Factor affecting C-section deliveries in Bangladesh: Structural equation modeling approach

Md. Jakaria Habib, *Department of Statistics, Jagannath University, Dhaka, Bangladesh*

Sutopa Roy, *Department of Statistics, Jagannath University, Dhaka, Bangladesh*

Ahmed Abdus Saleh Saleheen, *Department of Statistics, Jagannath University, Dhaka, Bangladesh*

Iqramul Haq, *Department of Agricultural Statistics, Sher-e-Bangla Agricultural University, Dhaka*

Shatabdi Shamrita Ume, *Department of Statistics, Jagannath University, Dhaka, Bangladesh*

Abstract

The purpose of this study was to examine the factors affecting complicated pregnancies that lead to the cesarean section in private clinics. A structural equation modeling approach was used to assess demographic, pregnancy, and institutional level factors that affect cesarean section. This analysis was conducted using nationally representative data named "Bangladesh Demographic and Health Surveys 2017-18" and comprising 2439 women. The study established age (ß=0.02), birth order (ß=-0.12), number of ANC visits (ß=0.05) were directly and significantly influenced the c-section delivery. Secondary education level had a direct effect (ß=0.35, $p<0.04$) on c-section delivery as compared to the uneducated women. The BMI status has a direct impact on the likelihood of c-section delivery. In terms of residence, women from rural regions were more interested (ß=0.17, $p<0.05$) in c-section delivery than women from the urban regions. The socio-economic status has an indirect but positive impact on c-section delivery. For example, compared with women from the richest household, women from the poorest, poorer, middle, and rich families had less caesarean delivery. That is, as wealth status increases, women tend to have more cesarean deliveries in Bangladesh.

Keywords: Structural equation model, C-section, maternal health

Introduction

Motherhood is the most pleasant things in a women's life. During this period, a woman has to go through many difficult situations. In a worst scenario women die as a result of complications during pregnancy as well as in childbirth. Most of these complications are preventable or treatable. According to WHO, the major complications that account for nearly 75% of all maternal deaths are severe bleeding, infections, high blood pressure during pregnancy, complications from delivery, unsafe abortion [1]. Thus, it is important to deliver in an appropriate setting where lifesaving equipment and hygienic conditions are available to reduce death of mother and the children [2].

Caesarean section (CS) is a surgical procedure to reduce complications arise in childbirth. CS delivery is often appeared as a lifesaving act but may also have higher risk of maternal mortality and neonatal morbidity [3]. Surgical interventions during childbirth are usually made to ensure safety of the mother and the child, however CS is risky in those area where access to good quality obstetric care and safe facilities are limited [4]. Caesarean delivery is believed to be safer for both mother and the children which influence women for childbirth through caesarean delivery [5]. Therefore, CS delivery has been increased in the last two decades in South Asia [6]. And private health sector is getting popular in Bangladesh during last two decades [6, 7]. Delivery in private hospital was founded as a strongest predictor of CS deliveries [3].

Though WHO in 1985 recommend a CS rate between 10 to 15 percent [8], the CS rates in Brazil was 55.9% in 2018 whereas mean global CS rate is 18.6% [9]. However, not all CS delivery are necessary. Koroukian (1998) estimated that 6.8% of primary and 39.2% of repeat caesarean deliveries are unnecessary [10]. Increasing CS rates do not necessarily lead to improved out-comes and elective CS could raise the chance of maternal death by three times [3]. However, rates of elective CS with no clinical basis have risen [11]. Also, factors such as varying professional practices, economic, social, and cultural factors, and increased fear facility provider about medical litigation have increased the CS rates [9]. Often private providers may be more likely to provide low-quality treatment while overprescribing diagnostics and pharmaceuticals and do not have the same incentive as public health provider [12]. Private facilities are mainly focusing on profit generating and have a tendency in CS without proper indications [7].

In this study, we tried to find out whether a complicated pregnancy in a private hospital resulted in a caesarean section delivery, and focusing on a relationship between socio-economic characteristics, maternal and pregnancy related factors, institutional factors as exogenous factors, the place of delivery and complication during pregnancy as an endogenous variable and caesarean section delivery as an outcome variable.

Materials and Methods

The study used data from the Bangladesh Demographic Health Survey (BDHS), 2017 that was implemented under the authority of the National Institute of Population Research and Training (NIPORT), Ministry of Health and Family Welfare. A multi-stage stratified cluster sampling approach has been used in this survey. In the survey, 20,250 households were selected and 20,127 women between the ages of 15 and 49 were interviewed, there were 2439 women who had given a birth at institution during the three years preceding the survey.

Outcome variable of our study is Caesarean section delivery, which is coded as "1" for Yes and "0" for No. The place of delivery and Complication during pregnancy was considered as endogenous variable. Since CS delivery only possible in hospital (public, or private), place of delivery coded as "1" for Private hospital and "0" for Public Hospital. Complication during pregnancy was coded as "1" for Yes and "0" for No.

In this study, we conducted a simple descriptive analysis and bivariate analysis. Bivariate analysis was used to examine the association between CS delivery and selected independent variables. The generalized structural equation model was also used to test the hypothetical causal path. There was no latent variable included in the model. All the analysis was conducted using the software R version 3.6.0.

Results

Descriptive statistics showed that a total of 2439 study participants responded to the study. The mean (±SD) age of the participants was 24.82 years (±5.50 years, range 19–31). The mean (±SD) parity was 1.88 (±1.05). Regarding the education level, half of the participants have secondary education (51.17%). Only a few (28.58%) have higher education. Maximum was the richest

(32.19%) family. The data was collected from both urban (41.78%) and rural (58.22%) areas including all the divisions of Bangladesh. The majority were in Dhaka (17.02%), Chittagong (15.99%), and Khulna (13.20%). More than two-thirds of the people (78.35%) have Iron supplements. 67.61% of mothers have caesarean babies. About two-thirds of the surveyed mothers (56.54%) had a body mass index (BMI) within the normal range. Of the total births, 32.96% were deliveries at Public Hospital. About 67.04% were deliveries at Private Hospital. 58.43% didn't face any pregnancy complications.

Bi-variate analysis showed that all the exogenous variables have significantly associated with outcome variable C-section delivery.

Table 1: Percentage distribution and Bi-variate analysis of mother by selected explanatory variables.

Variables	**Percentage/Mean ± SD** (n=2439)	**CS delivery (%)**
Age	24.82 ± 5.50	
Parity	1.88 ± 1.05	
Number of ANC	4.84 ± 2.86	
Education***		
No education	3.20	64.1
Primary	17.06	59.1
Secondary	51.17	64.8
Higher	28.58	78.2
Wealth index***		
Poorest	11.56	51.1
Poorer	15.70	60.3
Middle	17.67	64.3
Richer	22.88	65.6
Richest	32.19	80.5
Region***		
Barisal	9.02	66.8
Chittagong	15.99	60.9

Dhaka	17.02	78.3
Khulna	13.20	70.5
Mymensingh	10.41	66.1
Rajshahi	11.85	69.9
Rangpur	10.50	65.2
Sylhet	12.01	60.1
Place of residence[***]		
Urban	41.78	71.1
Rural	58.22	65.1
Iron supplement during pregnancy[***]		
No	16.48	62.9
Yes	78.35	69.5
BMI of mother[***]		
Under weight	12.26	56.9
Normal	56.54	64.3
Obese	6.48	86.7
Over weight	22.88	75.1
Hospital[***]		
Public	32.96	34.6
Private	67.04	83.9
Pregnancy complication[***]		
No	58.43	66.5
Yes	41.57	72.3
C-section		
No	32.35	
Yes	67.61	

[***] indicated highly significant in bivariate analysis

The goodness of fit index value of the structural equation model (GFI = 0.93) indicated a good fit model. Moreover, Values of error-of-approximation based fit indices (RMSEA = 0.04, SRMR = 0.01) was also specified the model as a good fit to the observed dataset (Table 2).

Table 2: Goodness of fit for Structural model.

Goodness of Fit Measures	Structural Model	Recommended Value
$\chi 2$ test statistics / (df)	$94.338/23 = 4.10^{***}$	≤ 5.00
GFI	0.93	≥ 0.90
RMSEA	0.04	≤ 0.08
SRMR	0.01	≤ 0.08

Note: ***p<0.001; GFI= Goodness of Fit Index; RMSEA= Root-mean-square Error of Approximation; SRMR= Standardized root mean square residual

Result from the structural equation model displayed in the Table 3 showed that, age, birth order, number of ANC significantly influenced CS delivery. Direct effect of parity (β=-0.122, p<0.01) had negative effect on CS delivery which indicated that women with higher parity less likely to prefer CS delivery.

BMI of mother is an important factor had significant negative effect on CS delivery directly compare to Obese mother (Underweight, β=-0.655, p<0.001; Normal, β=-0.477, p<0.001; Overweight, β=-0.323, p<0.01). Compare to urban residence, rural residence had positive direct effect (β=0.166, p<0.1) on CS delivery. Wealth index had a significant indirect negative effect on CS delivery mediated through place of delivery and complicated pregnancy although it had insignificant large direct effect on CS delivery. Private hospital had highly significant direct effect on CS delivery (β=0.703, p<0.001). Total effect of complication during pregnancy on CS delivery was insignificant (β=0.022, p=0.550).

Table 3: Direct effect, indirect effect and total effect of socio and reproductive factors on C-section delivery.

Variable	Direct		Indirect		Total	
	β	p-value	β	p-value	β	p-value
Age	0.023	**0.002**	0.000	0.859	0.023	**0.002**
Parity	-0.122	**0.003**	0.000	0.858	-0.122	**0.003**

Number of ANC	0.049	**0.000**	-0.001	0.856	0.048	**0.000**
Education						
Primary	-0.206	0.238	-0.083	0.517	-0.289	0.126
Secondary	-0.349	**0.041**	0.020	0.873	-0.329	0.074
Higher	-0.326	0.071	0.116	0.380	-0.210	0.281
BMI						
Normal	-0.477	**0.000**	0.000	0.879	-0.477	**0.000**
Overweight	-0.323	**0.017**	0.000	0.863	-0.324	**0.017**
Underweight	-0.655	**0.000**	0.001	0.857	-0.654	**0.000**
Residence						
Rural	0.166	**0.014**	-	-	0.166	**0.014**
Wealth index						
Poorest	-0.206	0.053	-0.346	**0.000**	-0.552	**0.000**
Poorer	-0.054	0.566	-0.278	**0.000**	-0.333	**0.002**
Middle	-0.072	0.426	-0.218	**0.002**	-0.290	**0.004**
Richer	-0.131	0.107	-0.186	**0.002**	-0.317	**0.000**
Division						
Chittagong	-0.224	0.056	-0.046	0.595	-0.270	**0.027**
Dhaka	0.208	0.091	-0.048	0.582	0.160	0.204
Khulna	0.044	0.704	0.012	0.891	0.057	0.655
Mymensingh	0.052	0.650	-0.053	0.563	-0.001	0.996
Rajshahi	0.014	0.908	0.050	0.576	0.064	0.620
Rangpur	-0.100	0.390	-0.043	0.644	-0.143	0.281
Sylhet	0.228	0.082	-0.347	0.000	-0.119	0.377
Hospital						
Private	0.703	**0.000**	-	-	0.703	**0.000**
Pregnancy complication						
Yes	-0.006	0.856	0.028	0.246	0.022	0.550
Iron supplement during pregnancy						
Yes	-	-	-0.001	0.857	-0.001	0.857

Discussion

This study investigates factors of CS delivery mediated through place of hospital and complicated pregnancy. The negative effect of wealth index on CS delivery mediated through place of delivery that is delivery in private hospital indicates that the cost of private hospital cannot afford by household with lower wealth index compare to the richest household [3, 13]. Parity of the mother was important factor of CS delivery. In our study, we found a negative effect of parity on CS delivery which means that women have low parity are more prone to CS delivery. Similar result was found any other studies [3]. Number of ANC has significant positive effect on CS delivery which is consistence with the results of another study [2, 3, 7]. Private hospital plays a significant role in CS delivery. Findings of the previous study identify the following factors that contribute in increasing CS delivery: perception of improved quality of care, easy accessibility, availability of preference doctors, a low trust level regarding care of public facilities [14, 15]. Our finding is similar to the previous study of high prevalence of CS delivery in Bangladesh [7] as well as South Asian countries [16]. Pregnancy complications are closely involved in the decision-making process leading to CS delivery. Unlike the findings of Huang et al., our study finds an insignificant positive effects of pregnancy complication through mediation variable private hospital on CS delivery [11]. Iron supplement during pregnancy has negative indirect effect on CS delivery through mediation variable pregnancy complication.

Conclusion

Unnecessary CS delivery increase the risk of maternal and child mortality and may cause long term damage in health. The present study illustrates that, rural women more likely to choose CS delivery, women who have any complications during pregnancy chose CS delivery in private hospital rather than public hospital. This psychosocial factor of caesarean section use should be stop for maternal and child wellbeing by taking appropriate steps like awareness rising program. Also, women's and health-care provider's preference together affect the choice of CS. Evidence-based information should be provided to health providers and users. However, this study has some limitations. Since BDHS is a cross-sectional study, it does not allow doing the causal inference between covariates and outcome variables.

Reference

1. Say L, Chou D, Gemmill A, Tunçalp Ö, Moller A-B, Daniels J, et al. Global causes of maternal death: a WHO systematic analysis. The Lancet Global health. 2014;2(6):e323-33.

2. Kamal SM. Preference for Institutional Delivery and Caesarean Sections in Bangladesh. Journal of Health, Population and Nutrition. 2013 Apr 25;31(1).

3. Sk R. Does delivery in private hospitals contribute largely to Caesarean Section births? A path analysis using generalised structural equation modelling. Joe W, editor. PLOS ONE. 2020 Oct 8;15(10):e0239649.

4. Rudey EL, Leal M do C, Rego G. Cesarean section rates in Brazil. Medicine. 2020 Apr;99(17):e19880.

5. Dodd J, Pearce E, Crowther C. Women's experiences and preferences following Caesarean birth. The Australian and New Zealand Journal of Obstetrics and Gynaecology. 2004 Dec;44(6):521–4.

6. Das S, Alcock G, Azad K, Kuddus A, Manandhar DS, Shrestha BP, et al. Institutional delivery in public and private sectors in South Asia: a comparative analysis of prospective data from four demographic surveillance sites. BMC Pregnancy and Childbirth. 2016 Sep 20;16(1).

7. Rahman MM, Haider MR, Moinuddin Md, Rahman AE, Ahmed S, Khan MM. Determinants of caesarean section in Bangladesh: Cross-sectional analysis of Bangladesh Demographic and Health Survey 2014 Data. Rahman M, editor. PLOS ONE. 2018 Sep 12;13(9):e0202879.

8. World Health Organization. Appropriate technology for birth. The Lancet. 1985 Aug;326(8452):436–7.

9. Rudey EL, Leal M do C, Rego G. Cesarean section rates in Brazil: trend analysis using the Robson classification system. Medicine. 2020 Apr;99(17):e19880.

10. Koroukian SM, Trisel B, Rimm AA. Estimating the Proportion of Unnecessary Cesarean Sections in Ohio Using Birth Certificate Data. Journal of Clinical Epidemiology. 1998 Dec;51(12):1327–34.

11. Huang K, Tao F, Faragher B, Raven J, Tolhurst R, Tang S, et al. A mixed-method study of factors associated with differences in caesarean section rates at community level: The case of rural China. Midwifery. 2013 Aug;29(8):911–20.

12. Anna M. Blind optimism: challenging the myths about private health care in poor countries. Oxford, UK: Oxfam International; 2009.

13. Pomeroy AM, Koblinsky M, Alva S. Who gives birth in private facilities in Asia? A look at six countries. Health Policy and Planning. 2014 Jul 1;29(suppl 1):i38–47.
14. Onah HE, Ikeako LC, Iloabachie GC. Factors associated with the use of maternity services in Enugu, southeastern Nigeria. Social Science & Medicine. 2006 Oct;63(7):1870–8.
15. Khawaja M, Kabakian-Khasholian T, Jurdi R. Determinants of caesarean section in Egypt: evidence from the demographic and health survey. Health Policy. 2004 Sep;69(3):273–81.
16. Neuman M, Alcock G, Azad K, Kuddus A, Osrin D, More NS, et al. Prevalence and determinants of caesarean section in private and public health facilities in underserved South Asian communities: cross-sectional analysis of data from Bangladesh, India and Nepal. BMJ Open. 2014 Dec;4(12):e005982.