Iranian J Publ Health, Vol. 43, No. 1, Jan 2014, pp. 16-27

Original Article

Determinants of Caesarean Risk Factor in Northern Region of Bangladesh: A Multivariate Analysis

Mostafizur RAHMAN [1], Asma AHMAD SHARIFF [2], Aziz SHAFIE [3], Rahmah SAAID [4], Rohayatimah MD TAHIR [2]

1. *Institute of Graduate Studies, University of Malaya, Malaysia*
2. *Centre for Foundation Studies in Science, University of Malaya, Malaysia*
3. *Dept. of Geography, University of Malaya, Malaysia*
4. *Dept. of Obstetrics and Gynecology, University of Malaya, Malaysia*

***Corresponding Author:** Email: mos_pshd@yahoo.com

(Received 25 Sep 2013; accepted 12 Nov 2013)

Abstract

Background: Caesarean section (c-section) rates have been increasing dramatically in the past decades around the world. This increase has been attributed to multiple factors such as maternal, socio-demographic and institutional factors. Therefore, this study examines the impact of maternal, socio-demographic and relevant characteristics on caesarean delivery in the northern region of Bangladesh.

Methods: This study is based on a total of 1142 delivery cases from four private hospitals and four public hospitals during the period of January to March 2010. The study was carried out using a cross-sectional design where data were collected by simple random sampling. In order to data analysis, first, an initial bivariate analysis was performed by the chi-square and Fisher exact test. Secondly, the risk factors which are associated with c-section identify by logistic regression model. Finally, a stepwise regression analysis was carried out to isolate the most influential risk factors.

Results: Among the 17 risk factors, nine were found significantly associated with type of delivery. Eight of the risk factors i.e. previous c-section, pregnancy-induced swollen of leg, prolonged labour, maternal education status, maternal age more than 25 years, low birth order, length of baby more than 45cm and irregular intake of a balanced diet remained independently significant for caesarean delivery. The value of $P<0.05$ was considered statistically significant. Maternal complications were found to be more significant in public hospitals than in private ones and conversely for the demographic characteristics.

Conclusion: The findings of this study suggested that the above factors may influence the health-seeking behaviour of women in the northern region of Bangladesh.

Keywords: Caesarean delivery, Risk factors, Multiple logistic regression, Stepwise regression analysis

Introduction

Caesarean delivery, also known as caesarean section (c-section), is a form of childbirth in which a surgical incision is made through a mother's abdomen and uterus to deliver the baby (1). It is one of the most common surgical procedures among women. The number of caesarean delivery has been growing in many developed and developing countries (2-4) and this increase has not been clinically justified. Over the last few years, the rates of c-section have risen substantially in many countries such as Brazil (30%) (5), Chile (40%) (6), USA (24.4%) (7) and Malaysia (15.7%) (8). The caesarean section rate is increasing day by day and is surprisingly high in most countries, including in

low income countries like Bangladesh. In the late 70's, the average caesarean section rate was 2.5%, ranging from 0.6 to 4.6% among middle and upper class population in Bangladesh and currently, 12.2% of births are delivered by c-section (9). According to WHO, there is no justification for any region to have a caesarean rate higher than 10-15%. This signifies a serious cause for concern in most of the countries in the world and due to several investigations into the reasons for the rising rates in caesarean delivery, now it is an identified as emerging "global epidemic" (10, 11).

The increase in caesarean deliveries has been attributed to multiple factors ranging from maternal, socio-demographic and institutional factors. Caesarean delivery rates are known to vary widely among different population groups, with known risk factors including maternal age (12-14), order of birth (15), baby weight (16), place of residence (17), socioeconomic status (18), high levels of maternal education (14, 19, 20), previous c-section (21-23), obstetric complications (24), maternal request (refers to a primary caesarean delivery performed because the mother requests this method of delivery in the absence of conventional medical or obstetrical indications) (25-27), high income level (14, 20, 28) and physicians' choices especially within private hospitals (29). A large number of studies have stressed that as the age of a mother increases, so does the likelihood of caesarean birth (30, 31). Age at marriage is also a significant cause of caesarean birth rates in the developing countries (32). The increase in caesarean delivery rates has also raised questions in Bangladesh like in most other countries. Though increased caesarean rates have been questioned and emphasized, for the lack of reliable administrative records on different characteristics at the national level, no early studies were carried out to examine the possible risk factors associated with the evaluated rates of caesarean birth whether among private or public hospitals in the northern region of Bangladesh. This study presents the most recent estimate of c-section delivery in northern region of Bang-ladesh and examines the association of reported complications around delivery as well as socio-demographic and relevant characteristics of women with c-section using data from sample survey.

Materials and Methods

Conceptual framework

Based on existing literature regarding caesarean delivery found that caesarean birth rates (CBR) is simultaneously influenced by numerous factors such as maternal, socio-demographic and other relevant factors. It is also found that these factors are interrelated to each other. It can be presented in an orderly manner by a conceptual framework where the relationships may be represented with some arrowheads. One sided arrow and ↓ indicates the direct and indirect effect of the destination factor respectively. Two sided arrow ( ) denotes that both factors are interrelated. Thus, the conceptual framework of the relationship may be represented as in Fig. 1. It shows that the relationship among the factors with CBR is too complex and needs to be addressed properly and carefully.

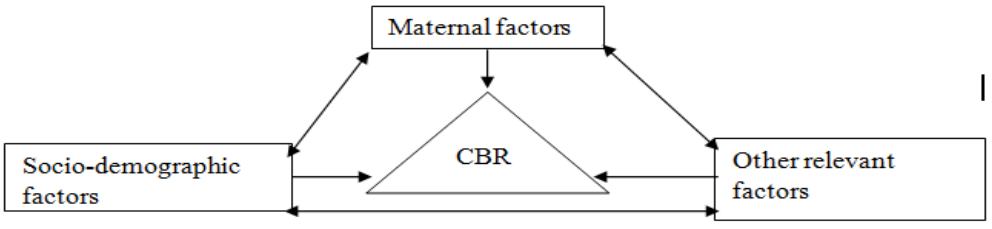

Fig. 1: A conceptual framework of interrelationships among maternal, socio-demographic and other relevant factors with CBR

Study area

In Bangladesh, both public and private hospitals have facilities for caesarean and non-caesarean delivery. To identify the risk factors that influence the choice of route of delivery in public and private hospitals, this study were carried out in the Northern region of Bangladesh.

Study population

Pregnant women admitted for delivery in the selected public and private hospitals.

Variables and their measurements

Dependent variable: The type of delivery was the dependent variable and it was taken to be dichotomous in nature (coded by the values 1 if the respondents undergo caesarean deliveries and 0 otherwise).

Independent Variables: The maternal variables included prolonged labour (more than 12 hours), fetal distress, previous c-section, pregnancy induced senseless, pregnancy induced swollen of leg (it is the condition of pregnant women that causes fluid retention and the inability of muscles to absorb liquid), breathing difficulty, child aborted around delivery, multiple births; head circumference, length and weight of babies.

For the analysis of data, the category relating to prolonged labour, fetal distress, previous c-section, pregnancy induced senseless and swollen of leg, breathing difficulty, child aborted around delivery and multiple births were assessed as yes or no. The head circumference of newborns was classified into two categories: <32 cm and more than 32 cm. The length and weight of baby were categorised into: <45 cm or more than 45 cm and <2.5 kg or more than 2.5 kg respectively.

The socio-demographic variables included maternal age at birth, age at marriage, parity (order of birth), and maternal educational level. Maternal age was categorized into four broad groups (years): <20, 20-24, 25-29 and more than 30. The age at marriage was classified into three categories: <18 years, 18-22 years and 23 years and above. The parity was divided into three groups: 1, 2, and ≥ 3. Education status is the highest level of schooling attained, measured as primary and below, secondary and higher.

Place of residence and duration of taking balance diet (it refers to milk, fish, egg, fruit and vegetables that contains adequate amounts of all the necessary nutrients required for healthy growth and activity and those diets were taken a woman in pregnancy period) were also considered as the other related variables in the study. Additionally, place of residence was classified as rural verses urban and duration of taking balance diet was measured as a categorical variable: often, once a week and rarely.

Data collection

This study is based on a proportion of $P = 0.5$ with an acceptable precision of $E = 0.029$ and significance level of $\alpha = 0.05$ and $Z = 1.96$, using the sample determinant formula $n = P(1-P) \times \left(\frac{Z}{E}\right)^2$. (33). The study sample comprised of 1142 women who had delivery either through caesarean or non-caesarean from four private and four public hospitals. Most of the questions were close-ended and the answers chosen by the respondents were indicated by tick mark. The inclusion criteria were pregnant women who were admitted in maternity wards of private and public hospitals for their deliveries. The study followed a cross-sectional design where data were collected by direct interviews. The participants were selected by simple random sampling and proportion to the estimated load of deliveries, which accounted for 60% of all deliveries during the period of January to March 2010. This percentage is considered more than enough to represent the minimum data sampling. All interviews were conducted within 24 to 48 hours post-delivery. Among the 1142 delivery cases, 652 were caesarean and the remaining 490 were non-caesarean.

Statistical analysis

An initial bivariate analysis was performed to identify significant associations between types of delivery (caesarean vs. non-caesarean) and a series of independent variables. Dichotomous variables were analyzed by the χ^2 test or Fisher's exact test,

where appropriate. To isolate some risk factors which are associated with the C-section, we performed the multivariable logistic regression analysis. In brief, to determine the risk factors, let Y_i denote a binary variable that equals 1 with probability P if the respondents undergo caesarean deliveries and 0 with probability 1-P otherwise. For a logistic regression,

$$\Pr(Y_i = 1) = \frac{e^{(\alpha + \beta_1 X_1 + \beta_2 X_2 + \ldots + \beta_k X_k)}}{1 + e^{(\alpha + \beta_1 X_1 + \beta_2 X_2 + \ldots + \beta_k X_k)}}$$

Where, X_j is the set of (j=1, 2,...,17) independent variables, α is the constant of the equation and β is the coefficient of the independent variables. Thus, the estimation form of the logistic transformation can be represented as:

$$Log_e\left[\frac{P(Y=1|X_1, X_2, ..., X_{17})}{1-P(Y=1|X_1, X_2, ..., X_{17})}\right] = \alpha + \beta_1 X_1 + \beta_2 X_2 + ... + \beta_{17} X_{17} = \alpha + \sum_{j=1}^{17} \beta_j X_j$$

The Cox-Snell and Nagelkerke test were also used to assess the overall goodness of fit of the logistic. Finally, a best regression model was estimated separately for overall, public and private hospital by stepwise forward selection. The data were analysed using the Statistical Packages for Social Sciences (SPSS) software for Windows (version 17.0).

Results

The sample comprised of 1142 mothers with the aggregate caesarean and non-caesarean rates among the participants were 57.1% and 42.9% respectively. The c-section (CS) rate in public hospitals was 30.28% (n=199), while the CS rate in private hospitals was 93.47% (n=453). Table 1 present the proportion of women reporting caesarean and non-caesarean delivery by patient characteristics and their significance level. Table 1 also shows that out of 17 variables examined, nine were statistically significant while the remaining eight were statistically not associated with the type of delivery. The significant proportion rate were highest among women having previous c-section (P<0.001), pregnancy-induced swollen of leg (P=0.006) and length of baby > 45 cm (P=0.029). The rate was highest among women with higher educational level followed by higher maternal ages (30 years and above) as compared to lower age groups (less than 20 years). In addition, both (maternal age and education) were found to be statistically significant (P<0.001). The same pattern was also observed in age at marriage. C-section deliveries were found to be less frequent in rural areas as compared to urban areas and place of residence was significantly associated with type of delivery (P<0.001). Duration of taking balance diet was found to be a significant predictor on the type of delivery (P<0.001) and the highest caesarean rate was also observed for those who rarely take a balanced diet.

The adjusted ORs (with 95% confidence intervals) of the logistic regression model of c-section delivery are presented in Table 2. As shown in Table 2, the adjusted OR for a CS in overall delivery cases increases significantly with having previous c-section, pregnancy-induced swollen leg, prolonged labour, higher educational level, mother age > 25 years, lower order of birth, length of baby > 45 cm, and irregular intake of balanced diet. To examine the caesarean delivery with associated risk factors by type of health facilities, separate models were constructed for deliveries in private and public hospitals (Table 3). It was found that women who have related complications around delivery (previous c-section, pregnancy-induced swollen of leg, prolonged labour) and delivered in public hospitals tend to have higher risk of c-section than those who delivered in private hospitals. Furthermore, those who have pregnancy-induced swollen of leg had the greatest impact on the likelihood of caesarean delivery in public hospital, compared to those who were not.

Table 1: Percentage distribution of maternal, socio-demographic and other characteristics by type of delivery and their significance level in northern region of Bangladesh

Selected variables	Delivery type				*P*-Value
	Caesarean delivery		Non-Caesarean delivery		
	n	%	n	%	
Fetal Distress					
No	588	57.2	440	42.8	0.829
Yes	64	56.1	50	43.9	
Previous C-Section					
No	561	53.6	485	46.4	<0.001
Yes	91	94.8	5	05.2	
Pregnancy Induced Senseless					
No	644	57.0	485	53.0	0.745
Yes	8	61.5	5	38.5	
Multiple Birth					
No	643	57.1	483	42.9	0.945
Yes	9	56.3	7	43.8	
Pregnancy-Induced Swollen Leg					
No	365	53.8	314	46.2	0.006
Yes	287	62.0	176	38.0	
Pregnancy-Induced Breathing Difficulty	612	57.1	460	42.9	0.993
No	40	57.1	30	42.9	
Yes					
Prolonged labour					
No	541	70.0	232	30.0	<0.001
Yes	111	30.1	258	69.9	
Mother's Education					
Primary and below	147	44.8	181	55.2	<0.001
Secondary	310	55.4	250	44.6	
Higher	195	76.8	59	23.2	
Mother's Age: years					
<20	185	44.5	231	55.5	
20-24	160	55.2	130	44.8	<0.001
25-29	198	69.0	89	31.0	
30+	109	73.2	40	26.8	
Age at Marriage: years					
<18	344	50.3	340	49.7	<0.001
18-22	188	61.2	119	38.8	
23+	120	79.5	31	20.5	
Order of Birth					
1	369	54.7	306	45.3	0.062
2	199	62.6	119	37.4	
3+	84	56.4	65	43.6	
Length of Baby: cm					
<45	457	55.1	372	44.9	0.029
45+	195	62.3	118	37.7	
Weight of Baby: kg					
<2.5	214	57.4	159	42.6	0.894
2.5+	438	57.0	331	43.0	
Head Circumferences: cm					
<32	486	56.0	382	44.0	0.180
32+	166	60.6	108	39.4	
Residence					
Rural	244	67.6	117	32.4	<0.001
Urban	408	52.2	373	47.8	
Ever had a Child Aborted					
No	631	57.2	473	42.8	0.817
Yes	21	55.3	17	44.7	
Duration of Taking Balanced Diet					
Often	363	51.2	346	48.8	<0.001
Once a week	74	49.3	76	50.7	
Rarely	215	76.0	68	24.0	

Table 2: Logistic regression of the effects of selected characteristics on c-section: Overall cases

Selected variables	Odds ratio [Exp (β)]	95% CI
Fetal Distress		
(No)	1.000	
Yes	1.087	0.671-1.761
Previous C-Section		
(No)	1.000	
Yes	20.184*	10.464-25.582
Pregnancy Induced Senseless		
(No)	1.000	
Yes	23.408	15.105-27.577
Multiple Birth		
(No)	1.000	
Yes	1.120	0.350-3.585
Pregnancy-Induced Swollen Leg		
(No)	1.000	
Yes	1.334**	0.994-1.790
Pregnancy-Induced Breathing Difficulty		
(No)	1.000	
Yes	1.061	0.552-2.039
Prolonged labour		
(No)	1.000	
Yes	0.172*	0.127-0.235
Mother's Education		
(Primary and below)	1.000	
Secondary	2.199*	1.551-3.118
Higher	2.687*	1.588-4.549
Mother's Age: years		
(<20)	1.000	
20-24	1.397	0.926-2.107
25-29	2.740*	1.588-4.729
30+	5.078*	2.319-11.123
Age at Marriage: years		
(<18)	1.000	
18-22	0.931	0.641-1.352
23+	1.062	0.549-2.054
Order of Birth		
(1)	1.000	
2	0.744*	0.493-1.125
3+	0.339	0.175-0.644
Length of Baby: cm		
(<45)	1.000	
45+	1.456**	1.048-2.023
Weight of Baby: kg		
(<2.5)	1.000	
2.5+	0.743	0.541-1.022
Head Circumferences: cm		
(<32)	1.000	
32+	1.084	0.762-1.542
Residence		
(Rural)	1.000	
Urban	0.854	0.612-1.910
Ever had a Child Aborted		
(No)	1.000	
Yes	0.578	0.251-1.332
Duration of Taking Balance Diet		
(Often)	1.000	
Once a week	1.457*	0.953-2.229
Rarely	1.870**	1.244-2.818
Intercept	-0.254	
-2 log likelihood	2997.819	
Cox &Snell R^2	0.542	
Nagelkerke R^2	0.573	

*P<0.01; **P<0.05, significant risk factors in the model; CI= Confidence interval; Parentheses indicate the reference categories

Table 3: Logistic regression of the effects of selected characteristics on c-section: Private & Public hospitals

Selected variables	Private hospital		Public hospital	
	Odds ratio [Exp (β)]	95% CI	Odds ratio [Exp (β)]	95% CI
Fetal Distress				
(No)	1.000		1.000	
Yes	1.325	1.041-2.511	1.573	0.823-2.112
Previous C-Section				
(No)	1.000		1.000	
Yes	6.721	3.483-12.051	8.988*	5.213-10.510
Pregnancy Induced Senseless				
(No)	1.000		1.000	
Yes	9.543	5.780-15.352	10.985	7.813-16.102
Multiple Birth				
(No)	1.000		1.000	
Yes	1.321	0.892-2.912	1.599	0.797-2.741
Pregnancy-Induced Swollen Leg				
(No)	1.000		1.000	
Yes	1.882	0.783-2.721	1.903*	0.489-2.879
Pregnancy-Induced Breathing Difficulty				
(No)	1.000		1.000	
Yes	1.254	0.983-2.034	1.522	0.787-2.019
Prolonged labour				
(No)	1.000		1.000	
Yes	0.026*	0.005-0.080	0.201*	0.114-0.282
Mother's Education				
(Primary and below)	1.000		1.000	
Secondary	0.499	0.131-1.487	1.657**	1.141-2.853
Higher	0.716	0.384-1.933	1.816	0.930-4.384
Mother's Age: years				
(<20)	1.000		1.000	
20-24	1.019	0.225-2.577	1.974	1.154-3.423
25-29	1.949	0.384-3.589	2.795*	1.232-5.360
30+	4.693	0.545-11.015	2.967**	0.943-7.325
Age at Marriage: years				
(<18)	1.000		1.000	
18-22	1.001	0.228-3.571	0.893	0.487-1.358
23+	1.053	0.231-5.899	0.883	0.349-2.236
Order of Birth				
(1)	1.000		1.000	
2	0.524**	0.165-1.832	0.713	0.465-1.345
3+	0.132	0.028-1.845	0.294*	0.190-1.013
Length of Baby's: cm				
(<45)	1.000		1.000	
45+	0.104*	0.029-0.384	1.498**	0.956-2.479
Weight of Baby's: kg				
(<2.5)	1.000		1.000	
2.5+	2.268	0.581-6.329	0.758	0.467-1.127
Head Circumferences: cm				
(<32)	1.000		1.000	
32+	0.567	0.198-1.459	0.804	0.478-1.279
Residence				
(Rural)	1.000		1.000	
Urban	4.606*	1.277-12.100	0.821	0.489-1.237
Ever had a Child Aborted				
(No)	1.000		1.000	
Yes	0.345	0.027-1.832	0.485	0.163-1.665
Duration of Taking Balance Diet				
(Often)	1.000		1.000	
Once a week	2.451	0.658-9.635	1.442**	0.820-2.596
Rarely	8.231	1.181-14.329	1.736	0.982-2.830
Intercept	4.382		-1.194	
-2 log likelihood	1123.014		1665.899	
Cox &Snell R^2	0.510		0.522	
Nagelkerke R^2	0.539		0.553	

*$P<0.01$; **$P<0.05$, significant risk factors in the model; CI= Confidence interval; Parenthesesindicate the reference categories

In public hospitals, the highest odds ratios for caesarean delivery were seen in women aged 30 years and above as compared to those aged 25 years and below. Similarly, first and second born babies had higher odds of being delivered by c-section as compared to third or above for deliveries occurring in private hospitals. For the length of baby, where compared between the two facilities, the study found that this determinant factor was also less important in public hospitals as compared to private hospitals. By the place of delivery, it was a significant determinant of c-section for women delivering in private hospitals, with the strongest risk shown for women residing in urban areas. Finally, a c-section was 1.73 times more likely to occur in public hospitals to women who rarely take a balanced diet.

To identify the most influential risk factors for caesarean delivery, we carried out a stepwise regression analysis on the variables in Table 3. In the overall and different health facilities, the most influential significant variables are listed in Table 4 and 5 respectively. By the stepwise selection in overall cases, the analysis reveals that seven remained significant independent risk factors to predict which patients were at highest risk for caesarean delivery. These variables were long time labour, previous c-section, mother's education, mother's age, order of birth, duration of taking a balanced diet and length of baby (Table 4). From Table 5, the study also found that long labour time, length of baby more than 45cm, urban residence and lower birth order were the most significant determinants of caesarean section in private hospitals, while for public hospitals long time labour, previous c-section, pregnancy-induced swollen of leg and higher maternal educational level were the most important risk factors for determinants of caesarean delivery in the Northern Region of Bangladesh.

Table 4: Stepwise regression of the effects of selected characteristics on c-section: Overall cases

Most influential variables among selected variables	Odds ratio [Exp (β)]	95% CI
Prolonged labour		
(No)	1.000	
Yes	0.174*	0.125-0.238
Previous C-Section		
(No)	1.000	
Yes	20.537*	10.235-24.923
Mother's Education		
(Primary and below)	1.000	
Secondary	2.047*	1.492-3.012
Higher	2.502*	1.489-4.312
Mother's Age: years		
(<20)	1.000	
20-24	1.358	0.826-1.826
25-29	2.856*	1.428-4.123
30+	5.766*	2.121-12.411
Order of Birth		
(1)	1.000	
2	0.703**	0.481-1.005
3+	0.316*	0.123-0.586
Duration of Taking Balance Diet		
(Often)	1.000	
Once a week	1.501*	1.101-2.521
Rarely	1.874**	1.321-2.856
Length of Baby's: cm		
(<45)	1.000	
45+	1.467**	1.112-2.243
Constant	0.664**	0.235-1.578

*$P<0.01$; **$P<0.05$, significant risk factors in the model; CI= Confidence interval; parentheses indicate the reference categories

Table 5: Stepwise regression of the effects of selected characteristics on c-section: Private & Public hospitals

Most influential variables among selected variables	Private hospital		Most influential variables among selected variables	Public hospital	
	Odds ratio [Exp (β)]	95% CI		Odds ratio [Exp (β)]	95% CI
Prolonged labour			Prolonged labour		
(No)	1.000		(No)	1.000	
Yes	0.029*	0.004-0.085	Yes	0.218*	0.115-0.271
Length of Baby: cm			Previous C-Section		
(<45)	1.000		(No)	1.000	
45+	0.174*	0.031-0.410	Yes	7.747*	4.123-9.362
Residence			Pregnancy-Induced Swollen Leg		
(Rural)	1.000				
Urban	4.070*	1.310-10.112	(No)	1.000	
			Yes	1.845*	0.381-2.148
Order of Birth			Mother's Education		
(1)	1.000		(Primary and below)	1.000	
2	0.897**	0.231-1.210	Secondary	1.433**	1.102-2.731
3+	0.233*	0.128-1.541	Higher	2.599*	1.823-5.934
Constant	8.643*	2.545-16.821	Constant	0.366*	0.128-1.678

*$P<0.01$; **$P<0.05$, significant risk factors in the model; CI= Confidence interval; Parentheses indicate the reference categories

Discussion

The study examined the maternal, socio-demographic and other relevant determinants of c-section in the northern region of Bangladesh. The c-section rates in the different health facilities had been of great concern. The analysis of the c-section deliveries for the private and public hospitals substantiates this concern. The rate for private hospitals was higher, where 453 out of 485 births were caesarean deliveries. Past studies in different countries found that the rate of caesarean delivery in private hospitals is also higher than public hospitals (3, 34, 35). It seems that the private practice of the doctors and the financial motive of the private hospitals may be playing some important role in determining the caesarean rates. This statement is bearing the weight of previous studies (29, 36). The result from the logistic regression analysis showed that previous c-section, pregnancy-induced swollen of leg, prolonged labour, maternal educational level, maternal age of more than 25 years, low birth order, length of baby more than 45cm and irregular intake of a balanced diet were important determinants of c-section. Furthermore, the association of these determinants with c-section varied by the different health facilities. By the stepwise selection in logistic regression analysis, we confirmed that demographic characteristics such as length of baby, place of residence and order of birth were more important in private facilities whereas maternal complication such as prolonged labour, previous c-section, pregnancy-induced swollen of leg were more significant determinants in public facilities. Therefore, as shown in this findings, we have expected the rate of c-section will be higher in public patients than private patients but the following result showed the inverse; the rate of caesarean delivery are 93.40% and 30.29% in private and public hospital respectively.

As previously mentioned, educational level, maternal age and parity were found the significant non-clinical factors as the best efficient models in the logistic model. Our results also confirmed by other studies (34, 37). The findings of the present study may indicate that educated women tend to delay childbearing, thus increasing their likelihood of having c-section. In the previous study, it was found that mother's education is a proxy of socio-economic variable and it is associated with c-section (38). In 2001, Ecker et al., cited changes in the childbearing population as a

significant cause of the increase of caesarean birth rates. It is also established that age of mother is closely related to c-section (31). Nassar & Sullivan (39) suggested that age and parity (order of birth) alone account for most demographic changes because there is a high primary caesarean rate for first birth to women 30 years age and older. Mothers with low birth order, who undergo c-section, explained that the choice was made mainly because of their greater risk of pregnancy and delivery-related complications (40, 41). Therefore, it has been imply that delivery by caesarean birth is a complicated health issue in a country level and also a global perspective. In addition, place of residence is one of the most important factors in determining whether to perform a c-section in private or public hospitals, which is consistent with the findings of other studies (17, 42). Padmadas et al. (38) and Misra & Ramanathan (41) have also found that there is a strong association between c-section and place of residence. It seems that women residing in urban areas of the northern region were more likely to undergo c-section in private hospitals. This also indicates the importance of social status in determining the type of delivery. Furthermore, numerous socio-economic and cultural factors influence the decision on pattern of feeding and balance diet that may be influenced to delivery system. As a point of view, duration of taking balance diet considered as an independent variable and the study found that irregular intake of a balanced diet is a significant determinant for caesarean delivery.

Conclusion

The above discussion leads to the conclusion that delivery by c-section is a complicated health issue. Efforts to reduce c-section birth in developing countries like the northern region of Bangladesh will require a comprehensive approach to address patients' variables, care giver practices and hospital policies. In order to addressing the reduction of caesarean rate in the northern region, these significant factors: previous c-section, pregnancy-induced swollen of leg, prolonged labour, maternal educational level, mother's age of more than 25 years, low birth order, length of baby more than 45cm and irregular intake of a balanced diet can be considered to predictors for c-section. Finally, from the statistical point of view, this study also suggests that these factors may influence the health-seeking behaviour of women. Thus, the following steps may be recommended in view of the observed findings:

i. In the study found that the rate of caesarean delivery is lower in public hospitals than private hospitals. Therefore, medical audit, quality assessment and supportive supervision should be considered in order to improve the quality of care in private hospitals. This is likely to minimize C-section rate.

ii. The result also shows that mothers of less than 19 years and more than 25 years of age are at higher pregnancy risks for c-section. Thus, age group of 20 to 24 are safer for normal delivery. However, future research should review maternal age when examining predictors of caesarean birth.

iii. Encouraging pregnant women to take a balanced and nutritional diet may be beneficial.

iv. 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.

v. Provide complete and reliable information to the mothers so that they do not opt for caesarean section in a state of panic or ignorance.

vi. Moreover, Government should be given more attention to monitor hospital data and corresponding strategies.

Ethical considerations

Ethical issues (Including plagiarism, Informed Consent, misconduct, data fabrication and/or falsification, double publication and/or submission, redundancy, etc.) have been completely observed by the authors.

Acknowledgements

We wish to thank the University of Malaya for the financial assistance under UMRG vote RG105-10AFR. The authors declare that there is no conflict of interests.

References

1. Joseph PP, Ann MM, Loise JP, Marion S, Rosemary EP (1988). Medical dictionary: A concise and up-to-date guide to medical terms, Houghton Mifflin Company, USA.
2. Gomes UA, Silva AA, Bettiol H, Barbieri MA (1999). Risk factors for the increasing caesarean section rate in Southeast Brazil: a comparison of two birth cohorts, 1978–1979 and 1994. *Int J Epi*, 28, 687–94.
3. Leung GM, Lam TH, Thach TQ, Wan S, Ho LM (2001). Rates of caesarean birth in Hong Kong: 1987-1999. *Birth*, 28: 166-72.
4. Leone T, Padmadas SS, Matthews Z (2008). Community factors affecting rising caesarean section rates in developing countries: an analysis of six countries. *Soc Sci Med,* 67: 1236-1246.
5. Belizán JM, Althabe F, Barros FC, Alexander S, Showalter E, Griffin A et al. (1999). Rates and implications of caesarean sections in Latin America: ecological study. *Br Medi J,* 319: 1397-02.
6. Murray SF (2000). Relation between private health insurance and high rates of caesarean section in Chile: qualitative and quantitative study. *Br Med J,* 321: 1501–05.
7. Martin JA, Park MM, Sutton PD. (2002). *Births: preliminary data for 2001*. National Vital Statistical Report 50, 1-20.
8. Ravindran J (2008). Rising caesarean section rates in public hospitals in Malaysia 2006. *Medi J Malaysia,* 63(5): 434-35.
9. BMMS (2010). Bangladesh maternal mortality and health care survey 2010: summary of key findings and implications, Dhaka, Bangladesh 1-12.
10. Savage W (2000). The caesarean section epidemic. *J Obstet Gynaecol*, 20: 223–5.
11. World Health Organization (1985). Appropriate technology for birth. *Lancet,* 2: 436-37.
12. Parrish KM, Holt VL, Easterling TR, Connell FA, LoGerfo JP (1994). Effect of changes in maternal age, parity, and birth weight distribution on primary caesarean delivery rates. *J Am Medi Asso,* 271: 443-47.
13. Ecker JL, Chen KT, Cohen AP, Riley LE, Lieberman ES (2001). Increased risk of caesarean delivery with advancing maternal age: indications and associated factors in nulliparous women. *Am J Obstet Gynaecol,* 185: 883-87.
14. Kun H, Fangbiao T, Brian F, Joanna R, Rachel T, Shenglan T *et al.* (2013). A mixed-method study of factors associated with differences in caesarean section rates at community level: the case of rural China. *Midwifery*, 29(8): 911-920.
15. Mossialos E, Allin S, Karras K, Davaki K (2005). An investigation of caesarean section in three greek hospitals: the impact of financial incentives and convenience. *Eur J Public Health,* 15: 288-95.
16. Onwude JL, Rao S, Selo-Ojeme DO (2005). Large babies and unplanned caesarean delivery. *Eur J Obstet Gynaecol Reprod Biol,* 118(1): 36-39.
17. Stanton CK, Holtz SA (2006). Levels and trends in caesarean birth in the developing world. *Studies in Family Planning,* 37(1): 41–48.
18. Skalkidis Y, Petridou E, Papathoma E, Revinthi K, Tong D, Trichopoulos D (1996). Are operative delivery procedures in Greece socially conditioned? *Int J Qual Health Care*, 8: 159–65.
19. Taffel SM (1994). *Caesarean delivery in the United States, 1990*. Vital Health Statistics 51, 1–24.
20. Tatar M, Gunalp S, Somunoglu S, Demirol A (2000). Women's perceptions of caesarean section: reflections from a Turkish teaching hospital. *Soc Sci Med*, 50: 1227–33.
21. Signorelli C, Cattaruzza MS, Osborn JF (1995). Risk factors for caesarean section in Italy: results of a multicentre study. *Public Health,* 109: 191–9.
22. Spaans WA, Sluijs MB, Van Roosmalen J, Bleker O (2002). Risk factors at caesarean section and failure of subsequent trial of labour. *Eur J Obstet Gynaecol Reprod Biol,* 100: 163–6.
23. Lynch CM, Kearney R, Turner MJ (2002). Maternal morbidity after elective repeat caesarean section after two or more previous procedures. *Eur J Obstet Gynaecol Reprod Biol,* 4320: 1–4.
24. Joshua LW, Fergal DM, Danielle E, Robert HB, David AN, Christine HC *et al.* (2004). Obesity, obstetric complications and caesarean delivery rate–a population-based screening study. *Am J Obstet Gynaecol*, 190(4): 1091-1097.
25. Mould TA, Chong S, Spencer JAD, Gallivan S (1996). Women's involvement with the decision preceding their caesarean section and their degree of involvement. *Br J Obstet Gynaecol,* 103: 1074–7.

26. Wilkinson C, McIlwaine G, Boulton-Jones C, Cole S (1998). Is a rising caesarean section rate inevitable? *Br J Obstet Gynaecol,* 105: 45–52.
27. Druzin ML, El-Sayed YY (2006). Caesarean delivery on maternal request: wise use of finite resources? a view from the trenches review article. *Seminars in Perinatology,* 30(5): 305-308.
28. Shearer EL (1993). Caesarean section: medical benefits and costs. *Soc Sci Med,* 37: 1223–31.
29. Parkhurst JO, Rahman SA (2007). Life saving or money wasting? Perceptions of caesarean sections among users of services in rural Bangladesh. *Health Policy,* 80: 392–401.
30. Khawaja M, Kabakian-Khasholian T, Jurdi R (2004). Determinants of caesarean section in Egypt: evidence from the demographic and health survey. *Health Policy,* 69: 273-281.
31. Kassak KM, Mohammad AA, Abdallah AM (2009). Opting for a caesarean: what determines the decision? *Public Administration and Management*, 13(3): 100-122.
32. Rahman M, Shariff AA, Saaid R, Shafie A (2012). Age at marriage, maternal age and caesarean delivery of first birth in the northern region of Bangladesh: a study on curve estimation. *Man in India*, 92(1): 93-113.
33. Cochran WG (1977). *Sampling techniques.* 3rd ed. New York: John Wiley & Sons 72-76.
34. Khawaja M, Jurdi R, Kabakian T (2004). Rising trends in caesarean section rates in Egypt. *Birth,* 31(1): 12-16.
35. Sufang G, Padmadas SS, Fengmin Z, Brown JJ Stones RW (2007). Delivery settings and caesarean section rates in China. Bulletin of World Health Org, Geneva 85, 10.
36. Rahman M, Shariff AA, Shafie A (2012). Caesarean Risk Factors in Northern Region of Bangladesh: A Statistical Analysis. *Tropical Journal of Pharmaceutical Research*, 11 (5): 823-833.
37. Abu-Heija AT, Jallad MF, Abukteish F (1999). Obstetrics and prenatal outcome for pregnancies after the age of 45. *J Obstet Gynaecol,* 19: 486-488.
38. Padmadas S, Kumar S, Nair, S, Kumari A (2000). Caesarean section delivery in Kerala, India: evidence from a national family health survey. *Soc Sci Med,* 51: 511– 21.
39. Nassar N, Sullivan E (2001). Australia's Mothers and Babies, 1999, AIHW Cat. no. PER19, Perinatal Statistics Series no. 11, AIHW National Perinatal Statistics Unit, Sydney.
40. Webster L, Daling J, Mcfarlane C, Ashley, D, Warren C (1992). Prevalence and determinants of caesarean section in Jamaica. *J Bio Sci,* 24: 515–25.
41. Mishra US, Ramanathan M (2002). Delivery-related complications and determinants of caesarean section rates in India. *Health Policy Planning,* 17: 90–8.
42. Villar J, Valladares E, Wojdyla D, Zavaleta N, Carroli G, Velazco A et al. (2006). Caesarean delivery rates and pregnancy outcomes: the 2005 WHO global survey on maternal and prenatal health in Latin America. *The Lancet,* 367(9525): 1819–1829.