Caesarean delivery and its associated factors among mothers in Bangladesh: A statistical analysis

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ABSTRACT

Background: *The caesarean section (CS) delivery is still a major surgery and carries some risks. In Bangladesh the CS rate has been increasing over time.* **Aims and Objectives:** *The aim of the study was to determine the associated factors of CS delivery among Bangladeshi women in reproductive age.* **Materials and Methods:** *Data was extracted from Bangladesh Demographic and Health Survey (BDHS), 2014. BDHS-2014 data collected from Bangladeshi women in reproductive age from the whole country using two stages stratified cluster sampling. Data derived from several levels of hierarchy may show cluster effect, therefore we adopted multilevel logistic regression analysis to remove them.* **Results:** *The prevalence of CS delivery among Bangladeshi women was 23.93%. With the sample population of 4378 women, we utilized χ^2-test to study selected socio-demographic factors. They were subsequently used as independent variables in multilevel logistic regression model. We showed that women along with their partner with higher education (p<0.01) and those coming from rich households were more likely to have CS delivery. Overweight and obese women had a more chance to get CS delivery than underweight women (p<0.05). Women who delivered their first baby at age 30 years and above were more likely to get Caesarean delivery than their counterparts (p<0.01). Women having large baby at delivery time are more likely to have CS (p<0.01).Long duration to take first baby after marriage like 2-4 years also lead women to go through CS delivery (p<0.01).* **Conclusion:** *We concluded that the prevalence of CS delivery in Bangladesh is high which is associated with some major factors. With limited medical and health resources, it is important for the government to understand the pattern of CS deliveries among the women to ensure proper indication of the procedure to reduce the rate of intra-partum morbidity and mortality.*

KEYWORDS: *Caesarean section (CS) delivery, Bangladeshi women, Socio-economic factors, Cluster effect, Multilevel model*

INTRODUCTION

Caesarean section (CS or C-section) is a surgical intervention to extract one or more babies from gravid uterus through the abdominal wall when vaginal delivery is considered not safe or not possible. CS can minimize the complications during natural delivery and post-partum haemorrhage in high risk cases. In some cases, the procedure may be life saving for the mother and baby. In 2015, World Health Organization (WHO) recommended that every effort should be made to provide CS to women in need, rather than striving just to achieve a specific rate (Betran *et al.,* 2016). Among the common indications for CS are breech presentation, twin pregnancy, pre-maturity, cephalo-pelvic disproportion, and maternal or foetal distress during labour.

CS is not free from surgery related morbidities. Intraoperative haemorrhage, infection, wound dehiscence and deep vein thrombosis are some of the possible complications that may require prolonged hospitalization or readmission (Hannah *et al*., 2000). WHO global survey on maternal and prenatal health in Latin America reported that increasing rate of CS was associated with increasing postpartum use of antibiotics, higher rate of maternal / neonatal morbidity and mortality after adjustment of demographic characteristics, risk factors, type of institution and proportion of referrals (Villar *et al*., 2006 and Lumbiganon, 2010).

Currently, the rate of CS continues to rise in both developed and many developing countries. In China, one important reason of growing rate of CS is the increasing number of institutional births (Sufang *et al*., 2007 and Gibbons *et al.*, 2010). In other countries, demographic profiles of women (Declercq *et al*., 2005), fear of litigation among caregivers (Tollanes, 2009), physician's convenience (Gomes *et al*., 1999), insurance facility and mode of hospital payment (Remez, 1991 and Bertollini *et al*., 1992) were some of factors associated with this increasing trend. Some studies reported that patient preference was an important cause for this development (MacDorman *et al*., 2008), but others did not support this observation (Hopkins, 2000). For elective cases, fear of labour pain, risk of future sexual dissatisfaction, perceived unsympathetic and inadequate care during vaginal delivery were some of the common reasons for women to opt for CS (Oumachigui, 2006 and McCourt *et al*., 2007). Based on data collected from 36 developing countries, Wylie and Mirza (Wylie and Mirza, 2008) concluded that the rate of CS in the least-developed countries was often <5%, while in most-developed countries, it stood at more than 30%. From a global survey conducted in 2007-2008, China was reported to have the highest CS rate (46.2%) (Rosenthal and Paterson-Brown, 1998). In other

developing countries, the rates varied widely ranging from as low as 1.62% in Angola to 42.0% in Paraguay (Shah *et al.,* 2009). In India, the rate of CS has increased from 3% to 10% from 1992-93 period to 2005-06 period (IIPS and Macro International, 2007). In Bangladesh, rate of CS has gradually increased from 4% in 2004, 9% in 2007, 17% in 2011, to the current level of 23% (NIPORT, 2014). Lack of knowledge on CS and misinformation about natural childbirths is important reasons for women choosing delivery by CS (Arjmandi and Farzin, 2005).

In Bangladesh, more than 62% of the deliveries took place at home, and only 37% birth were conducted in maternity homes or hospitals (NIPORT, 2014). Delivery by CS was higher among mothers who had completed secondary education (49%), from highest wealth quintile (41%), living in urban areas (29%), and delivering their first baby (24%) (NIPORT, 2013). Most of these studies used logistic regression model to investigate the relationship between delivery type (Caesarean or non-Caesarean) and relevant covariates (independent variables). Increasing maternal age (Kassak *et al*., 2009) and age at marriage (Rahman *et al*. 2012) have been associated with higher rate of CS. A previous study presented the most recent estimate of C-section 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 C-section using data from a sample survey (Rahman *et al*., 2014). There have been a few studies conducted on women's preference on delivery methods and factors associated with CS in different parts of the world (Signorelli *et al*., 1995, Mishra and Ramanathan, 2002 and Mossialos *et al.*2005).

In order to better understand the association between socio-economic and demographic factors and the practice of CS among the Bangladeshi women, we decided to conduct this study using multilevel logistic regression models on a multistage clustered national database. We tried to measure the influence of the combination of selected factors on rate of CS, taking into consideration the effect of the levels.

MATERIALS AND METHODS

The study was conducted based on secondary data from the Bangladesh Demographic and Health Survey (NIPORT, 2014), a cross-sectional national survey conducted from June 28, 2014 to November 9, 2014. The data   set was   obtained   from NIPORT (2014). Sample population was chosen from 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 chosen from 259,532 enumeration areas (EAs) created for 2011 census (BBS, 2011). At the second stage, 18,000 residential households were chosen (with an average of 30 households per EAs). All married women within the reproductive age group (15 to 49 years) were considered. The sampling technique, survey design, survey instruments, measuring system, quality control, ethical approval and subject consent for the 2014 BDHS have been described in previous publication (NIPORT, 2013). We identified 4493 mothers who were within the reproductive age giving birth within the last five years, and enrolled them in the study. After removing outliers and cases with incomplete information, the data set was reduced to 4378 for final analysis. The mean age of these women was 31.02 ± 9.22 years.

In our study we implemented multilevel analysis from hierarchical data structure. Due to cost and time considerations, stratified multistage samples are used. Though there are challenges for model-based statistical inference, this method is efficient for the estimation of descriptive population quantities. The dependence among observations for multistage clustered samples often comes from several levels of the hierarchy. Hence, in order to draw appropriate inferences and conclusions from multistage stratified clustered survey data, we may require a convenient modelling technique like multilevel modelling. Here the units at level-1 were individuals (ever-married women having child aged $15-49$) who are nested within units at higher level clusters: level-2. Clusters were primary sampling units (PSU) defined by the National Census of 1981, and correspond approximately to village in rural areas. The response variable in this study is "delivery type (Caesarean and non-Caesarean)" which is binary and hence multilevel logistic regression model is a natural choice for modelling. In a Traditional logistic regression analysis the independence of the observations are conditional on the explanatory variables and residual errors are uncorrelated. But the multilevel logistic regression analysis considers the variations due to hierarchy structure in the data.

Outcome variables

In the present study we considered the dichotomous variable, Caesarean delivery, (i) No or (ii) Yes. This variable was measured by a question to participants: did you deliver by Caesarean section?

Selected predictors

The socio-demographic factors studied include husband's education, age at first marriage, age at first birth, current working status, baby's birth weight, wealth Index, duration of marriage to first birth and body mass index (BMI). These factors was chosen as the explanatory variable for this study. The socioeconomic, demographic, and household information included in our study was derived from

two of the three questionnaires used in BDHS-2014. We also collected information on body height and weight and calculated the BMI: ratio of weight in kilograms to height in meters squared (kg/m^2).

Ethics statement

The BDHS data belongs to the Ministry of Health and Family Welfare of the Government of Bangladesh. A written permission was obtained from all respondents before starting the interview. The BDHS was conducted according to protocols prescribed by the World Health Organization (WHO), therefore additional ethical approval for this study is not necessary.

Statistical analysis

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

The BDHS-2014 multistage 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: $\beta_{0j} = y_{00} + u_{0j}$, $\beta_{1j} = y_{10}$, $u_{0j} \sim N(0, \tau_{00})$, $\pi = P(Y = 1 | X_1 = x_1, X_2 = x_2;...; X_p = x_p) =$

$\frac{e^{g(x_i)}}{1+e^{g(x_i)}}$, where $g(x_i) = \beta_0 + \beta_1 x_{i1} + \beta_2 x_{i2} +...+ \beta_k x_{ik}$; $(i = 1, 2,..., n)$ and $\beta_i =$ unknown logistic

regression coefficients $(i = 1, 2,..., n)$ (Goldstein, 1995).

The parameter β_i refers to the effect of X_i on the log odds such that $Y = 1$, controlling the other X_i. 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).

RESULTS

Out of the 4378 women recruited in our study, 1402were from the rural area and 2976 from the urban area. The prevalence of CS delivery among Bangladeshi women was 23.93% (36.9 % in urban, and 17.8 % in rural areas).

Chi-square ($\chi2$) test was used to investigate the association between rate of CS delivery and selected factors. The bivariate analysis revealed that the association between the divisions and delivery mode was statistically significant, and the rate of CS delivery among urban women was significantly higher than those from rural areas ($p<0.01$). The rate varied by level of education of the mother: higher among women or their husband with higher education (57.3 %) compared to those with lower level or no education ($p<0.001$). The rate of CS was higher among women who were working at the time of survey ($p<0.01$), and those who came from small family (member≤4) ($p<0.05$). We also noted that the rate was higher in mothers who were from higher age group ($p<0.05$), older at first childbirth ($p<0.01$), practising contraception ($p<0.05$), and married at 18 years or older ($p<0.01$). On the other hand, those with more children were associated with lower rate of CS delivery ($p<0.01$). We also noted that higher rate of CS was associated with higher wealth index ($p<0.01$). Women with higher BMI ($p<0.01$), and babies with large birth weights ($p<0.01$) were associated with higher rate of CS delivery. Duration of marriage to first birth was also associated with CS delivery ($p<0.01$). Finally, availability of proper toilet facility at home ($p<0.01$), and religion of the women ($p<0.05$) were also an associated factor.

We further analyzed some factors that showed statistically significant association with CS delivery by considering them as independent variables in a multilevel (two-level) logistic regression model. These factors are husband's education, working status, age at first marriage, age at first birth, duration of marriage to first birth, baby's birth weight, BMI and wealth index. A previous study has already revealed the significance influence on CS delivery with the other factors (Khan *et al.*, 2017). In these models, the fixed effects (measures of association) would express the association between the likelihood of CS delivery as odds ratio with their 95 % confidence intervals (Table 1). The model demonstrated that the likelihood of CS delivery increased with increase in the

level of individual's along with partner's education; secondary education (OR = 2.30, 95% CI: 1.72-3.06; p<0.01) or higher than secondary education (OR = 4.58, 95 % CI: 1.33–3.60; p < 0.01).

Table 1: Effect of and socio demographic factors on Caesarean delivery of Bangladeshi women using multilevel logistic regression

Covariate	OR	P value	95% CI of OR
Education			
No education	Ref.		
Primary	1.32	0.009	0.90 to 1.94
Secondary	1.96	0.000	1.33 to 2.87
Higher	2.98	0.000	1.88 to 4.71
Husband's Edu.			
No education	Ref.		
Primary	1.49	0.007	1.12 to 1.99
Secondary	2.30	0.000	1.72 to 3.06
Higher	4.58	0.000	1.33 to 3.60
Working status			
No	Ref.		
Yes	0.69	0.001	0.56 to 0.87
Age at first marriage			
< 15	Ref.		
15-18	1.21	0.038	1.01 to 1.45
18+	2.22	0.000	1.77 to 2.79
Age at 1st Birth			
<=20	Ref.		
21-29	1.70	0.000	1.32 to 2.05
30 or more	10.72	0.000	3.62 to 31.75
Duration of marriage to first birth			
0-1	Ref.		
2-4	1.29	0.003	1.09 to 1.53
4+	1.61	0.001	1.20 to 2.16
Birth weight			
Low	Ref.		
Normal	0.89	0.319	0.72 to 1.11
Large	1.47	0.009	1.10to 1.96
BMI			
Under weight	Ref.		
Normal	1.36	0.007	1.09to 1.70
Over weight	2.39	0.000	1.81 to 3.16
Obese	3.05	0.000	1.79 to 5.21
Wealth index			
Poor	Ref.		
Middle	1.89	0.000	1.45 to 2.47
Rich	3.49	0.000	2.75 to 4.44

Note: OR, Odds Ratio; CI, Confidence Interval; Ref., Reference; No., Number; BMI, Body Mass Index; 1% level of significance (p < 0.01)

Surprisingly, we also noted that non-working women had a greater chance to have CS delivery than working women (OR = 0.69, 95 % CI: 0.56–0.87; p < 0.01). Women with first marriage age of 18 and more are more likely go through CS delivery(OR = 2.22, 95 % CI: 1.77– 2.79; p < 0.01). Women who were younger (age 21-29) when they delivered their first baby were likely (OR = 1.70, 95% CI: 1.32-2.05; p<0.01) to have CS delivery like older women (age 30 or more, OR = 10.72, 95% CI: 3.62-31.75; p<0.01). Women who take more than one year time to first conceive are more likely to have CS delivery (OR = 1.29, 95 % CI: 1.09–1.53; p < 0.01) following the women with duration of first conceive more than four years (OR = 1.61, 95 % CI: 1.20–2.16; p < 0.01). Women with large birth weight babies (OR = 1.47, 95% CI: 1.10-1.96; p<0.01) are more likely to undergo CS delivery. Overweight (OR =2.39, 95% CI: 1.81-3.16; p<0.01) and obese women (OR = 3.05, 95% CI: 1.79-5.21; p<0.01) are more likely to undergo CS delivery. Finally, compared to women from poor families, those from richer families were more likely to undergo CS (OR =3.49, 95 % CI: 2.75–4.44; p < 0.01) for childbirth (Table 1).

DISCUSSION

The overall rate of CS in Bangladesh was reported to be 23.94% (based on BDHS-2014), showing an obvious increase from 17.10% reported few years earlier (based on BDHS-2011). Many factors could contribute towards the increase, but improvement in economic status and level of education would probably be the main contributing factors for the increasing rate, and this was shown by our study. We can expect these women to have more confidence in modern medicine, be more aware of the benefits of CS delivery, and have financial resources to afford this surgical intervention (Caldwell 1981 and Kamal, 2009]. There were also other factors that might influenced women to deliver by CS. They included working status of women, age at first childbirth, duration of marriage to first child birth, baby's birth weight, BMI appeared to be factors favouring CS delivery.

Nassar & Sullivan (2001) observed that the rate of primary CS delivery was higher for women aged 30 years and older, and our study supports this finding. Women who became pregnant for the first time at an older age were known to have higher risk of pregnancy related morbidities (Rosenthal and Paterson-Brown, 1998). In some of the cases, delivery by CS was considered to be a safer option.

Our study results indicated that working women were less likely to have CS delivery than their non-working counterparts. A possible explanation would be due to time constrain. Working mothers may not have the time to attend antenatal clinics regularly, and they may not have the chance to be exposed to this method of delivery. Education on maternal and child health for pregnant mothers were usually packaged together with family planning, and mothers who were busy working may not have the opportunity to learn about contraception and CS delivery as noted by Kamal (2009). It is customary for a Bangladeshi woman to marry a man of the same socioeconomic status, therefore our study revealed that the level of husband's education are strongly associated with rate of CS delivery.

Our study showed that overweight and obese women (BMI > 25) were more likely to have CS delivery than underweight women. Intra-partum morbidity for complicated pregnancies is lower in CS delivery compared to vaginal deliveries, irrespective of the underlying conditions. Most doctors and obstetricians would advise CS delivery for these women, and this would be one of the reasons why CS deliveries were more commonly performed for low and high birth weight babies in our study, a finding that has been reported (Chen *et al*., 2015).

In a country where specialized medical care is very limited, optimum use of available resources is very important. Spontaneous vaginal delivery is safe, convenient, and would require very little resource for low risk deliveries. On the other hand, for complicated pregnancies such as cephalopelvic disproportion, placenta previa, breech presentation, pre-eclampsia/eclampsia, and active genital infection, CS would offer safer alternative to vaginal deliveries. It is important for the general public to be aware about the potential benefits and limitations of CS delivery, because this would potentially safe the life of mother or children when there is a clear indication. Information derived from this study would allow the government or non-governmental organizations to focus on geographical areas, specific communities or selected groups of women to create awareness on this mode of delivery. Posting of trained obstetricians and anaesthetists to

strategic locations will also reduce the transfer time for obstructed or prolonged labour and foetal distress where urgent CS delivery is indicated.

Limitations of the study

Some selected socio demographic and cultural factors used in our analysis, there is a host of other factors that may influence the delivery practices, such as accessibility, quality, and costs of delivery services. Social and cultural factors may also be important, such as religion, prejudices, women's role in decision-making process, and subordinate status of women in specific communities. We were not able to analyse these factors because these data were not collected during the primary survey. In addition, we do not have adequate information to study actual indication for CS delivery, although this will allow us to better understand the behaviour pattern of the doctors and mothers who underwent the procedure.

Conclusion:

The rate of CS delivery among married women of reproductive age in Bangladesh is rapidly increasing. Women living in urban areas, those with higher education and women in middle and rich households have significantly higher rates of CS delivery. Women who were not working, overweight or obese, older age at first childbirth and prolonged birth duration were more likely to undergo CS delivery. In order to reduce the risk of perinatal and intra-partum morbidities or mortalities, the government can focus their effort to reach out to women who may not be aware of CS delivery, while at the same time planning for human and facility resources for this service.

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