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Evaluation of Surgical Site Infections After Cesarean Section and Its Related Factors in Women Referring to Emam khomeini Hospital, Ahvaz, Iran 2021-2022

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ABSTRACT

Background & Objective: A cesarean section is a surgical procedure in which incisions are made in a woman's abdomen and uterus to deliver a baby. One common complication associated with this surgery is a surgical site infection. These infections can lead to increased maternal morbidity, longer hospital stays, and higher medical costs.

Materials & Methods: A cross-sectional study assessed the rates of surgical site infections following cesarean sections and identified associated factors at Imam Khomeini Hospital in Ahvaz, conducted between April 1, 2021, and April 30, 2022. This retrospective chart review included 384 women, and the data were analyzed using GraphPad Prism software, version 8.

Results: Our results indicated that the incidence of post-cesarean infection decreased with higher maternal education, while it increased with body mass index and the number of surgeries. Cases with premature rupture of membranes and emergency cesarean sections had higher infection rates. Additionally, there was a significant difference in infection rates related to gestational diabetes and the length of hospitalization. Singleton births showed lower infection rates, and working mothers had lower probabilities of site infections compared to non-working mothers.

Conclusion: Our results indicated that surgical site infections after cesarean sections were significantly associated with factors such as maternal education, body mass index, number of surgeries, premature rupture of membranes, emergency cesarean sections for singletons, and maternal employment.

Keywords: Prevalence, Surgical Wound Infection, Cesarean Section

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1. Introduction

Cesarean section is one of the most significant and common surgeries for women **(1, 2)**. The rising trend in cesarean births is primarily attributed to non-obstetrical factors, such as concerns about patient complaints, financial incentives, physicians' preferences, and existing medical training philosophies. Additionally, women are having fewer children and often prefer cesarean deliveries, particularly among first-time mothers **(3, 4)**.

Women who undergo cesarean sections face a risk of infection that is 5 to 20 times higher than that of women who have normal deliveries. Infectious complications following cesarean sections contribute significantly to treatment costs. These complications can include fever, wound infections, endometritis, urinary infections, and more serious issues such as pelvic abscesses, septic shock, necrotizing fasciitis, and pelvic venous thrombophlebitis **(5)**.

Surgical site infections refer to infections at the incision site, organ, or body space. They are the most common and costly complications that occur after surgery, with an estimated incidence of 2-5% in patients who undergo surgical procedures **(6)**. Infection is the third leading cause of maternal mortality, particularly in developing countries **(7)**. It can result in complications such as prolonged hospitalization, increased healthcare costs, long-term antibiotic usage, and issues like adhesions that may lead to infertility. On average, wound infections extend the length of hospitalization by 72 days and significantly raise the overall cost of care **(8, 9)**.

The frequency of infection following a cesarean section is estimated to be between 3% and 15%. This infection rate varies based on socio-economic factors, and it has changed significantly over the years due to the increased use of antimicrobial drugs during the perioperative period **(10-12)**. Multiple factors contribute to the increased risk of postoperative infection. These factors can be classified as controllable and uncontrollable. Among the risk factors are low socio-economic status, obesity, maternal diabetes, immune deficiencies, and inadequate nutrition and hygiene **(13, 14)**. Other risk factors include emergency cesarean sections, the duration of labor, the frequency of vaginal examinations, the duration of amniotic sac rupture, and fetal meconium discharge **(15-19)**. The fundamental principles for preventing surgical infections encompass surgical techniques, the use of skin disinfectants, and antimicrobial prophylaxis **(20)**.

Reducing wound infections after a cesarean section is important to minimize unnecessary complications and the socio-economic impacts on both the patient and their family. This study was conducted to investigate the incidence rate and risk factors associated with surgical site infections following cesarean sections.

2. Materials and Methods

Study subjects

This descriptive cross-sectional study involved patients who underwent cesarean sections between April 2021 and April 2022.

Sample size

Sampling was conducted using available methods. First, to assess the rate of surgical site infections, all hospital records of patients who underwent cesarean sections were reviewed in a census format, allowing us to determine the prevalence rate of these infections. To investigate the correlation and differences across various variables in individuals with and without surgical site infections, a sample size of 428 individuals was established based on the following relationship.

$$n = \frac{(Z_{1-\alpha/2} + Z_{1-\beta})^2 \times [(P_1(1-P_1) + P_2(1-P_2)]}{(P_1 - P_2)} = 428$$

Inclusion and exclusion criteria

The criteria for inclusion included all women candidates for cesarean sections (both emergency and elective) aged 18 to 40. Cases with incomplete information were excluded.

Assessment of patients

Data was collected using a two-part, self-designed checklist. The first part includes general information such as age, gestational age, occupation, weight, and education level. The second part specifically addresses the risk factors that may influence the occurrence of surgical site infections following a cesarean section. These risk factors include the number of pregnancies, premature rupture of the amniotic sac, type of cesarean section, number of previous cesarean sections, weight at the end of pregnancy, baby weight, gestational diabetes, duration of hospitalization, antibiotic treatment, length of surgery, and post-cesarean care.

The records of all individuals who visited a gynecologist at the clinic 24 to 48 hours after giving birth between April 2021 and April 2022, were reviewed. The examination focused on symptoms of wound infection, including the presence of secretion, tenderness, swelling, inflammation, and redness at the stitch site, as well as fever. Any signs of infection, such as wound separation or surgical site infection characterized by purulent drainage, inflammation, and swelling, were classified as case groups.

Statistical analysis

After the study concluded, descriptive statistics were employed, including frequency and percentage distribution tables, as well as calculations of the mean (a measure of central tendency) and standard deviation (a measure of dispersion). To explore the relationship between the incidence of infection after cesarean sections and the various factors involved, chi-square tests and independent t-tests were conducted at a significance level of $P = 0.05$. All results were analyzed using Graph Pad Prism software, version 8 (GraphPad Software, USA).

3. Results

The results indicated no statistically significant difference in age and surgical site infection incidence between the case group (445.5 ± 74.29) and control group (872.5 ± 93.28). Similarly, gestational age showed no significant difference between the groups (case: 112.3 ± 94.36; control: 640.20 ± 86.37). However, a significant relationship was found between body mass index (BMI) and surgical site infections, with averages of 600 ± 4.34 in the case group and 541.1 ± 93.23 in the control group. Other factors, such as the number of pregnancies, previous cesarean sections,

weight at the end of pregnancy, and baby's weight, also showed no significant differences. Notably, there was a significant difference in hospitalization days (case: 175.2 ± 20.4; control: 0.743 ± 64.2), suggesting that longer hospitalization correlates with increased surgical site infections. No significant difference was observed in the duration of surgery between the groups (case: 34.8 ± 38.61; control: 97.8 ± 57.60) (Table 1).

The study found that individuals with higher education levels have a lower probability of surgical site infections. In patients with premature rupture of the amniotic sac, the infection rate was 9.4% in this group compared to 1.9% in the control. Emergency cesarean sections also showed a higher infection rate (9.25% vs. 3.14%). Additionally, gestational diabetes was associated with varying infection rates between groups (3.14% in the case group vs. 6.2% in the control). There was no significant difference in surgical site infections related to antibiotic treatment (6.48% case vs. 5.49% control) or prophylaxis (5.99% case vs. 49.5% control). Notably, single pregnancies had lower infection rates (9.44% case vs. 7.47% control), and differences were observed based on the mother's occupation and the number of surgeries performed (4.8% case vs. 2.0% control) (Table 2).

Table1. Basic information.

Variable	Group		P-Value
	Control	SSI	
Age	28.93 ± 5.872	29.74 ± 5.445	0.571
Pregnancy age	37.86 ± 20.640	36.94 ± 3.112	0.222
Body mass index (BMI)	23.93 ± 1.541	35.34 ± 4.600	<0.001
Number of pregnancies	2.62 ± 1.474	2.56 ± 1.231	0.096
Number of previous cesarean section	1.00 ± 1.07	1.00 ± 1.04	0.815
Mother's weight at the end of pregnancy	68.15 ± 7.57	73.50 ± 8.66	0.152
Birth weight	3377.10 ± 561.86	3329.35 ± 528.43	0,372
Days of hospitalization	2.64 ± 0.743	4.20 ± 2.175	<0.001
Duration of surgery	60.57 ± 8.97	61.38 ± 8.34	0.181

Table 2. Variables examined in the study groups.

Variable		Group			P-Value
		Control	SSI	Total	
Education level	illiterate	44 (10.3%)	54 (12.6%)	98 (22.9%)	0.06
	diploma	141 (32.9%)	123 (28.7%)	264 (61.7%)	
	post graduate	3 (0.7%)	0	3 (0.7%)	
	Bachelor's degree	26 (6.1%)	37 (8.6%)	63 (14.7%)	
Premature rupture of membranes	Yes	21 (4.9%)	39 (9.1%)	60 (14%)	0.01
	No	193 (45.1%)	175 (40.9%)	368 (86%)	
Type of caesarean section	Emergency	61 (14.3%)	111 (25.9%)	172 (40.2%)	<0.01
	Elective	153 (35.7%)	103 (24.1%)	256 (59.8%)	
Gestational diabetes	Yes	11 (2.6%)	61 (14.3%)	72 (16.8%)	<0.01
	No	203 (47.4%)	153 (35.7%)	356 (83.2%)	
Antibiotic treatment	Yes	212 (49.5%)	208 (48.6%)	420 (98.1%)	0.284
	No	2 (0.5%)	6 (1.4%)	8 (1.9%)	
Care after cesarean section	Yes	187 (43.7%)	126 (29.4%)	313 (73.1%)	<0/01
	No	27 (6.3%)	88 (20.6%)	115 (26.9%)	
Antibiotic prophylaxis	Yes	214 (50%)	212 (49.5%)	426 (99.5%)	0.499

Variable		Group			P-Value
		Control	SSI	Total	
	No	0	2 (0.5%)	2 (0.5%)	
Type of pregnancy	Multiple	10 (2.3%)	22 (5.1%)	32 (7.5%)	0.04
	Single	204 (47.7%)	192 (44.9%)	396 (92.5%)	
Mother's job	Employee	9 (2.1%)	24 (5.6%)	33 (7.7%)	0.01
	Freelance job	51 (11.9%)	40 (9.3%)	91 (21.3%)	
	Housekeeper	154 (36%)	150 (35%)	304 (71%)	
Previous history of number of surgeries	Yes	1 (0.2%)	36 (8.4%)	37 (8.6%)	<0.01
	No	2.3 (49.8%)	178 (41.6%)	391 (91.4%)	

4. Discussion

The study revealed that the rate of SSI was 6.63%. The finding was high compared with studies done in Nanjing at 3.34% **(21)**, southern India at 4.1% **(22)**, Israel at 3.7% **(23)**, and Rwanda at 4.9% **(24)**. The observed disparities may be due to differences in the quality of surgical care provided, as it is generally assumed that higher-income countries offer superior care. Another factor could be the variation in study settings and follow-up durations. Consequently, the quality of surgical care differs, with high-income and middle-income countries expected to deliver better services. Additionally, this study is a follow-up investigation, which can better capture the effects of specific exposures; therefore, the incidence of surgical site infections (SSIs) may be higher compared to other studies. These findings suggest that policymakers and stakeholders should prioritize improving the quality of care to reduce the incidence of SSIs.

In contrast, the incidence of surgical site infections (SSI) in this study was lower than that reported in studies conducted in Debre Markos, Ethiopia (25.4%) **(25)**, Addis Ababa, Ethiopia (15%) **(26)**, and other regions in Ethiopia (9.72%) **(27)**. Comparatively, rates in Nepal were 12.6% (28), Karachi reported 24.3% **(29)**, India had 13%, and Nnewi, Nigeria, showed a rate of 12.5% **(30, 31)**. These differences may be attributed to variations in sample size and the duration of the studies. Another possible explanation is that women in Karachi tend to have a higher prevalence of obesity and diabetes, which may have contributed to the increased SSI rates observed there.

In a study conducted by Alizadeh et al **(32)** it was found that factors such as being over 30 years old, having undergone emergency surgery, having repeated surgeries, being obese, lacking education, having a history of diseases, high blood pressure, or experiencing preeclampsia can increase the likelihood of postpartum infection **(32)**. These findings align with the cases reviewed in this study, which were also analyzed in our research.

In the present study, a significant difference was observed regarding the relationship between the rupture of membranes and the risk of infection following a cesarean section. A history of membrane rupture has been identified as a potential risk factor for infection after this surgical procedure **(2)**. However, a study conducted by Amiri et al **(33)** found that premature rupture of membranes did not increase the risk of infection. This discrepancy may be attributed to the small sample size, which is similar to the present study **(33)**. Additionally, the research conducted by Mohammadian and Mobaien **(34)** also reported no significant relationship between membrane rupture and infection following a cesarean section.

In the present study, all women who developed postpartum infections were housewives. Maternal employment appeared to be a protective factor against infection, potentially due to higher levels of education and greater maternal awareness. Similarly, Alizadeh et al **(32)** noted that increased literacy and education levels have a protective effect in preventing wound infections after cesarean sections.

Our study identified a significant correlation between the length of hospitalization and the incidence of surgical site infections (SSI). In line with this, Alemye et al **(35)** conducted research in Ethiopia, highlighting that careful follow-up to prevent unnecessary extended hospital stays can effectively reduce the rates of SSI and maternal complications.

Additionally, our findings align with those of Dayo-Dada et al **(36)** from Nigeria, who found that the rate of infection after cesarean sections is associated with a history of previous surgeries **(36)**. A cross-sectional study in Iran conducted by Moradi et al **(37)** also revealed that the risk of infection after cesarean sections is linked to the quality of prenatal care. Furthermore, our study indicated that post-cesarean care plays a crucial role in reducing the incidence of surgical site infections.

Dousti and Haghdoost **(38)** conducted a study in Iran indicating that the infection rate following cesarean sections is associated with gestational diabetes and body mass index (BMI). Similarly, our research found that a high body mass index and gestational diabetes

were significantly linked to an increased risk of wound site infections. In line with our findings, Dayo-Dada et al **(36)** in Nigeria also reported an association between the infection rate after cesarean sections and emergency cesarean sections. Furthermore, Yang and Sun **(39)** and Krieger et al **(40)** similarly found a significant relationship between surgical site infections and emergency cesarean sections.

5. Conclusion

Based on this study, one limitation of this study is that it focused solely on wound infections following a cesarean section, while other types of postoperative infections, such as endometritis, were not examined. This focus may explain why the prevalence of infection observed aligns with rates typically found in developed countries.

6. Declarations

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Ethical Considerations

This study was conducted according to experimental protocols approved by the ethics committee of Ahvaz Jundishapur University of Medical Sciences, Ahvaz, Iran, with an ethics code of (IR.AJUMS.HGOLESTAN.REC.1403.025).

Authors' Contributions

Farnaz Iran Nezhad Deljavan, Razieh Mohammad Jafari, Elham Karegarzadeh, and Roshan Nikbakht have been involved in drafting the manuscript. All authors read and approved the final manuscript.

Conflict of Interest

The authors declare no conflict of interest.

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