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PREOPERATIVE RISK FACTORS FOR SURGICAL SITE INFECTION FOLLOWING CESAREAN SECTION: A CASE-CONTROL STUDY

Faktor Risiko Praoperasi terhadap Kejadian Infeksi Daerah Operasi Pascaseksio Sesarea: Studi Kasus-Kontrol

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ABSTRAK

Infeksi daerah operasi (IDO) pascaseksio sesarea masih tinggi di Indonesia, termasuk di RSUP Dr. Hasan Sadikin Bandung. Angka kejadian IDO tahun 2022–2024 berkisar 2,34%–3,15%, melebihi standar nasional 2% dan target internal rumah sakit ≤1%, sehingga perlu perhatian terhadap faktor risikonya. Penelitian ini bertujuan untuk menganalisis hubungan faktor risiko praoperasi dengan kejadian infeksi daerah operasi pascaseksio sesarea di RSUP Dr. Hasan Sadikin Bandung. Penelitian ini menggunakan desain observasional analitik kasus-kontrol dengan ukuran sampel sebanyak 180 pasien (45 kasus dan 135 kontrol) yang menjalani seksio sesarea di rumah sakit tersebut dari Januari 2022 hingga Desember 2024, dipilih melalui teknik simple random sampling. Analisis univariat, bivariat (Chi-Square, Fisher's Exact), dan multivariat (regresi logistik biner) dilakukan untuk menilai hubungan antara variabel independen dengan kejadian IDO. Analisis menunjukkan adanya hubungan signifikan antara kejadian IDO dengan variabel praoperasi seperti tipe operasi (p=0,035), usia (p=0,035), riwayat seksio sesarea (p=0,000), anemia (p=0,000), hipertensi (p=0,013), dan obesitas (p=0,047). Diabetes tidak menunjukkan hubungan signifikan dengan kejadian IDO (p=0,109). Analisis multivariat mengidentifikasi anemia (p=0,000), tipe operasi (p=0,006), riwayat seksio sesarea (p=0,009), usia (p=0,015), dan obesitas (p=0,030) sebagai faktor risiko paling dominan terhadap kejadian IDO. Hasil penelitian menekankan pentingnya penatalaksanaan dini terhadap faktor risiko praoperasi sebagai bagian dari strategi pencegahan IDO dan peningkatan mutu pelayanan kebidanan.

***Kata kunci**: faktor risiko, infeksi daerah operasi, praoperasi, seksio sesarea*

ABSTRACT

Post-Cesarean Section Surgical Site Infections (SSIs) remain prevalent in Indonesia, including at Dr. Hasan Sadikin General Hospital, Bandung. The incidence of SSIs from 2022 to 2024 ranged from 2.34% to 3.15%, exceeding the national standard of 2% and the hospital's internal target of ≤1%, highlighting the need for greater attention to risk factors. This study aimed to analyze the association between preoperative risk factors and the incidence of SSIs following cesarean section at Dr. Hasan Sadikin General Hospital. An analytical observational case-control design was used, involving 180 patients (45 cases and 135 controls) who underwent cesarean section from January 2022 to December 2024, selected through simple random sampling. Univariate, bivariate (Chi-square, Fisher's Exact), and multivariate (binary logistic regression) analyses were performed to assess the relationship between independent variables and SSI incidence. The results showed significant associations between SSI and preoperative variables such as type of surgery (p=0.035), age (p=0.035), history of cesarean section (p=0.000),

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anemia (p=0.000), hypertension (p=0.013), and obesity (p=0.047). Diabetes was not significantly associated with SSI incidence (p=0.109). Multivariate analysis identified anemia (p=0.000), type of surgery (p=0.006), history of cesarean section (p=0.009), age (p=0.015), and obesity (p=0.030) as the most dominant risk factors for SSIs. These findings underscore the importance of early management of preoperative risk factors as part of a strategy to prevent SSIs and improve the quality of obstetric care.

Keywords: cesarean section, preoperative, risk factors, surgical site infection

INTRODUCTION

Healthcare-Associated Infections (HAIs) or nosocomial infections are a major challenge in the global health system due to their broad impact on morbidity, mortality, and health care costs, including in Indonesia.[1]According to Regulation of the Minister of Health of the Republic of Indonesia Number 27 of 2017, HAIs are infections that arise while a patient is undergoing treatment at a healthcare facility and are not incubating upon admission. HAIs also include infections that arise after a patient is discharged or infections that occur in healthcare workers due to their work[1].

Cesarean section (CS) is a major surgical procedure contributing to high rates of healthcare-associated infections (HAIs), particularly surgical site infections (SSIs). Globally, the trend of performing cesarean sections continues to show a significant increase. The World Health Organization (WHO) reports that more than one in five births worldwide (21%) in 2021 were delivered by cesarean section, and this figure is expected to increase to nearly 29% by 2030[2]. Cesarean section is now a primary intervention in modern obstetric practice, including at Dr. Hasan Sadikin General Hospital (RSHS) Bandung, which recorded 1,775 CS procedures or approximately 50.3% of all deliveries during the 2022–2024 period[3]. Although often considered an effective solution for managing high-risk deliveries, CS still carries the potential for complications that cannot be ignored, one of which is SSI. Several studies show that women who undergo CS have a five to twenty times higher risk of postpartum infection than those who deliver vaginally[4].

A surgical site infection (SSI) is an infection that occurs in the incision area after surgery, which can appear within a period of up to 30 days after surgery, or up to 90 days in procedures involving prosthetic implantation[5]. Based on a report by the World Health Organization (WHO), as cited in a study by Chairani et al., SSIs are the most common type of healthcare-associated infection (HAIs) in developing countries, with a combined incidence rate of approximately 11.8 cases per 100 surgical patients[6]. In Indonesia itself, the prevalence of SSI is reported to range from 2.3% to 18.3%, and accounts for approximately 38% of all HAIs cases[7].

A similar situation was also found at Dr. Hasan Sadikin General Hospital (RSHS) Bandung, where the trend of SSI incidence after cesarean section showed fluctuations over the past three years, namely 3.15% in 2022, decreasing to 2.34% in 2023, and to 1.98% in 2024[8]. Although the trend shows a decline to below the national standard (2%) in 2024, this achievement still does not meet the hospital's internal target of ≤1%[9].

The impact of SSIs on the healthcare system is significant, including increased length of hospital stay, escalated treatment costs, and increased patient morbidity and mortality. Globally, SSIs can lead to a fourfold increase in treatment costs, extend hospital stays from an average of 2–4 days to 7–10 days, and increase the risk of death by up to elevenfold[5], [10], [11], [12]. A preliminary study at RSHS confirms this, finding that most patients with SSI after cesarean section experienced an extended hospital stay of more than 10 days, indicating a substantial clinical and logistical burden[13].

Various efforts have been made at RSHS to reduce the SSI rate, including the implementation of a SSI prevention bundle that includes preoperative bathing, prophylactic antibiotic administration, body temperature monitoring, incision shaving if

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necessary, and blood sugar control. Furthermore, education and increased compliance with protocols are also ongoing for healthcare workers[9].However, most of these strategies still focus on procedural aspects and the behavior of healthcare workers, without addressing factors inherent in patients before surgery. Preoperative risk factors such as type of surgery, age, history of CS, anemia, hypertension, obesity, and diabetes significantly contribute to the incidence of SSI. Data from a preliminary study at RSHS in 2024 of 730 obstetric patients showed that 40.4% had anemia, 25.7% had hypertension, 14.9% had obesity, and 1.23% had diabetes. While 83.3% underwent emergency CS, and 16.2% had a history of CS. This condition indicates a high prevalence of risk factors that can increase patient vulnerability to SSI[3].

A global meta-analysis showed that a number of maternal factors, such as obesity, advanced age, history of cesarean section, and comorbidities such as diabetes mellitus, hypertension, and anemia, were proven to increase the risk of surgical site infection (SSI)[14], [15]. In addition, surgical procedures performed in emergency conditions also increase the possibility of post-operative infections[14], [15]. However, to date, there is no research data available at Dr. Hasan Sadikin General Hospital, Bandung, specifically examining the relationship between preoperative risk factors and SSI incidence in cesarean section patients. As a national referral hospital and educational institution that handles highly complex obstetric cases, the patient population at Dr. Hasan Sadikin General Hospital has clinical characteristics that do not always represent the general population.

This study aims to address the data gap regarding risk factors for post-cesarean section surgical site infections (SSIs) through a local context-based analysis. The findings are expected to inform the development of more targeted SSI prevention strategies tailored to patient profiles in tertiary care facilities, while also contributing to efforts to improve the quality of obstetric care. Specifically, this study analyzes the relationship between preoperative risk factors and SSI incidence in cesarean section patients. Emphasis is placed on individual patient factors, which can potentially be targeted for clinical interventions to strengthen prevention efforts, reduce infection rates, and improve the safety and quality of obstetric care in referral hospitals.

METHODS

This research is an observational analytical study with a case-control design conducted in the obstetrics ward of Dr. Hasan Sadikin General Hospital, Bandung. Data collection was conducted in March–April 2025 using secondary data from the medical records of cesarean section patients during January 2022–December 2024.Of the 1,775 patients, 1,500 qualified as the accessible population. After selection based on inclusion and exclusion criteria, 825 eligible patients were obtained. The case sample consisted of 45 patients with SSI (total sampling), while 135 patients without SSI were selected as controls (simple random sampling) with a ratio of 1:3. This ratio was selected considering statistical efficiency and test power[16], although potentially inducing selection bias, was controlled through multivariate analysis. Inclusion criteria included patients with complete medical records relevant to the study variables. Data collection was assisted by IPCLN trained in infection surveillance and control, using a standardized questionnaire. Validation was performed through double data entry and cross-checking between researchers.

Data analysis used SPSS version 27.0. Univariate analysis described the distribution of subjects, bivariate analysis used the Chi-Square test or Fisher's Exact to assess the relationship of risk factors with SSI, accompanied by Odds Ratio (OR) and 95% confidence interval. Binary logistic regression stepwise method was used in multivariate analysis to identify independent risk factors, with AOR reporting as a measure of association that has been controlled for other variables. This study has been approved

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by the Research Ethics Committee of Dr. Hasan Sadikin General Hospital Bandung (No. DP.04.03/D.XIV.6.5/45/2025).

RESULTS

This study conducted univariate, bivariate, and multivariate analyses. The results of the univariate analysis can be seen in Table 1.

Table1. Basic Characteristics of Study Patients

Variables	Total (%) n = 180
Operation Type	
Emergency	121 (67.2%)
Elective	59 (32.8%)
Age	
<20 years and >35 years	50 (27.8%)
20-35 years	130 (72.2%)
SC History	
Yes	35 (19.4%)
No	145 (80.6%)
Anemia	
Yes	61 (33.9%)
No	119 (66.1%)
Hypertension	
Yes	40 (22.2%)
No	140 (77.8%)
Obesity	
Yes	14 (7.8%)
No	166 (92.2%)
Diabetes	
Yes	8 (4.4%)
No	172 (95.6%)

Description: Data is presented with quantity/frequency and percentage.

Based on Table 1, 67.2% of study subjects underwent emergency cesarean sections. The majority of respondents were in the 20–35 age group (72.2%). Most patients (80.6%) had no history of previous cesarean sections. In terms of clinical condition, the majority of patients were not anemic (66.1%), did not suffer from hypertension (77.8%), were not obese (92.2%), and did not have diabetes (95.6%). The results of the bivariate analysis are presented in Table 2.

Table 2. Bivariate Analysis of the Relationship between Preoperative Risk Factors and Infection Incidence Post-Cesarean Section Operating Area

Variables	Group		P value	OR CI 95%
	Case n=45	Control n=135		
Operation Type				
Emergency	36 (80.0%)	85 (63.0%)	0.035*	2,353 (1,047-5,287)
Elective	9 (20.0%)	50 (37.0%)		
Age				
<20 years and >35 years	18 (40.0%)	32 (23.7%)	0.035*	2,146 (1,048-4,392)
20-35 years	27 (60.0%)	103 (76.3%)		
SC History				
Yes	17 (37.8%)	18 (13.3%)	0.000**	3,946 (1,808-8,615)
No	28 (62.2%)	117 (86.7%)		
Anemia				
Yes	30 (66.7%)	31 (23.0%)	0.000**	6,710 (3,207-14,038)
No	15 (33.3%)	104 (77.0%)		

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Hypertension				
Yes	16 (35.6%)	24 (17.8%)	0.013*	2,552 (1,202-5,419)
No	29 (64.4%)	111 (82.2%)		
Obesity				
Yes	7 (15.6%)	7 (5.2%)	0.047*	3,368 (1,112-10,205)
No	38 (84.4%)	128 (94.8%)		
Diabetes				
Yes	4 (8.9%)	4 (3.0%)	0.109NS	3.195 (0.765-13.346)
No	41 (91.1%)	131 (97.0%)		

For categorical data, the P value is calculated based on the test.*Chi-Square with an alternative Fisher Exact test if the requirements of Chi-Square are not met. The significance value is based on a p value < 0.05. NS Not Significant (P value is not significant), * P value is significant, ** P value is very significant*

The bivariate analysis results in Table 2 indicate that several preoperative risk factors are significantly associated with post-cesarean section surgical site infection (SSI). Emergency surgery, maternal age outside the 20–35 year range, prior cesarean section, anemia, hypertension, and obesity have been shown to increase the risk of SSI. Among these factors, anemia showed the strongest association. Meanwhile, diabetes status did not show a statistically significant association, although there was a trend towards an increased risk.

Multivariate analysis was performed to control for potential confounding between clinically relevant variables and demonstrate a relationship in bivariate testing. After modeling and interaction testing, the final results of the preoperative risk factor analysis for SSI incidence are presented in Table 3.

Table 3. Final Modeling of Preoperative Risk Factors for Post-Cesarean Section Surgical Site Infection

Variables	B	P value	*Adjusted Odds Ratio*(AOR)	AOR CI 95%	
				Lower	Upper
1. Operation Type	1,378	.006	3,966	1,499	10,492
2. Age	1,107	.015	3,024	1,238	7,385
3. SC History	1,280	.009	3,597	1,386	9,332
4. Anemia	1,829	.000	6,230	2,687	14,443
5. Obesity	1,523	.030	4,587	1,161	18,119

Note: Significant at p-value <0.05 based on binary logistic regression test.

Multivariate analysis results (Table 3) showed five preoperative variables significantly associated with the incidence of surgical site infection (SSI) after cesarean section. Anemia was the strongest predictor, with a more than sixfold increased risk. Emergency cesarean section, previous CS, extreme age (<20 or >35 years), and obesity also increased the risk of SSI by three to fourfold, with confidence intervals indicating a stable and significant association.

DISCUSSION

The results of the multivariate analysis showed that there were five preoperative variables that had a statistically significant relationship with the incidence of SSI, namely: anemia, type of surgery, history of CS, age, obesity.

Anemia

The results of this study indicate that anemia is the strongest predictor of post-cesarean section surgical site infection (SSI). A high AOR indicates that mothers with anemia have a more than sixfold higher risk of SSI compared to mothers without anemia, after adjusting for other variables. This finding is consistent with several previous studies, which also showed an increased risk of SSI in patients with anemia, both mild to moderate and severe[17], [18], [19], [20].

Physiologically, anemia reduces the oxygen-carrying capacity of the blood, impairs cellular immune function, and inhibits wound healing by disrupting collagen synthesis. This condition increases susceptibility to postoperative infections. The high proportion of

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anemia in this group reinforces its role as a major modifiable risk factor for SSI. Therefore, early detection and preoperative management of anemia are crucial to prevent complications, including surgical site infections. Interventions during the perioperative period are strongly recommended to improve hemoglobin status, accelerate healing, and reduce the risk of postoperative morbidity[21], [22], [23].

Operation Type

The type of surgery was the second significant variable associated with the incidence of surgical site infection (SSI) after cesarean section. Multivariate analysis showed that emergency cesarean section increased the risk of SSI almost fourfold compared to elective procedures. This finding is consistent with previous research, such as that reported by Ayesha et al. (2024), which found a 2.1-fold increased risk of SSI in emergency procedures.[24]Sattar et al. (2022) noted a higher proportion of infections in emergency (33.3%) than elective (17.0%) surgeries[25], and Meena et al. (2022) reported that most cases of postoperative wound infections occurred during emergency procedures[26].

The high risk of infection in emergency cesarean sections is likely due to limited preparation time, so that the implementation of preventive measures such as prophylactic antibiotics and aseptic techniques is less than optimal[27]. Emergency surgery also tends to be accompanied by more bleeding and a longer duration of surgery, both of which are risk factors for infection[28]. In contrast, elective procedures allow for more thorough preparation, including management of comorbidities and implementation of comprehensive infection prevention protocols[29]. These findings underscore the importance of optimizing preoperative management in emergency situations, as well as improving the competence of healthcare workers in implementing infection protocols. Furthermore, early identification of high-risk pregnancies and proactive delivery planning are necessary to reduce the need for emergency cesarean sections, especially in patients at high risk of infection[30], [31].

SC History

A history of cesarean section (CS) has been shown to be significantly associated with the incidence of surgical site infection (SSI). The study found that patients with a history of cesarean section had a nearly fourfold increased risk of SSI compared to those who had never undergone the procedure. This finding aligns with previous studies, such as those reported by Gillespie et al. (2022) with a 1.62-fold increased risk[11], and Bukhari et al. (2022) who found that 11.9% of SSI cases occurred in patients with repeated CS[32]. Dessu et al. (2021) reported an OR of 6.2[33], while Ketema et al. (2020) noted a relative risk of 1.21 times, although lower than other factors such as anemia[34].

Physiologically, a CS procedure leaves fibrotic tissue that can lead to adhesions during subsequent operations. These adhesions complicate surgery and increase the risk of tissue trauma, bleeding, and impaired wound healing [35], [36].Therefore, a history of CS should be considered an important risk factor in preventing SSI. The 2025 Enhanced Recovery After Surgery (ERAS) guidelines recommend preoperative risk assessment and optimization for patients with a history of CS, especially those with comorbidities such as obesity, hypertension, or diabetes. This approach aims to comprehensively prepare patients to reduce the risk of postoperative complications, including SSI[37].

Age

Age has been shown to significantly correlate with the incidence of post-cesarean section surgical site infection (SSI). Mothers in the extreme age groups (<20 years and >35 years) have a higher risk of SSI compared to those in the optimal reproductive age group (20–35 years). This finding is supported by studies by Dessu (2021) and Murniati (2020), both of which found a significant association between age and SSI[38], [39].However, several other studies such as Gomaa (2021) and Yuanna D (2023) did

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not find a statistically significant association[28], [40], indicating that there is variation in results between populations.

Physiologically, extremes of age are associated with less than optimal body conditions for surgical procedures and wound healing. In young mothers, physical and psychological immaturity can affect the body's response to surgical stress[41].Meanwhile, in older age, increased comorbidities and slower healing processes due to physiological changes associated with aging also increase susceptibility to wound infections[42].Therefore, the age groups <20 years and >35 years require special attention in the implementation of antenatal care (ANC). Intensive monitoring and personalized services are important to detect and manage comorbidities such as anemia, hypertension, or diabetes, which contribute to an increased risk of SSI[43].

Obesity

Obesity has been found to be a significant risk factor for post-cesarean section surgical site infection (SSI). Mothers with a high body mass index (BMI) have an almost fivefold increased risk of SSI. This finding is supported by various previous studies. Rosylianti (2020) noted that a BMI >27 kg/m² significantly increases the risk of SSI (OR 5.91)[44], while Errity (2023) reported a higher risk at BMI ≥35 kg/m² (OR 4.07) [45]Gillespie (2022) also identified obesity as a significant risk factor in elective CS patients[11], and Gomaa (2021) reported a 1.34-fold increase in risk[28].

Physiologically, the accumulation of subcutaneous fat tissue in obese patients creates dead space, impeding blood circulation and oxygen supply to surgical wounds. Consequently, healing is slowed and the immune response is decreased, increasing susceptibility to infection[46], [47].

These findings underscore the importance of pre-pregnancy weight control interventions to reduce postoperative complications. The FIT study-PLESE (2021) showed that a 7% weight loss before pregnancy can reduce the risk of obstetric complications, including cesarean section.[48]. In addition, the BMC Infectious Diseases study (2025) emphasized the need for nutritional monitoring, glucose control, and optimization of perioperative conditions in obese women to reduce the risk of SSI after cesarean section[49].

Multivariate analysis findings indicate that the incidence of surgical site infections (SSI) after cesarean section is multifactorial. Factors such as anemia, emergency surgery, prior cesarean section, extreme age, and obesity all contribute to increasing the risk of infection. Therefore, SSI prevention requires a comprehensive approach, focusing on controlling modifiable factors, particularly anemia and obesity, as well as planning elective procedures and intensive management of high-risk patients.

Clinical Implications

These findings support the need to strengthen post-cesarean section surgical site infection (SSI) screening and risk management policies. Identification of preoperative risk factors such as anemia, obesity, extreme age, prior cesarean section, and emergency surgery should be integrated into antenatal and preoperative protocols. Primary and secondary care facilities play a role in early detection and timely referral, while hospitals need to update their standard operating procedures (SOPs) for systematic risk evaluation. This risk-based approach is expected to improve the effectiveness of SSI prevention and maternal safety.

Research Limitations

This study has several limitations. The case-control design with a limited number of cases and the total sampling technique in the case group pose a risk of selection bias. The use of medical record data mitigates recall bias, but the potential for error due to inconsistent recording remains. Furthermore, several potential factors such as

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micronutrient status, antibiotic adherence, and surgical environment conditions could not be analyzed. Therefore, these findings should be confirmed through prospective studies with more robust designs and more comprehensive variable controls.

CONCLUSION

The results of this study indicate that post-cesarean section surgical site infections are closely related to the mother's preoperative condition, which includes clinical and obstetric factors. Anemia, emergency surgery, a history of cesarean section, maternal age outside the optimal reproductive range, and obesity are factors that significantly increase the risk of infection. These findings confirm that postoperative infections are not only influenced by intraoperative procedures but also by the mother's preoperative health status. Therefore, preoperative risk screening and preventive interventions from the primary to tertiary care levels need to be an integral part of postoperative infection prevention efforts, especially in referral hospitals. These results provide a basis for strengthening clinical policies that focus on early detection and optimization of maternal conditions before surgery.

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