]	0.14	0.040	1.25	1.00	1.54
Khulna Vs Sylhet[R]	0.14	0.130	1.20	0.95	1.51
Rajshahi Vs Sylhet[R]	0.14	0.205	1.16	0.92	1.46
Rangpur Vs Sylhet[R]	0.17	0.005	1.40	1.10	1.77
Barisal Vs Sylhet[R]	0.15	0.153	1.19	0.94	1.52
Place of residence					
Rural Vs Urban[R]	0.07	0.280	1.08	0.94	1.23
Respondents' education level					
No education Vs Higher[R]	0.15	0.039	1.28	1.01	1.64
Primary Vs Higher[R]	0.22	0.001	2.36	1.97	2.82
Secondary Vs Higher[R]	0.21	0.001	1.99	1.60	2.48
Household wealth index					
Middle Vs Poor[R]	0.09	0.580	1.05	0.89	1.23
Rich Vs Poor[R]	0.07	0.040	0.85	0.73	0.99
Age at first marriage (Year)					
<18 Vs ≥18[R]	0.43	0.001	12.58	11.23	14.08
Husbands' educational level					
No education Vs Higher[R]	0.21	0.001	1.95	1.57	2.41
Primary Vs Higher[R]	0.25	0.001	2.52	2.07	3.06
Secondary Vs Higher[R]	0.15	0.001	1.80	1.52	2.12
Total ever born children					
3-4 children Vs ≤ 2 children[R]	0.10	0.001	1.53	1.34	1.74
≥ 5 children Vs ≤ 2 children[R]	0.18	0.001	1.71	1.40	2.10
Number of family member					
5-7 member Vs ≤ 4 member[R]	0.07	0.040	1.13	1.01	1.27
≥ 8 member Vs ≤ 4 member[R]	0.10	0.002	1.29	1.10	1.52
Goodness of Fit	Hosmer and Lemeshow test, χ^2-value=9.032, p=0.340				

N.B.: B-Coefficients, SE-Standard error, CI-Confidence interval, AOR-Adjusted odd ratio, R-Reference case.

women living in Chittagong [AOR=1.56, 95% CI: 1.26-1.95; p<0.01], Dhaka [AOR=1.25, 95% CI: 1.00-1.54; p<0.05] and Rangpur [AOR=1.40, 95% CI: 1.10-1.77; p<0.01] divisions were 1.56, 1.25 and 1.40 times greater risk to become ECB mothers than women living in Sylhet division respectively. Uneducated [AOR=1.28, 95% CI: 1.01-1.64; p<0.05], primary [AOR=2.36, 95% CI: 1.97-2.82; p<0.01] and secondary [AOR=1.99, 95% CI: 1.60-2.48; p<0.01] educated women were more likely to become ECB mothers compared to higher educated mothers. Women living in the poor family is

15% more likely to become ECB mothers compared to women living in a rich family [AOR=0.85, 95% CI: 0.73-0.99; p<0.05]. It was found that women who got married earlier (age<18 years) had a 12.58-fold greater risk to become ECB mothers than their counterparts [AOR=12.58, 95% CI: 11.23-14.08; p<0.01]. Uneducated [AOR=1.95, 95% CI: 1.57-2.41; p<0.01], primary [AOR=2.52, 95% CI: 2.07-3.06; p<0.01] and secondary [AOR=1.80, 95% CI: 1.52-2.12; p<0.01] educated husbands' wives had respectively 1.95, 2.52 and 1.80 times greater risk to become ECB mothers

Table 4: The Prevalence of Nutritional Status among Early and Non-Early Childbearing Mothers in Bangladesh

Nutritional status, N(%)	ECB mothers, N (%)	Non- ECB mothers, N (%)	Z-value	p-value
Under nutrition, 2643(17.6)	2301(18.5)	342(13.4)	2.2986	0.0214
Normal (healthy), 8543(56.9)	7198(57.8)	1345(52.7)	3.4678	p<0.01
Over nutrition, 3829(25.5)	2963(23.7)	866(33.9)	-6.0192	p<0.01
Total	12462	2553		

N.B.: ECB: Early childbearing.

Table 5: Effect of Early Childbearing on Nutritional Status of Mothers in Bangladesh

Nutritional status	COR	COR (95% CI)		p-value	AOR[++]	AOR (95% CI)		p-value
		Lower	Upper			Lower	Upper	
Under nutrition Vs Normal[R]	1.26	1.11	1.43	p<0.01	1.21	0.96	1.30	0.14
Over nutrition Vs Normal[R]	0.64	0.58	0.70	p<0.01	0.88	0.78	0.99	0.04

N.B.: B-Coefficient; COR-Crude odds ratio; CI-Confidence interval; AOR-Adjusted odds ratio; **R**-Reference.
[++]Adjusted of other all selected independent factors.

compared to higher educated husbands' wives. It was observed that the AOR was increasing with increasing the number of children; early childbearing mothers had comparatively more ever born children than their counterparts. Women living in a family having 5-7 [AOR=1.13, 95% CI: 1.01-1.27; p<0.01] and ≥8 [AOR=1.29, 95% CI: 1.10-1.52; p<0.01] members had a 1.13 and 1.29-fold higher risk to become ECB mothers than women living in the comparatively small family (≤ 4 members). Hosmer and Lemeshow test (Chi-square value=9.032, p=0.340) showed that our selected model was well fitted to our data (Table **3**).

The nutritional status among ECB and non- ECB mothers in Bangladesh is presented in Table **4**. It was noted that 25.5% of mothers in Bangladesh were overnourished, while 17.6% of mothers were undernourished. Z-proportional test demonstrated that significantly a greater number of ECB mothers (18.5%) were undernourished than that of non- ECB mothers (13.4%) (p<0.05), while the number of overnourished mothers among non- ECB (33.9%) was significantly higher than ECB mothers (23.7%) (p<0.01). Also, it was observed that the number of healthy among ECB mothers (57.8 %) was higher than that of non-ECB mothers (52.7%) (p<0.01) (Table **4**).

Nutritional status was three categories; (i) undernutrition, (ii) healthy and (iii) over nutrition. It was used as a dependent variable; multinomial logistic regression was used to find the effect of ECB on nutritional status. Healthy mothers were considered as reference cases. Both univariable and multivariable multinomial logistic models were used for this purpose. The univariable model demonstrated that ECB mothers had a 1.26-fold greater risk to be undernourished than non-ECB mothers [COR=1.26, 95% CI: 1.11-1.43; p<0.01]. It was also found that ECB mothers had a 36% higher chance to get normal weight compared to non-ECB mothers [COR=0.64, 95% CI: 0.58-0.70; p<0.01]. The multivariable model showed that ECB mothers were more likely to get normal weight by 12% than non-ECB mothers [AOR=0.88, 95% CI: 0.78-0.99; p<0.05] (Table **5**).

DISCUSSION

Globally around 17 million adolescent girls give birth each year comprising 11.0% of all births and 90% of them occurs in low and middle-income countries. The most prevalent countries are Bangladesh, Brazil, the Democratic Republic of the Congo, Ethiopia, India, Nigeria and the United States [29]. Early pregnancy and motherhood are still common in Bangladesh. This study investigated the factors which influence ECB among Bangladeshi mothers because ECB creates a poor nutritional status of mothers. Some studies in Bangladesh found the effects of various factors on the nutritional status of ECB mothers in Bangladesh using BDHS 2007 and 2011 data [1, 2]. Moreover, they did not compare with non-ECB mothers. In the present study, we investigated the factors influencing ECB among Bangladeshi mothers, using Bangladesh

Demographic Health Survey data 2014 (BDHS 2014) which was the latest dataset. However, our findings showed that the overall prevalence of ECB among Bangladeshi mothers was 83% which were slightly lower than the previous study (86%) from BDHS 2011 [1]. The percentage of ECB among mothers has decreased due to the increase in the female education and household wealth quintile during the last two decades in Bangladesh and these may be the most important reason for the development of ECB [23].

Effect of Socio-Economic and Demographic Factors on ECB

We analyzed the divisional distribution of ECB as regional coverage. The prevalence of ECB mothers was varied among divisions' and the highest number of ECB was observed in Rangpur and lowest in Sylhet division due to differentiation of customs, cultures and economic conditions among the regions [30-32]. Therefore, these facts could be potential reasons for ECB. A study in Brazil found a strong association between childbearing at young ages and the mother's subsequent economic and social indicators. Young mothers were less likely to complete high school, less likely to participate in the labour force, more likely to have lower earnings, than women who did not bear children as teenagers [33]. The effect of education may be explained by the likelihood that educated mothers are more able to receive and understand health promotion messages. This study also exhibited that a positive association exist between a mother's education level and ECB. The illiterate are more likely to be ECB than educated mothers. Subsequently, the higher educated mothers were 0.797 times less likely to be ECB than uneducated mothers. This could be depicted as the fact that uneducated mothers were mostly served as housewives with improper knowledge of the effect of early pregnancy. Our results revealed that mothers from rural areas were more likely to commence early pregnancy than urban areas. Similar results were observed among other south Asian mothers in India and Nepal [8, 34]. The other necessary socio-economic characteristics were also considered in this study such as the number of the family members, total ever born children, age at first marriage and household wealth quintile [1].

Impact of ECB on Nutritional Status

In this study, we found that Bangladeshi mothers had faced the dual burden of malnutrition; still, more than 17% of mothers were suffering from chronic energy deficiency while 25% of mothers were overnourished. The trends in the number of overnourished mothers in Bangladesh have been increasing but the number of undernourished mothers has been decreasing with increasing the household wealth quintile during the last two decades in Bangladesh [23]. The prevalence of undernutrition among ECB mothers was significantly higher than that of non- ECB mothers. This may indicate the impact of ECB with other mentioned contributing factors. Interestingly, the prevalence of healthy among ECB mothers was also significantly higher than their counterparts may illustrate the optimum utilization of nutrients by young mothers. Alternatively, the prevalence of overnutrition was lower among ECB mothers than non- ECB mothers. This also indicates the imbalance of intake and utilization of nutrients by adult mothers. These results were also supported by the previous study based on Bangladesh Demographic and Health Survey, 2011 [1] and also a cross-sectional study among the nutritional and health risks among adolescent pregnant mothers in Bangladesh [35].

Strength and Limitation of the Study

Perhaps, it is the first time to investigate the associated factors of ECB mothers in Bangladesh and analyze the effect of ECB on their nutritional status compared with non-ECB mothers. We analyzed also the risk factors were identified after removing the clustering effect of ECB using multilevel binary logistic regression analysis. However, there were some limitations of this study. We used secondary cross-sectional data derived from BDHS-2014, women's parental related factors were not available such as the household wealth quintile of women's parents before their marriage, the education level of parents which were more important predictors for early marriage as well as ECB. Sampling weight was essential to analyze BDHS-2014 data for ensuring national representation of the survey, but in this survey, we did not consider a proportional allocation technique for selecting samples from different regions such as divisions. We only controlled the effect of some socio-economic, demographic and anthropometric factors for determining the effect of ECB mothers on their nutritional status, but physiological factors which may also impact nutritional status such as level of physical activities, level of energy intake and behavior patterns like dietary habits, smoking habits, weight maintenance, methods of weight-loss etc [36, 37] due to unavailability of these factors in BDHS-2014 dataset. However, the mentioned factors would be the potential

clues for researchers to conduct more research on ECB mothers in Bangladesh.

CONCLUSIONS

We investigated the factors of ECB among non-pregnant mothers in Bangladesh aged 15-49 years and compared with non-ECB non-pregnant mothers, in addition, the effect of ECB on nutritional status were also observed. Two-level and multinomial logistic regression models were applied to find the effect of socio-economic and demographic factors on ECB and the effect of ECB on nutritional status of mothers respectively. The prevalence of ECB mothers in Bangladesh was 83%. It was found that living location (division), respondents and their husbands' education, household wealth quintile, age at first marriage, number of family members were the predictors of ECB among mothers in Bangladesh. Still, 17.6% of mothers were suffering from chronic energy deficiency; among them, 18.5% and 13.4% were ECB and non- ECB mothers respectively. On the other hand, 25.5% of mothers in Bangladesh were overnourished, among them 23.7% and 33.9% were ECB and non- ECB mothers respectively. ECB mothers had a higher risk to be underweight than non-ECB mothers. The health authorities of the Bangladesh government and non-government organizations should special attention to childbearing mothers' health and nutritional status due to their potential contribution to the family and productivity. We hope our findings could be considered to reduce the ECB mothers in Bangladesh as well as to improve their nutritional status.

LIST OF ABBREVIATIONS

AOR   = Adjusted odd ratio

BBS   = Bangladesh Bureau of Statistics

BDHS = Bangladesh Demographic and Health Survey

BMI   = Body mass index

CI   = Confidence interval

COR   = Crude odds ratio

EAs   = Enumeration areas

GOB   = Government of Bangladesh

HDI   = Human Development Index

IBM   = International Business Machines

MDGs = Millennium development goals

MOR   = Median odds ratio

PSU   = Primary SamplingUunit

SDGs = Sustainable development goals

SE   = Standard error

SPSS = Statistical Package For Social Sciences

STATA = Software for Statistics and Data Science

Ups   = Union parishads

DECLARATIONS

Ethics Approval and Consent to Participate

The 2014 BDHS received ethics approval from the Ministry of Health and Family Welfare, Bangladesh. The 2014 BDHS also received written informed consent for participation in the study was obtained where participants were children (under 16 years old) from their parent or guardian.

Consent for Publication

Not applicable for this study.

Availability of Data and Material

The BDHS-2014 datasets are freely available at https://dhsprogram.com/data/dataset/Bangladesh_Standard-DHS_2014.cfm?flag=0

Competing Interests

The authors have no conflict of interests.

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Authors Contributions

KS and MGH conceptualized and designed the research; ASMAM analyzed the data; KS, MAS drafted the original manuscript; MGH, SC, PB, MAT and MAS critically reviewed and edited the manuscript. All the authors read, discussed and approved the final version of the manuscript for publication.

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