

Prevalence and Risk Factors for Surgical Site Infection Following Cesarean Section in a Tertiary Care Hospital

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Abstract

Background: Cesarean sections have become increasingly prevalent in both developed and developing nations. Nevertheless, postoperative complications, including surgical site infections (SSIs), remain a substantial concern that contributes to heightened morbidity and mortality. This study is designed to evaluate the frequency and key determining factors associated with surgical site infections following cesarean section procedures in a tertiary care hospital in Bangladesh. **Materials and Methods:** This observational cross-sectional study, conducted at the Gynecology Department of Dhaka Medical College Hospital, involved 100 patients aged 15 - 45 who had cesarean deliveries. Data was collected during hospitalization and post-discharge and analyzed to determine the prevalence and relationship between socio-demographic characteristics and surgical site infection. **Results:** Among the study participants, 14% developed surgical site infections following cesarean operations. More than half of these patients were under the age of 25, with a mean age of 24.45 ± 4.44 years. Surgical site infections were more prevalent in individuals over 30 years old (P-value < 0.001), illiterate women (P-value 0.004), obese women (P-value 0.038), and women with anemia (P-value < 0.001). Maintaining proper hygiene (P-value 0.001), having regular menstrual cycles (P-value 0.002), and attending antenatal check-ups (P-value 0.039) can reduce the risk of infections. The primary reasons for undergoing a cesarean section included a history of previous cesarean deliveries, fetal distress, breech presentation, pre-eclampsia, placenta previa, and twin pregnancies. Notably, 94% of participants delivered a live baby, while 6% sadly experienced stillbirth. **Conclusion:** Post-cesarean surgical site infections are notably prevalent among the partic-

ipants in this study. Several risk factors have been identified, including age, body mass index (BMI), socioeconomic status, anemia, preterm delivery, personal hygiene practices, regular menstrual cycles, and adherence to antenatal check-ups. The implementation of an effective awareness program, coupled with updated antibiotic protocols, is crucial for significantly reducing the incidence of these infections.

Keywords

Surgical Site Infection (SSI), Cesarean Section, Risk Factors

1. Introduction

The global prevalence of cesarean section deliveries has seen a notable increase across numerous countries. When clinically warranted, cesarean sections play a critical role in reducing maternal and perinatal mortality as well as morbidity. However, the evidence does not support the benefits of cesarean delivery in the absence of specific medical indications for either mothers or infants. According to the latest data from 2010 to 2018 across 154 countries—encompassing 94.5% of all live births—approximately 21.1% of women globally underwent cesarean delivery. This percentage exhibits significant regional variation, with reported averages of 5% in sub-Saharan Africa compared to 42.8% in Latin America and the Caribbean. Projections suggest that by 2030, the global cesarean delivery rate could escalate to 28.5%, which would equate to nearly 38 million cesarean sections performed annually [1]. Additionally, data from the Bangladesh Demographic and Health Survey (BDHS) 2014 indicated a cesarean delivery prevalence of 24% among Bangladeshi mothers. A marked disparity was observed based on residency, with cesarean rates of 36.9% in urban populations compared to 17.9% in rural areas, highlighting the influence of geographical context on delivery methods [2].

Surgical site infections (SSIs) are a prevalent postoperative complication, representing a significant clinical challenge concerning morbidity, mortality, extended hospitalization, and increased healthcare costs following cesarean delivery [3]. Evidence indicates that maternal morbidity associated with infections is eight-fold higher after cesarean sections compared to vaginal deliveries [4]. The reported incidence of SSIs post-cesarean section varies widely in the literature, ranging from 4% to 23%, influenced by factors such as patient demographics, antibiotic prophylaxis protocols, and the methodologies employed in infection surveillance [5]. Recent data on SSI incidence following cesarean section reveal notable variations: Indonesia reports 4.14% [6], India 13% [7], Nepal 12.6% [8], Nigeria 9.1% [9], Tanzania 10.9% [10], and Australia 17% [11], and China, reports the highest at 23% [12]. These discrepancies in SSI rates across various studies are attributed to differences in diagnostic criteria and varying postoperative follow-up durations. A 2010 intervention study conducted in Bangladesh revealed an in-

fection rate exceeding 10% after cesarean section, despite the implementation of appropriate antibiotic prophylaxis [13].

Several risk factors associated with the occurrence of surgical site infection after cesarean section have been identified. Identifying these factors plays an essential role in determining the methods that can be used to reduce the risk of SSI. Numerous recent studies have investigated the risk factors related to morbidity following cesarean sections. Several key predictors of wound infection have been consistently identified, which include the duration of labor, obesity, the interval between membrane rupture and delivery, the number of vaginal examinations, inadequate operating room conditions, and patient overload [14]. Most existing research on SSIs has been conducted in Western countries, with relatively few studies focusing on South Asian women, particularly those from Bangladesh. Bangladesh has a diverse population with varying levels of access to healthcare, and many women undergo cesarean sections in resource-limited settings where infection prevention practices may not be optimal. Identifying and understanding the risk factors associated with SSIs can provide insights into the specific characteristics of women who are more likely to develop these infections. Therefore, it is essential to investigate the particular risk factors for wound infections following cesarean sections in Bangladeshi patients. This study aims to examine the prevalence and risk factors associated with surgical site infections following cesarean sections in a tertiary care hospital.

2. Materials and Methods

This study was an observational cross-sectional design conducted in the Department of Obstetrics and Gynecology at Dhaka Medical College Hospital (DMCH). Ethical clearance was also taken from the ethical committee of Dhaka Medical College. All the patients who underwent low transverse Cesarean Section in the ward and met inclusion and exclusion criteria were recruited over the three-month data collection period. The inclusion criteria encompassed all pregnant women aged 15 to 45 years who underwent cesarean section and provided informed consent while demonstrating a willingness to adhere to the study procedures. Patients experiencing obstructed labor and/or premature rupture of membranes (PROM) and prolonged labor, which indicated the presence of contaminated wounds, were excluded from the study.

Data were collected in the postoperative ward of the Department of Obstetrics and Gynecology at DMCH. Systematic documentation was performed to gather pertinent socio-demographic and obstetric information, which included variables such as age, gestational age, history of antenatal check-ups, weight, height, parity, and the presence of conditions such as diabetes, hypertension, or anemia. The status of the wound was evaluated prior to the patient's discharge. Furthermore, a follow-up telephone interview was conducted on the 30th day post-operation to evaluate the patient's infection status.

The collected data were initially compiled into a master chart. Subsequently, a

descriptive analysis was conducted on the study variables, and frequency tables depicting the determinants and socio-demographic characteristics were generated. Data are presented as mean \pm standard deviation, while prevalence rates are reported as percentages. Tests of significance (P value < 0.05) and cross-tabulation methods were utilized to explore the relationship between socio-demographic characteristics and surgical site infections. Pearson's Chi-square test of independence was employed to assess the existence of a significant association between categorical data. All analyses were executed using SPSS for Windows, version 22.0 (SPSS Inc., Chicago, IL, USA).

3. Results

The study engaged a substantial number of participants, with more than half being under the age of 25 years, resulting in a mean age of 24.45 ± 4.44 years. Most participants were literate, with 43% having attained only primary education. The mean Body Mass Index (BMI) was recorded at 26.36 ± 4.24 , ranging from 18.95 to 39.18. A notable 92% of participants presented with anemia, comprising 36% classified as mild, 35% as moderate, and 11% as severe at the time of study inclusion. Personal hygiene practices were upheld by 63% of the participants, whereas 37% did not maintain adequate hygiene standards. Among the participants, 80% reported regular menstrual cycles, in contrast to 20% who experienced irregular cycles. Approximately half of the participants lacked a history of antenatal check-ups, while 33% had irregular antenatal care. The mean gestational age at delivery was 38.33 ± 2.45 weeks, with a range spanning from 30 to 42 weeks. The majority exhibited regular menstrual cycles, and 47% underwent a Cesarean section (C/S) at gestational ages exceeding 39 weeks. Only 10% of participants experienced a C/S before 34 weeks of gestation (**Table 1**).

Table 1. Association of SSI and Socio-demographic characteristics of the study population ($n = 100$).

Variables	Frequency	Surgical Site Infection		P-value [#]
		Yes	No	
The age group of participants (years)				
<25 Years	54	2 (3.7%)	52 (96.3%)	<0.001
25 - 30 Years	42	8 (19%)	34 (81%)	
>30 Years	4	4 (100%)	0 (0%)	
Educational status				
Illiterate	17	7 (41.2%)	10 (58.8%)	0.004
Primary	43	6 (14%)	37 (86%)	
Secondary	12	1 (8.3%)	11 (91.7%)	
Higher Secondary	22	0 (0%)	22 (100%)	
Graduate	6	0 (0%)	6 (100%)	

Continued

Body Mass Index (BMI)				
Normal (18.50 - 24.99)	48	3 (6.3%)	45 (93.8%)	0.038
Overweight (25 - 29.99)	36	6 (16.7%)	30 (83.3%)	
Obesity (>30)	16	5 (31.3%)	11 (68.8%)	
Monthly Income in taka				
<6000	5	3 (60%)	2 (40%)	<0.001
6000 – 12,000	32	9 (28%)	23 (72%)	
12,001 - 18,000	34	2 (6%)	32 (94%)	
>18,000	29	0 (0%)	29 (100%)	
Anemia status				
No	18	0 (0%)	18 (100.0%)	<0.001
Mild	36	1 (2.8%)	35 (97.2%)	
Moderate	35	8 (22.9%)	27 (77.1%)	
Severe	11	6 (45.5%)	5 (54.5%)	
Maintenance of personal hygiene				
Not Maintain	37	11 (29.7%)	26 (70.3%)	0.001
Maintain	63	3 (4.8%)	60 (95.2%)	
Menstrual cycle				
Regular	80	7 (8.8%)	73 (91.2%)	0.002
Irregular	20	7 (35%)	13 (65%)	
ANC				
No	49	11 (22.4%)	38 (77.6%)	0.039
Yes	51	3 (5.88%)	48 (94.11%)	
Gestational Age at delivery				
<34	10	4 (40%)	6 (60%)	0.001
35 - 38	43	0 (0%)	43 (100%)	
>39	47	10 (21.3%)	37 (78.7%)	
H/O C/S				
No Previous C/S	45	10 (22%)	35 (78%)	0.097
Previous 1 C/S	45	3 (7%)	42 (93%)	
Previous 2 C/S	10	1 (10%)	9 (90%)	

Within the cohort, 14% of patients developed surgical site infections post-Cesarean operation, while 86% experienced normal recovery (**Figure 1**). The documented reasons for Cesarean section deliveries among all patients are depicted in **Figure 1**. Around half of the participants (45%) had a recorded history of prior C/S, followed by 23% due to fetal distress, 12% due to Breech presentation, 10% attributable to pre-eclampsia, 4% relating to placenta previa, and 4% due to twin

pregnancies. Among all cases, 7% underwent C/S for various other indications (such as transverse lie or fetal distress). (**Figure 2**) Notably, 94% of participants delivered a live baby, whereas 6% tragically experienced stillbirth, as presented in **Table 2**.

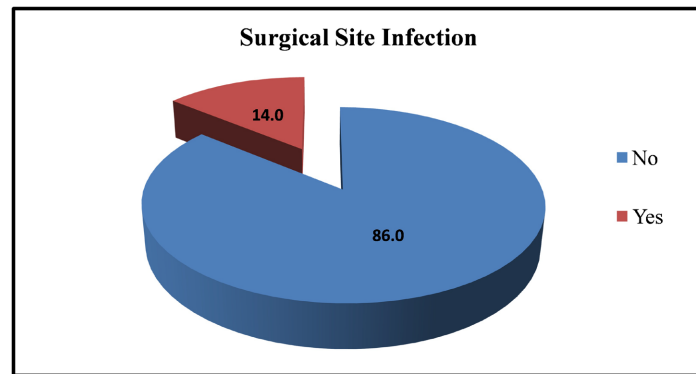


Figure 1. Percentage of Surgical site infection after C/S among the participants.

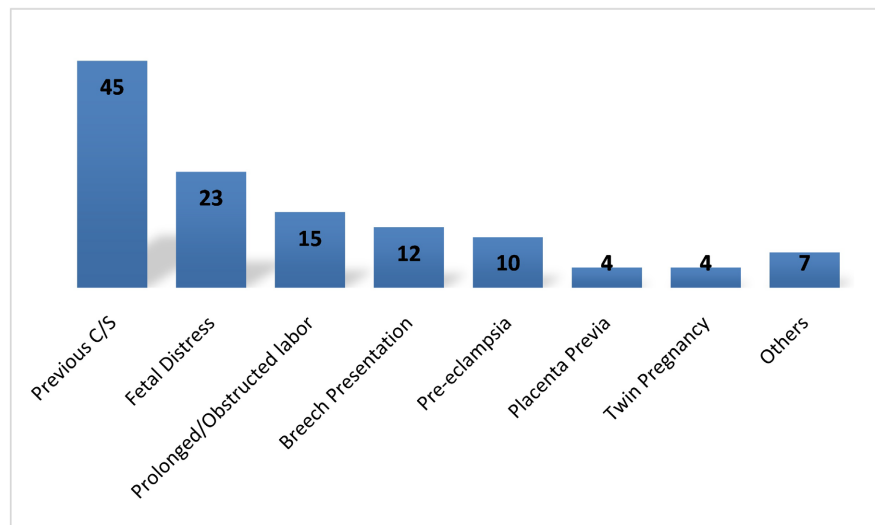


Figure 2. Reasons for Cesarean section delivery.

Table 2. Fetal outcome of pregnancy of participants (n = 100).

Fetal Outcome of Pregnancy	Frequency	Percentage
Livebirth	94	94.0
No NICU	83	10.0
Needs NICU admission	11	11.0
Stillbirth	6	6.0
Total	100	100.0

Surgical site infections (SSIs) were more prevalent among participants over 35 years, revealing a statistically significant association with factors such as age, education level, and body mass index (BMI). The incidence of SSIs was notably higher

among obese participants (31%), followed by overweight participants (17%) and normal-weight participants (6%). Additionally, among those with a monthly income below 6000 taka, 60% experienced SSIs, whereas no cases were recorded among individuals with incomes exceeding 18,000 taka. In terms of anemia, nearly 50% of patients in the severe anemia group developed SSIs following cesarean sections, compared to 22.9% in the moderate anemia group and 2.8% in the mild anemia group. The data indicated a statistically significant correlation between the occurrence of SSIs and personal hygiene practices, with 35% of participants reporting a history of irregular menstrual cycles developing SSIs.

Furthermore, among participants with no record of antenatal check-ups, 23% developed SSIs. In contrast, no SSIs were observed in those who underwent regular antenatal care (ANC), and 9% was noted in individuals with irregular ANC. The findings also revealed that almost half of the participants with a gestational age of less than 34 weeks developed SSIs, while no cases were seen in those between 35 and 38 weeks, and 21% in participants exceeding 39 weeks of gestational age.

Lastly, the study indicated a higher prevalence of SSIs (22%) among participants without a history of previous cesarean sections; however, no statistically significant association was established between SSIs and the history of prior cesarean deliveries (**Table 1**).

4. Discussion

The present study evaluated the prevalence and risk factors associated with surgical site infections (SSIs) following cesarean sections within a tertiary care hospital. This observational research identified that 14 patients, which corresponds to 14% of the total sample, developed surgical site infections after undergoing cesarean operations. Four patients experienced infections while hospitalized, whereas the remaining 10 were identified through post-discharge follow-up telephone interviews. The infection rate observed in this study is comparable to findings from similar studies conducted in India (13%) [7], Nepal (12.6%) [8], and Brazil (11.6%) [15]. However, it is lower than the rates reported in Australia (17%) [11], China (23%) [12], and Saudi Arabia (19%) [16], while exceeding the rates documented in Indonesia (4.14%) [6], England (9.6%) [17], and Türkiye (0.3%) [18]. These findings highlight the variability in SSI rates, which can be attributed to factors such as the characteristics of the study cohort, the presence of preexisting medical conditions, the administration of antibiotics, and the methodologies employed in SSI documentation and reporting.

In the study, the mean age of participants was 24.45 years with a standard deviation of 4.44 years, ranging from a minimum of 18 years to a maximum of 40 years. More than half of the participants were under 25 years of age, and very few developed surgical site infections (SSI) within this age group. In contrast, all participants over 35 years of age experienced SSI. The study concluded that advanced age is linked to an increased risk of SSI following a cesarean section. These find-

ings align with other studies indicating that older age, along with decreased host immunity and associated comorbidities, raises the risk of SSI occurrence [19] [20].

More than half of the participants had a body mass index (BMI) that was higher than usual. The study revealed that surgical site infections (SSIs) were more prevalent among obese participants compared to those who were overweight or of normal weight, which supports the growing evidence that adipose tissue leads to chronic inflammation and increased vulnerability to pathogens. Additionally, there was a strong correlation between obesity and the development of SSIs, with the risk increasing as BMI categories progressed (P-value: 0.038). An integrative literature review that included a total of 13 studies also supported the link between obesity and SSIs, concluding that cesarean sections were more frequent among obese women [21]-[23].

The study found that educational status and monthly income were linked to higher rates of post-cesarean infections. About half of the illiterate participants and more than half of those with lower family incomes developed surgical site infections after undergoing a cesarean section. In contrast, none of the participants who had completed their higher secondary education or those from relatively higher-income groups experienced surgical site infections. These higher infection rates among lower socioeconomic groups may be due to financial barriers to healthcare, poor nutritional status, lower standards of personal hygiene, and differences in bacterial flora.

The study found that post-cesarean surgical site infection was linked to participants' anemia, personal hygiene, and menstrual cycle history. Severe anemia led to almost half of the infections, while no SSI cases were found in those without anemia [16]-[18]. However, our study could not measure blood loss as we included the patient postoperatively. However, anemia status might give us an impression of blood loss during the operation. Almost one-fourth of surgical site infections developed among the participants who had no history of antenatal check-ups. On the other hand, no SSI was found who had a history of regular ANC. Antenatal care provides opportunities for health education and detection/correction of maternal problems. One study found that fewer than seven prenatal visits resulted in a significantly increased risk for incisional infection [24]. Antenatal care provides opportunities for health education and detection/correction of maternal problems. Cases requiring elective cesarean delivery can be identified, reducing the number of emergency cesarean deliveries. Such cases include many of those with previous cesarean delivery, although there is a case for allowing most patients with prior cesarean delivery to have a trial of scar [25]. The study found that previous cesarean section operations were the most common reason for cesarean birth, with lower infection rates and breech presentation, pre-eclampsia, placenta previa, and twin pregnancy being significant causes. Only six women delivered a stillborn child, with wound infections being less frequent [26].

Almost half of the participants with a gestational age of less than 34 weeks developed surgical site infections (SSIs), whereas no cases were reported among

those with gestational ages between 35 and 38 weeks. This suggests that pre-term delivery may be a significant risk factor for the development of SSIs. This phenomenon may be partly attributed to the fact that, during the preterm period, the vaginal flora has not yet reached the optimal level of lactobacilli, and the antibacterial properties of amniotic fluid are less effective than at full term. Furthermore, many preterm operative deliveries are performed in emergencies [27]. Low socioeconomic status may also play a role in preterm labor, even in cases where the membranes remain intact. While numerous studies have shown that prophylactic antibiotics can reduce the incidence of wound infections, all participants in this study received prophylactic antibiotics [28] [29]. As a result, the study was unable to establish a definitive association between the use of prophylactic antibiotics and the occurrence of SSIs after cesarean sections. Since all participants who developed SSIs had been administered prophylactic antibiotics, it underscores the need to review and monitor antibiotic prescribing patterns in line with effective antibiotic stewardship. On a more positive note, the study indicated that wound infections were less common in cases of previous cesarean deliveries. Given that most of these cases were elective, this contributed to a reduced rate of surgical site infections. This study had some limitations. One major issue was the small sample size, which may have influenced the lack of significant differences in risk factors observed. In addition, surgical site infections were not confirmed microbiologically due to resource constraints.

5. Conclusion

Post-cesarean surgical site infections represent a significant challenge within the study area, making it imperative to understand the associated risk factors. Notably, low socioeconomic status, limited educational attainment, anemia, and pre-term delivery are observed to considerably increase the risk of infection, alongside more commonly recognized factors such as advanced age and elevated body mass index. However, we can significantly lower this risk by emphasizing the importance of personal hygiene, regular menstrual cycles, and routine antenatal check-ups. An effective awareness program and updated antibiotic strategies are key to substantially reducing infection rates. Therefore, further research is essential for broadening our understanding and ensuring that these strategies benefit the entire community.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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