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Multilevel Logistic Regression of Factors Influencing Caesarean Delivery among Married Women in Bangladesh

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Abstract

Background: The caesarean section (CS) delivery is still a major surgery and carries some risks. The aim of the study was to determine the prevalence and predictors of CS delivery among Bangladeshi women in reproductive age.

Method: Data was extracted from Bangladesh Demographic and Health Survey (BDHS), 2014. BDHS-2014 collected data from Bangladeshi women in reproductive age from overall Bangladesh using two stages stratified cluster sampling. Data came from several levels of hierarchy, there was a cluster effect to the data set. A single-level statistical model would not be appropriate for analysing this type of data set. Multilevel logistic regression analysis was used in this study. The sample size for our study was 4493.

Results: The prevalence of CS delivery among Bangladeshi women was 23.94%. χ^2-test showed that some socio-demographic factors were significantly associated with delivery system and these factors were considered as independent variables in logistic regression model. Multilevel logistic regression analysis exhibited that women who gave birth at age 30 year and above were more likely to get caesarean delivery than younger ($p<0.01$). Overweight and obese women had a more chance to get CS delivery than underweight

women ($p<0.05$). Women with higher education ($p<0.01$) were more likely to have CS delivery than those with no education. Women came from rich household were more likely to get CS delivery ($p<0.05$) than their counterparts. CS delivery was less pronounced among women using contraception ($p<0.05$).

Conclusions: The present study demonstrated that the prevalence of CS delivery in Bangladesh is very high. CS delivery is more costly than normal deliveries, and there are many risks for caesarean deliveries. Consequently, health authorities should improve policy to make awareness among women in Bangladesh for normal deliveries.

Keywords: Caesarean Delivery, BDHS-2014, Multilevel Logistic Regression

AMS Subject Classification: 62J99.

1. Introduction

Caesarean section (CS or C-section) is a surgical intervention in obstetrical care which is carried out to ensure safety of mother and child when vaginal delivery is not possible. It can be life-saving and is also a highly effective procedure for preventing complications such as dystocia. The WHO stated, in 2015(BMG-2006), that every effort should be made to provide CS to women in need, rather than striving to achieve a specific rate.

In Bangladesh more than 62% of the deliveries took place at home, and only 37% birth were under safe and hygienic conditions (BDHS-2014). Lackof knowledge on CS and misinformation about natural childbirths are important reasons for women of choosing the mode of delivery by CS (Arjmandi & Farzin, 2005). Also, studies showed that fear, anxiety and pain have an important role in the choice of delivery type (Monar *et al.*, 2008). Delivery by CS in Bangladesh was highest among births to mothers who completed secondary education (49%), highest

wealth quintile (41%), living in urban areas (29%), and first births (24%) (NIPORT, 2013).The increase in caesarean deliveries has been attributed to multiple factors ranging from maternal, socio-demographic and institutional factors. A large number of studies have stressed that as the age of a mother increases, so does the likelihood of caesarean birth (Kassak, Mohammad & Abdallah, 2009). Age at marriage is also a significant cause of increasing caesarean birth rates in the developing countries (Rahman *et al.,* 2012). A previous study presented the most recent estimate of CS deliveries in the northern region of Bangladesh and examined the association of reported complications around delivery as well as socio-demographic and relevant characteristics of women with CS using data from a sample survey (Rahman *et al.,* 2014).

So far known, a few studies have been conducted on women's preference for delivery settings and factors associated with delivery through caesarean section in Bangladesh. Since there is lack of studies on this area, the information on socioeconomic and demographic inequality in service-use for facility-based delivery and caesarean section is potentially significant. Through this paper we try to measure the influence of the combination of the selected factors on the mode of birth of women in Bangladesh, and emphasis is given to explore the true effect of the factors on the caesarean delivery prevalence taking into consideration the effect of the levels.

2. Methods

2.1 Design and study population

The study used cross sectional data from 2014 Bangladesh Demographic and Health Survey (BDHS), a nationally representative survey conducted from June 28, 2014 to

November 9, 2014. The data set used in the analysis was obtained from NIPORT. The BDHS-2014 used a two-stage stratified cluster sampling method based on enumeration areas (EAs) and household samples. In the first stage, 600 EAs (207 and 393 clusters from urban and rural, respectively) were selected with having child (last five years) proportionally from 259,532 enumeration areas (EAs) which were created for 2011 census (BDHS-2014). At the second stage, a total of 18,000 residential households were selected, with an average of 30 households per EAs. All ever-married women of reproductive age (15 to 49 years) were selected. The sampling technique, survey design, survey instruments, measuring system, quality control, ethical approval and subject consent for BDHS-2014 have been described elsewhere (NIPORT, 2013). It was determined that 4493 ever-married women having child (last five years) aged 15–49 were available for the study sample. The mean age of the women was 31.02 ± 9.22 years (BDHS-2014).

2.2 Multilevel analysis for multistage clustered data

From hierarchical data structure a multistage sample is used in multilevel research. Because of cost, time and efficiency considerations, stratified multistage samples are the norm for sociological and demographic surveys. In our study we apply two stage multilevel regression model. Here the units at level-1 are individuals (ever-married women having child aged 15−49) who are nested within units at higher level clusters: level-2. Clusters are primary sampling units (PSU) defined by the National Census of 1981, and correspond approximately to village in rural areas. All clusters are approximately of equal size in terms of area. The response variable in this study is "**mode of delivery** (caesarean and non-caesarean)"which is binary and hence multilevel logistic regression model is a natural choice for modelling. Traditional logistic regression (which, in multilevel analysis terms, is single-level) requires the

assumptions: (a) independence of the observations conditional on the explanatory variables and (b) uncorrelated residual errors. But the multilevel logistic regression analysis consider the variations due to hierarchy structure in the data.

2.3 Outcome variables

The outcome variable in the present study was dichotomous variable, caesarean delivery, (i) No or (ii) Yes. This variable was measured by a question to participants did you deliver by caesarean?

2.4 Selected predictors

The primary choice of some explanatory variables for this study was based on previous other studies on the factors influencing caesarean delivery (Kassak et al., 2009; Padmadas et al., 2000; Nassar & Sullivan 2001). The socio-demographic factors include age, residence, education, age at first marriage, age at first birth, no. of children, current working status, religion, family member, baby's birth weight, wealth Index, body mass index. Moreover, height and weight were measured for each women. The socioeconomic, demographic and household information included in our study came from the questionnaires used in BDH-2014.

2.5 Statistical Analysis

In this study an initial bivariate analysis was performed to determine significant associations between mode of delivery (caesarean vs. non-caesarean) and socio-demographic factors. Actually, $\chi 2$-test was used in this study for selecting the independent variables for multiple logistic regression model. Multiple logistic regression analysis was utilized to determine the effect of socio-economic, demographic factors on caesarean deliveries among Bangladeshi women.

The BDHS-2014, dataset is of hierarchical structure. The hierarchy for this study follows individuals as level-1 and clusters as level-2. The multilevel logistic regression model is a powerful statistical tool for detecting an association between dependent (category) and independent variables at different levels of the data hierarchy. The two levels of multiple logistic regression models used in the study are:

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

$$ln\left(\frac{P_{ij}}{1-P_{ij}}\right) = \beta_{0j} + \beta_{1j}x_{ij}$$

Level II: $\beta_{0j} = y_{00} + u_{0j}$, $\beta_{1j} = y_{10}$, $u_{0j} \sim N(0, \tau_{00})$, $\pi = P(Y = 1|X_1 = x_1, X_2 = x_2;\ldots; X_p = x_p) = \frac{e^{g(xi)}}{1+e^{g(xi)}}$, where

$g(x_1) = \beta_0 + \beta_1 x_{i1} + \beta_2 x_{i2} + \ldots + \beta_k x_{ik}$; (i = 1, 2,…, n) and β_i = unknown logistic regression coefficients (i = 1, 2,…, n) (Goldstein, 1995).

The parameter βi refers to the effect of Xi on the log odds such that Y = 1, controlling the other Xi. An important assumption in the multiple logistic regression model is that the explanatory variables are independent of each other. In the present study, the magnitude of the standard error (SE) was used to detect the multicollinearity problem; if the magnitude of the SE lies between 0.001 and 0.5, there is no evidence of multicollinearity (Chan, 2004). Statistical significance was accepted at $p < 0.05$. Statistical analyses were carried out using STATA (version 11) and SPSS software (version IBM 20).

3. Results

Table 1 describes the percentage of caesarean deliveries by location. We analysed data for 4422 births of ever-married Bangladeshi women aged 15 to 49, among them 1413 in rural and 3009 in urban from seven divisions of Bangladesh. The proportion of caesarean delivery is pretty close between divisions from 36.9% in urban to 17.8% in rural area and the overall prevalence of caesarean delivery among these women was 23.94%. Among the divisions caesarean delivery rate is high in urban Rajshahi 48% and rural Khulna 32% respectively.

Table 1: Characteristics of caesarean delivery by location

Division	Births			Caesarean birth	
	Urban (%)	Rural (%)	Total (%)	Urban (%)	Rural (%)
Dhaka	321(41.15)	459(58.85)	780(17.64)	150(46.7)	107(23.3)
Chittagong	263(30.98)	586(69.02)	849(19.2)	69(26.2)	102(17.4)
Borishal	160(30.30)	368(69.70)	528(11.94)	63(39.4)	43(11.7)
Khulna	178(33.97)	346(66.03)	524(11.85)	76(42.7)	110(31.8)
Rajshahi	169(31.59)	366(68.41)	535(12.1)	81(47.9)	67(18.3)
Rangpur	146(26.84)	398(73.16)	544(12.3)	46(31.5)	59(14.8)
Sylhet	176(26.59)	486(73.41)	662(14.97)	36(20.5)	49(10.1)
Total	1413(31.95)	3009(68.05)	4422(100)	521(36.9)	537(17.8)

The Chi-square ($\chi 2$) test was used to investigate the association between caesarean delivery and selected factors. The variables which significantly associated with the mode of delivery were divisions, residence, education level, husband's education, family member, working status, age, age at first marriage, no. of children, wealth index, age at first birth, birth weight of baby, religion, body mass index (BMI) and use of contraception. All the significant associated factors were regarded as independent variables for CS delivery in the two-level logistic regression model. In table 2 we have showed both the results of multiple logistic and multilevel logistic regression analysis.

Table 2: Risk factors and effects of socio demographic factors on caesarean delivery of Bangladeshi Women using multilevel logistic regression

Covariate	Multiple OR	95% CI	P value	Multilevel OR	95% CI	P value
Division						
Dhaka	Ref.			Ref.		
Chittagong	0.493	0.381 to 0.637	P<0.001	0.485	0.358 to 0.657	P<0.001
Brishal	0.643	0.475 to 0.870	0.004	0.634	0.446 to 0.903	0.011
Khulna	1.206	0.920 to 1.582	0.175	1.265	0.922 to 1.737	0.145
Rajshahi	0.924	0.696 to 1.227	0.584	0.939	0.677 to 1.305	0.712
Rangpur	0.600	0.442 to 0.814	P<0.001	0.606	0.428 to 0.859	0.005
Sylhet	0.397	0.290 to 0.544	P<0.001	0.390	0.272 to 0.559	P<0.001
Residence						
Urban	Ref.			Ref.		
Rural	0.737	0.617 to 0.880	P<0.001	0.706	0.574 to 0.867	P<0.001
Age Group						
<=20	Ref.			Ref.		
21-25	0.980	0.795 to 1.207	0.846	0.983	0.792 to 1.221	0.880
26 or more	1.190	0.854 to 1.658	0.305	1.191	0.843 to 1.682	0.321
Education						
No education	Ref.			Ref.		
Primary	1.314	0.901 to 1.916	0.156	1.320	0.897 to 1.943	0.158
Secondary	1.983	1.367 to 2.876	P<0.000	1.956	1.334 to 2.867	P<0.001
Higher	3.001	1.926 to 4.676	P<0.000	2.978	1.881 to 4.713	P<0.001
Husband's Edu.						
No education	Ref.			Ref.		
Primary	1.178	0.883 to 1.507	0.265	1.219	0.906 to 1.642	0.190
Secondary	1.523	1.139 to 2.037	0.005	1.595	1.179 to 2.156	0.002
Higher	2.344	1.660 to 3.310	P<0.001	2.514	1.752 to 3.607	P<0.001

Working status						
No	Ref.			Ref.		
Yes	0.657	0.532 to 0.812	P<0.001	0.649	0.521 to 0.813	P<0.001
Family member						
<= 4	Ref.			Ref.		
5-8	0.900	0.749 to 1.080	0.257	0.905	0.748 to 1.095	0.304
9 +	0.827	0.639 to 1.070	0.149	0.823	0.633 to 1.086	0.174
Age at marriage						
< 18	Ref.			Ref.		
18 +	1.091	0.828 to 1.437	0.538	1.071	0.803 to 1.420	0.639
Age at 1st Birth						
<=20	Ref.			Ref.		
21-29	1.439	1.106 to 1.873	0.007	1.469	1.117 to 1.932	0.006
30 or more	6.803	2.222 to20.833	p<0.001	6.911	2.193 to 2.775	P<0.001
No. of Children						
1-2	Ref.			Ref.		
3-5	0.719	0.555 to 0.933	0.013	0.709	0.542 to 0.929	0.013
6 and more	0.550	0.247 to 1.222	0.142	0.577	0.255 to 1.307	0.187
Birth weight						
Low	Ref.			Ref.		
Normal	0.856	0.691 to 1.059	0.151	0.858	0.688 to 1.069	0.172
Large	1.331	1.008 to 1.757	0.044	1.358	1.018 to 1.811	0.037
BMI						
Under weight	Ref.			Ref.		
Normal	1.381	1.110 to 1.717	0.004	1.397	1.115 to 1.751	0.004
Over weight	2.458	1.874 to 3.224	P<0.001	2.429	1.832 to 3.219	P<0.001
Obese	2.857	1.704 to 4.789	P<0.001	3.011	1.754 to 5.169	P<0.001

Use Contraceptive						
No	Ref.			Ref.		
Yes	0.822	0.691 to 0.977	0.026	0.817	0.682 to 0.979	0.028
Religion						
Non-Muslim	Ref.					
Muslim	0.760	0.569 to 1.014	0.062	0.756	0.555 to 1.030	0.077
Wealth Index						
Poor	Ref.			Ref.		
Middle	1.698	1.316 to 2.190	P<0.001	1.728	1.327 to 2.250	P<0.001
Rich	2.773	2.180 to 3.528	P<0.001	2.775	2.152 to 3.577	P<0.001

Note: p-value ($p < 0.01$,1 % and $p < 0.05$, 5 % level of significance)

The model demonstrated that women living in Dhaka divisions were more likely to have CS delivery than those living in Chittagong (OR = 0.485, 95% CI: 0.358-0.657; p<0.001), Borishal (OR = 0.634, 95% CI: 0.446-0.903; p<0.05), Rangpur (OR = 0.606, 95% CI: 0.428-0.859; p<0.05) and Sylhet (OR = 0.390, 95% CI: 0.272-0.559; p<0.001). Women living in urban areas were more likely to have caesarean delivery than those living in rural areas (OR = 0.706, 95% CI: 0.574–0.867; p <0.001). The likelihood of caesarean delivery increased with the higher level of women's education like secondary education (OR = 0.664, 95% CI: 1.334-2.867; p<0.001) or higher education (OR = 1.091,95 % CI: 1.881–4.713; p < 0.001) along with husband's education. Non-working women had a greater chance to have CS delivery than working women (OR = 0.649,95 % CI: 0.521–0.813; p<0.001). As the women's age of first birth increase so dose in the caesarean delivery, like age 21-29 (OR = 1.469, 95% CI: 1.117-0.932; p<0.05) or age 30 or more (OR = 6.911, 95% CI: 2.193-21.775; p<0.05). Women having children 1-2 are more likely to have CS delivery than having children 3-5 (OR = 0.709, 95% CI: 0.542-0.929; p<0.05). Women having baby with large birth weight (OR = 1.358, 95% CI: 1.018-1.811; p<0.05) are more likely to go

through caesarean delivery. The overweight (OR =2.429, 95% CI: 1.832-3.219; p<0.001) and obese women (OR = 3.011, 95% CI: 1.754-5.169; p< 0.001) are more likely to undergo caesarean delivery. Women were less likely to have caesarean delivery than their counterparts if they were: Muslim (OR = 0.817, 95 % CI: 0.555–1.030; p < 0.001) and currently using contraception (OR = 0.817, 95 % CI: 0.682–0.979; p < 0.05). Compared to the poor women, the rich women (OR =2.775, 95 % CI: 2.152–3.577; p < 0.001) were more likely to undergo caesarean sections for childbirth.

4. Discussion

This study was aimed to explore factors affecting the preference for child-delivery settings and caesarean sections in Bangladesh. According to the BDHS-2014, the caesarean rate in Bangladesh is 23.94% where was in the survey of BDHS-2011 the rate was 17.1 %. The study has identified several factors that have significant influence on the delivery process for child birth. The findings of this study showed that women education exerts a positive significant influence on the mode of delivery. Women with higher economic status and higher level of education used more opportunities of the appropriate place for delivery and underwent caesarean sections. The possible explanation could be, educated and wealthy women have a greater confidence and capabilities to take actions regarding their own health (Kamal, 2009; Caldwell, 1981). Among other variables included in the analyses, place of residence, working status of women, first birth age, number of children, baby's birth weight, BMI, use of contraception and regions appeared as important determinants of caesarean delivery. The findings of this study concerning to birth order, portrayed that the odds of caesarean delivery decreases with an increase in child birth order. A possible explanation is that, after the birth of the first and second child by caesarean, subsequent deliveries are perceived to be of high risk,

thus decreasing the likelihood of delivering subsequent babies. This reflects women's perceptions regarding the efficacy of the procedure as a means to ensure newborn survival and to avert the risks of birth complications or stillbirth. Nassar & Sullivan, 2001 suggested that there is a high primary caesarean rate for first birth to women 30 years age and older. Our study also support this findings, in fact it revealed that the age range has decreased to 30. It is because the chances of pregnancy complication are more at higher age. This finding corroborates the findings of Padmadas et al. (2000) and Rosenthal and Paterson (1998). Surprisingly, working women were less likely to have caesarean delivery than their non-working counterparts. Perhaps working women experience time constraints that reduce their opportunities for receiving antenatal care (Furuta and Salway, 2006). The rate of caesarean section with low and large birth weight of baby were significantly higher than those of normal birth weight (NBW). Our results also confirmed by other studies Chen et al., 2015.

According to the doctors, caesarean section is normally justified under certain situations such as dystocia, cephalopelvic disproportion, placenta previa, breech presentation, foetal distress, multiple births, previous caesarean section, pre-eclampsia/eclampsia, active genital herpes of mother etc. However, when there is no pregnancy or delivery related complications, even then, some doctors perform CS as it is less time consuming and more profitable. The following facts are also pointed out by some doctors. In a country where there is extreme shortfall of obstetricians and anaesthetists and they are not available round the clock in medical institutions, physician's convenience is an important contributing factor for high CS.

5. Limitations of the Study

The study was based on the most recent BDHS with a nationally representative large sample size. In addition, this study applied multilevel modeling to accommodate the hierarchical nature of the BDHS data. Despite the above strengths, the study has several limitations. For example, besides the selected socio demographic factors which have been included in this analysis, a host of other programmatic factors, e.g. accessibility, quality, and costs of delivery services, and cultural factors, e.g. religiosity, prejudices, women's role in decision-making process, and subordinate status of women are also likely to influence the delivery practices of women. However, due to lack of relevant data, the effects of these programmatic and cultural factors on the child-delivery practices could not be examined in this study. In addition, the available data did not permit us to examine all aspects of the delivery practices. Finally, patient's medical records were not examined to determine on what grounds the doctors opted for caesarean delivery; therefore, we did not include the physician factor in relation to caesarean birth rates.

6. Conclusions

The CS-delivery among ever-married women of reproductive age in Bangladesh is increasing in a high rate. Women living in urban areas, those with higher education and women in middle and rich households have significantly higher rates of caesarean delivery. Other variables associated with caesarean delivery are: being not working, being overweight and obese, currently not using a contraceptive method, birth order and first birth age. Finally, from the statistical

point of view, this study also suggests that these factors may influence the health-seeking behaviour of women.

Health awareness and educational programs should be given to focus on educating women, on appropriate delivery types when their health and specific status will be known. Provide complete and reliable information to the mothers so that they do not opt for caesarean section in a state of panic or ignorance. Further researches of these factors are needed to better understand how these factors may affect the decision to seek caesarean delivery. Women of child bearing age should be better informed about having a caesarean delivery only on medical grounds.

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