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Exploring spatial variations and risk factors associated with cesarean section delivery in Bangladesh

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ABSTRACT

This study was to explore the spatial variations and risk factors of cesarean delivery in Bangladesh. We used the Bangladesh Demographic and Health Survey (BDHS) 2017-18 data. The Getis-Ord Gi* statistic was applied to assess the hot spots and cold spots of cesarean delivery, and a multilevel logistic regression model was utilized to determine the risk factors related to cesarean delivery in Bangladesh. This study found that one-third of all births (33%; 95% CI = 30.68-34.66) delivered through cesarean section. The hot spots of cesarean delivery were in Dhaka, Khulna, Rajshahi and Rangpur divisions. The cold spots were in Barisal, Rangpur, and Sylhet divisions. Women with higher education (OR =2 .24, 95% CI = 1.49-3.36), overweight/obese women (OR = 2.07, 95% CI = 1.63–2.63) and women from Khulna division (OR = 1.87, 95% CI= 1.32–2.64) were significantly associated with cesarean section. Therefore, concentrating on factors including women's education, partner's education, partner's occupation, age at first birth, wealth index, women's body mass index (BMI) status, media exposure, and divisions might play a crucial role in reducing the unnecessary cesarean section in Bangladesh.

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1. INTRODUCTION

A cesarean section (CS) is a life-saving surgical approach to avoid the risks of maternal and newborn health complications. In addition, this kind of surgery is necessary when vaginal delivery is not possible because of the health risks for both the fetus and mother [1]. Moreover, CS delivery can play a crucial role in eliminating maternal and child mortality [2], [3]. Worldwide, the number of cesarean section deliveries is increasing over time, and, by 2030, approximately 29% of births are likely to occur by cesarean delivery [4]. However, unnecessary cesarean section increases the possibility of maternal and neonatal morbidity and mortality [5]. Besides, it is responsible for short-term and long-term health difficulties in mothers and childbirth [6], [7]. Uterine rupture, wrong placentation, ectopic pregnancy, and stillbirth are the negative consequences of CS delivery [6]. Furthermore, the personal preference of women for CS is one of the main reasons for increasing cesarean deliveries. World Health Organization (WHO) recommends that the maximum standard rate of CS delivery in a country is 10-15% [8]. But about 21% of all births were delivered by CS around the globe, which has become a very alarming issue [9].

From 1990 to 2014, the global CS rate went up to 12.4%. Besides, both Latin America and the Caribbean had the highest rate of CS delivery (19.4%), whereas Africa had the lowest CS delivery rate (only 4.5%) [10]. Within the past few decades, the number of CS deliveries has dramatically increased in both

developed and underdeveloped countries [8]. In South and Southeast Asian countries, the CS delivery rate is 13%, which is gradually increasing [11]. In Bangladesh, the prevalence of CS delivery remains high. According to the Bangladesh Demographic and Health Survey conducted in 2017–2018, the rate of cesarean deliveries was 33%; however, the Multiple Indicator Cluster Survey (MICS) conducted in 2019 found that the rate was 36%. [12]. Over the past years, almost 13% of cesarean deliveries were occurred in nine South and Southeast Asian countries, including Bangladesh. However, this number increased to 19% when including institutional deliveries [11]. The Sustainable Development Goal 3 (SDG-3) focused on reducing both neonatal mortality (12 deaths per 1,000 live births) and under-5 mortality (25 per 1,000 live births). In addition, SDG-3 aims to decline maternal mortality to less than 70 per 100,000 live births [13]. Unsafe abortion, gestational diabetes, hypertension, infections (normally after childbirth), pregnancy related complications, and mistimed labor are the major causes of maternal death worldwide [14], [15]. To avoid these risks during pregnancy, most women choose CS delivery without the justification of whether they actually need it. As a result, unnecessary CS delivery is increasing day by day [16]. When CS perform without any proper medical justification, it accelerates the risk of maternal and neonatal mortality [17], [18].

Several studies were conducted to determine the risk factors of CS delivery in Bangladesh. Most of the research focused on women's education, partner's educational status, partner's occupations, birth order, wealth index, age at first birth, women's body mass index (BMI) status, media exposure, religion, place of residence, and division. However, there was an insufficiency to identify the hot spot and cold spot areas of cesarean delivery and its risk factors. This study was to identify spatial variations and risk factors of cesarean delivery in Bangladesh.

2. METHOD

2.1. Study design and sample size

We used data from the Bangladesh Demographic and Health Survey (BDHS) 2017–2018, including a representative sample of the total population. The Ministry of Health and Family Welfare and the National Institute of Population Research and Training (NIPORT) provided assistance in conducting this study. This survey employed a two-stage stratified sampling technique. 675 enumeration areas were identified by applying the probability proportional to enumeration area in the first stage. After three regions were excluded because of flooding, 672 enumeration areas were considered to conduct the survey. After that, systematic sampling was used to select 30 households per cluster. In total, 20,127 women aged 15–49 participated for final interviews. 5,127 women were considered as a study sample in this study. The inclusion criterion was at least one live birth in the last three years before the survey. Data on cesarean section delivery was also gathered by the survey. Details information for sampling technique are provided elsewhere [19].

2.2. Outcome variable

The outcome variable was CS delivery in this study. It was coded as 1 if respondents took CS delivery during their delivery time. On the other hand, it was coded as 0 if respondents did not take CS delivery during their delivery.

2.2. Explanatory variables

The explanatory variables were divided into two categories, namely individual- and community-level factors. We identified the explanatory variables based on the literature review [1], [20]-[22] and data availability of BDHS. Women's education, partner's education, partner's occupations, age at first birth, wealth index, BMI status and media exposure were considered as individual-level factors. On the other hand, community-level factors were considered as place of residence, religion, and division.

2.3. Statistical analysis

In this study, a descriptive study was utilized to identify the background characteristics of respondents. To assess the regional variations in CS delivery, the global Moran's I statistic was used. The Getis-Ord General G statistic was employed to explore the clustering degree for CS delivery. We applied multilevel logistic regression to assess the risk factors of CS delivery. In addition, the odds ratio (OR) with a 95% CI was used to provide the result. Each model provides different intra-class correlation (ICC), Akaike information criterion (AIC), and Bayesian information criterion (BIC). For all kinds of statistical analysis in this study, we used STATA (version 14.0) and ArcGIS (version 10.4.1).

3. RESULTS AND DISCUSSION

3.1. Results

Descriptive statistics, including the proportion of CS in all categories, are provided in Table 1. The prevalence of cesarean section delivery was 33.0% (95% CI: 30.68–34.66). Around 49.02% of women who completed secondary education, 35.24% of women whose partners completed higher education, 34.47% of women whose partners were manual laborers, 55.81% of women who lived in rural areas, 60.58% of women who belonged to the rich wealth index, and 19.38% of women who resided in the Dhaka division delivered via cesarean section. Muslim women (90.22%), women who were exposed to media (80.92%), and women with normal weight (54.38%) had greater percentages of CS.

3.1.1. Factors associated with cesarean section delivery

Model 3 showed that women's education, partner's education, partner's occupation, age at first birth, wealth index, women's BMI status, media exposure, and division were significantly associated with cesarean section (Table 2). Women with higher education had a 2.24 times (95% CI = 1.49–3.36) higher likelihood of delivering by CS than women with no education. Compared to women with uneducated partners, women with higher-educated partners had 2.24 times (95% CI = 1.63–3.07) greater odds of giving birth via caesarean section. The likelihood of receiving CS was 1.43 times (95% CI = 1.10–1.85) higher for women whose partners were engaged in services compared to those whose partners were engaged in agriculture. Women's age at first birth, 25 and above, had 2.71 times (95% CI = 1.95–3.77) higher chances of delivering through a CS than women's age at first birth, under 18 years. Women belonging to the rich wealth index had 1.79 times (95% CI = 1.46-2.20) higher odds of receiving CS than women who came from the poor wealth index. Overweight/obese women had 2.07 times (95% CI = 1.63–2.63) higher chance of giving birth through CS compared to underweight women. The likelihood of a cesarean delivery was 1.87 times (95% CI = 1.32-2.64) higher for women in the Khulna division compared to those in the Barisal division.

Table 1. Background characteristics of the respondents

Variables		Cesarean delivery	
		No (%)	Yes (%)
Women's education	No education	8.14%	2.98%
	Primary	34.26%	14.97%
	Secondary	47.30%	49.02%
	Higher	10.29%	33.04%
Partner's education	No education	17.36%	6.86%
	Primary	39.57%	22.84%
	Secondary	31.97%	35.06%
	Higher	11.10%	35.24%
Partner's occupation	Agricultural	23.10%	12.88%
	Manual labor	41.51%	34.47%
	Business	18.06%	21.29%
	Services	12.55%	13.95%
	Others	4.78%	17.41%
Age at first birth	<18	46.06%	29.76%
	18-20	38.55%	36.55%
	21-24	12.75%	22.30%
	>=25	2.64%	11.39%
Wealth index	Poor	52.14%	22.30 %
	Middle	18.52%	17.11%
	Rich	29.33%	60.58%
Women's BMI status	Underweight	18.38%	10.67%
	Normal	65.62%	54.38%
	Overweight/obese	16.00%	34.94%
Media exposure	No	44.78%	19.08%
	Yes	55.22%	80.92%
Residence	Urban	28.99%	44.19%
	Rural	71.01%	55.81%
Religion	Muslim	92.29%	90.22%
	Non – Muslim	7.71%	9.78%
Division	Barisal	11.57%	8.71%
	Chittagong	17.77%	13.77%
	Dhaka	12.00%	19.38%
	Khulna	8.49%	13.77%
	Mymensingh	12.96%	10.32%
	Rajshahi	9.74%	12.34%
	Rangpur	11.36%	10.61%
	Sylhet	16.12%	11.09%

Table 2. Factors associated with cesarean section delivery in Bangladesh using multilevel logistic regression model (N=5,127)

Variables		Model 0 OR (95%CI)	Model 1 OR (95% CI)	Model 2 OR (95%CI)	Model 3 OR (95% CI)
Women's education	No education		1.00		1.00
	Primary		0.96(0.67-1.38)		0.95(0.66-1.38)
	Secondary		1.56(1.09-2.23) *		1.53(1.07-2.19) *
	Higher		2.28(1.52-3.41) ***		2.24(1.49-3.36) ***
Partner's education	No education		1.00		1.00
	Primary		1.14(0.88-1.47)		1.15(0.89-1.49)
	Secondary		1.41(1.08-1.84) **		1.44(1.11-1.88) **
	Higher		2.26(1.65-3.10) ***		2.24(1.63-3.07) ***
Partner's occupation	Agricultural		1.00		1.00
	Manual labor		1.03(0.84-1.28)		1.05(0.85-1.30)
	Business		1.12(0.88-1.42)		1.16(0.91-1.47)
	Services		1.38(1.07-1.78) **		1.43(1.10-1.85) **
	Others		1.32(0.96-1.81)		1.35(0.98-1.86)
Age at first birth	<18		1.00		1.00
	18-20		1.11(0.94-1.30)		1.13(0.97-1.33)
	21-24		1.51(1.23-1.86) ***		1.53(1.24-1.89) ***
	>=25		2.67(1.92-3.72) ***		2.71(1.95-3.77) ***
Wealth index	Poor		1.00		1.00
	Middle		1.27(1.03-1.56)		1.27(1.03-1.56) *
	Rich		1.80(1.48-2.17) ***		1.79(1.46-2.20) ***
Women's BMI status	Underweight		1.00		1.00
	Normal		1.12(0.91-1.38)		1.14(0.93-1.41)
	Overweight/obesity		2.02(1.56-2.56) ***		2.07(1.63-2.63) ***
Media exposure	No		1.00		1.00
	Yes		1.74(1.47-2.07) ***		1.62 (1.36-1.92) ***
Residence	Urban			1.00	1.00
	Rural			0.50(0.41-0.60) ***	0.93(0.77-1.11)
Religion	Muslim			1.00	1.00
	Non – Muslim			1.31(1.01-1.71) *	1.15(0.88-1.49)
Division	Barisal			1.00	1.00
	Chittagong			0.96(0.66-1.40)	0.76(0.55-1.06)
	Dhaka			1.83(1.26-2.65) ***	1.48(1.06-2.05) *
	Khulna			2.12(1.44-3.12) ***	1.87(1.32-2.64) ***
	Mymensingh			1.06(0.72-1.57)	1.13(0.80-1.59)
	Rajshahi			1.76(1.19-2.59) **	1.62(1.15-2.28) **
	Rangpur			1.19(0.80-1.76)	1.22(0.86-1.74)
	Sylhet			0.83(0.56-1.23)	0.94(0.67-1.34)
Model diagnosis	Variance (CI)	0.97(0.77-1.22)	0.36(0.24-0.54)	0.70(0.53-0.91)	0.28(0.18-0.45)
	ICC (%)	0.23	0.10	0.18	0.08
Model fitness	Log-likelihood	-3097.94	-2710.34	-3043.56	-2684.85
	AIC	6199.88	5460.68	6109.13	5427.70
	BIC	6212.99	5591.53	6181.09	5617.43
	N	5,127	5,127	5,127	5,127

Note:
- Model 0: Null Model; Model 1: adjusted individual-level factors; Model 2: Adjusted community-level factors; Model 3: Adjusted individual-level factors and community-level factors.
- OR: Odds ratio, ICC: Intra-class correlation coefficient, CI: Confidence interval, AIC: Akaike information criterion, BIC: Bayesian information criteria.
- *p<0.05; **p<0.01; ***p<0.001

3.1.2. Random effect results

The variation in the prevalence of cesarean section delivery was found in the null model (σ^2= 0.97, 95% CI: 0.77, 1.22). In the null model (Model 0), the intra-class correlation coefficient (ICC) explained that differences across clusters accounted for approximately 0.23% of total variability. The log-likelihood and Akaike Information Criteria (AIC) values were the lowest in Model 3 (log-likelihood = 2,684 and AIC = 5,427) compared with other models. Therefore, model 3 was identified as the best model to assess the determinants of cesarean delivery in Bangladesh.

3.1.3. Spatial autocorrelation of cesarean section delivery in Bangladesh

The spatial autocorrelation was applied to examine whether the cesarean section delivery is random or not. Global Moran's I test was used to determine the spatial autocorrelation of CS in Bangladesh. The result of this index (Global Moran's I value = 0.19, z-score = 7.14, p < 0.000) indicates a statistically significant autocorrelation as shown in Figure 1. The figures right side displayed the higher proportion of deliveries by cesarean section.

3.1.4. Hot spots and cold spots of cesarean delivery in Bangladesh

Hot spot and cold spot areas of cesarean delivery in Bangladesh were identified utilizing the Getis-Ord Gi* statistic. The hot spots of cesarean delivery were mainly located in Dhaka, Khulna, Rajshahi, and Rangpur divisions, which were marked in red color as shown in Figure 2. On the contrary, the cold spots were mainly in Barisal and Sylhet divisions. Rangpur division was both the hot spot and cold spot area of cesarean delivery.

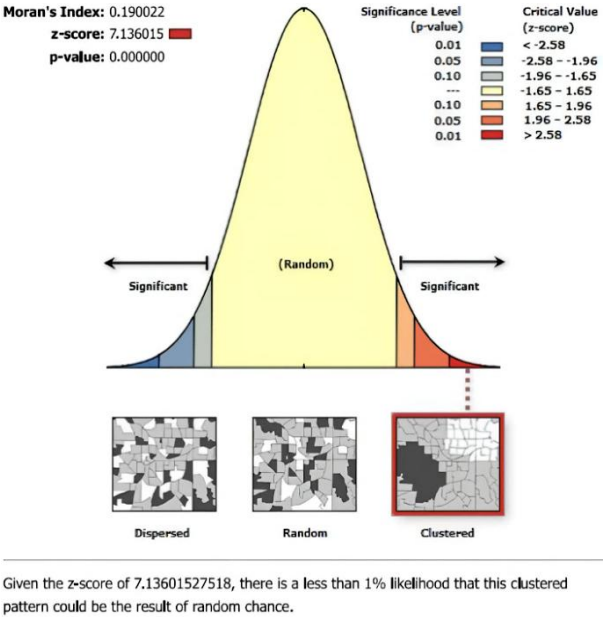

Figure 1. Spatial autocorrelation of cesarean section delivery

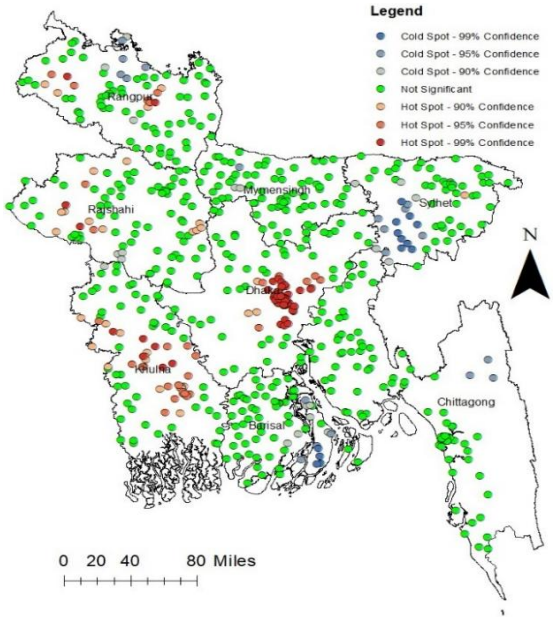

Figure 2. Hot spots and cold spots of cesarean section delivery in Bangladesh

3.2. Discussion

This study was to identify the spatial variations and risk factors of CS delivery in Bangladesh. The prevalence of CS delivery in Bangladesh was 33.0%. In this study, it was explored that the hotspot areas of CS delivery were Dhaka, Khulna, Rajshahi, and Rangpur divisions. Previous studies also identified significant spatial variations in CS delivery in Bangladesh [23], [24]. Differences in socioeconomic status and attitude towards CS delivery were the main reasons for significant regional variations [25], [26]. Though the prevalence of CS delivery is increasing across all wealth quintiles, this study explored that the ultimate rise of CS delivery in the richest household group is quite higher than in the poorest household group. This result is supported by some previous studies conducted in Bangladesh [26], [27]. Women with higher education had a higher prevalence of CS delivery than women with no education. This study also explored that the chances of receiving CS delivery are increasing with the increase in women's education. This finding was also similar to that of the previous study [21], [28]. Educated women are more conscious of their health compared to uneducated women. Also, the majority of educated women are economically independent, and they want to deliver via CS for painless and safe delivery. Another possible reason was that higher-educated women might have higher chances of delayed pregnancy; as a result, they choose CS delivery to avoid the risk of pregnancy complications [27], [29].

Women whose partners were more educated had a higher prevalence of CS delivery. This finding was also similar to the other studies [27]. The possible reason may be that educated partners were more concerned about the health status of women than uneducated partners. Also, educated partners usually have a higher socio-economic status. Furthermore, health education and health awareness are more common among higher-educated partners [30]. Age at first birth was one of the drivers of CS. Most of the women who gave birth after 25 years of age chose CS delivery to avoid any kind of pregnancy complications [31]. Also, they were more frightened about their first pregnancy. Higher CS deliveries were more common among women whose husbands engaged in the service than among those whose husbands worked in agriculture. Women who were obese or overweight had a higher chance of CS delivery. This result was consistent with a prior study carried out in Bangladesh [31], [25]. Obese women may suffer from more pregnancy-related complications than normal-weight women during their gestation period. Apart from this, obese women suffer

from various non-communicable diseases, namely gestational diabetes, hypertensive disorders, preeclampsia, and excess cholesterol [32]-[34]. To avoid these vulnerabilities during pregnancy, most of the obese women went for CS delivery. This study also revealed that media exposure was one of the most significant factors in CS delivery. Women who were exposed to media had higher chances of CS during delivery. The health sector relies substantially on the mass media. Previous studies also identified a similar finding conducted in Bangladesh [21]. It often advertises the advantages of timely delivery care and the adverse effects of deliveries performed by unskilled birth attendants. As a result, most of the women want CS delivery to avoid the adverse effects. This study explored the fact that Khulna Division had the highest number of CS deliveries. This might be possible due to socio-economic conditions. Limited access to quality healthcare during pregnancy, especially in rural areas of Khulna division, makes them to choose CS delivery due to concerns about many potential complications during vaginal delivery. Apart from these, better living standards, access to media, and health education may be the major reasons for CS delivery in the Dhaka division compared to other divisions in Bangladesh.

4. CONCLUSION

In Bangladesh, the prevalence of cesarean section delivery remains high. This rate is dramatically increasing day by day, which has become a major concern for both maternal and child health. This study explored that women's education, partner's education, partner's occupation, women's BMI status, age at first birth, wealth index, access to media, and divisions were the most significant risk factors for CS delivery in Bangladesh. In this study, it was identified that CS is more common in higher socio-economic groups. To reduce the dramatically increasing rate of CS in Bangladesh, the government and policymakers should emphasize the identified risk factors and go up awareness about the detrimental effects of unnecessary CS delivery.

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Md. Mamunur Rashid	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	

C : **C**onceptualization
M : **M**ethodology
So : **So**ftware
Va : **Va**lidation
Fo : **Fo**rmal analysis
I : **I**nvestigation
R : **R**esources
D : **D**ata Curation
O : Writing - **O**riginal Draft
E : Writing - Review & **E**diting
Vi : **Vi**sualization
Su : **Su**pervision
P : **P**roject administration
Fu : **Fu**nding acquisition

CONFLICT OF INTEREST STATEMENT

Authors state no conflict of interest.

DATA AVAILABILITY

The datasets used and analyzed in this study are available from the measure DHS website: (https://dhsprogram.com/data/available-datasets.cfm).

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