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# Risk factors influencing caesarean wound infection (CWI)

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**Abstract**

**Background:** Cesarean section (CS) is a delivery method that continues to increase and carries a risk of complications, one of which is surgical wound infection (SWI). SWI can hinder healing and increase morbidity. Risk factors for infection include preoperative, intraoperative, and postoperative conditions, necessitating analysis to prevent postoperative complications.
**Purpose:** To identify risk factors for surgical site infection in Cesarean section procedures and to determine the association between nutritional status, hemoglobin levels, and wound care with the occurrence of surgical site infection.
**Method:** This study is an observational analytical study using a cross-sectional approach conducted at RSIA Sitti Khadijah 1 Muhammadiyah Makassar from March to June 2025. Data were analyzed using univariate and bivariate analysis with the Chi-square test at a significance level of $p < 0.05$.
**Results:** There was a significant association between several risk factors and the occurrence of postoperative wound infections following Cesarean section. Based on bivariate analysis, nutritional status, hemoglobin (Hb) levels, wound care, and type of cesarean section procedure were found to influence the occurrence of postoperative wound infections. However, although the duration of surgery showed a statistical association, the data obtained were not varied, so a definitive conclusion regarding the relationship between surgery duration and postoperative wound infections after cesarean section could not be drawn.
**Conclusion:** Nutritional status, hemoglobin levels, wound care, and type of cesarean section are factors associated with the occurrence of postoperative wound infections after cesarean section. These findings highlight the importance of attention to maternal nutritional status, hemoglobin levels, wound care standards, and the selection of Cesarean section type in efforts to prevent postoperative infections. A comprehensive evaluation of these factors is necessary to minimize the risk of complications and improve patient safety.

**Keywords: Maternal Hemoglobin Levels; Maternal Nutritional Status; Surgical Wound Infection; Wound Care.**

## INTRODUCTION

Sectio Caesarea (SC) is a process of childbirth or surgical procedure involving an incision in the abdominal wall (*laparotomy*) and uterus (*hysterectomy*) to remove the fetus, placenta, and amniotic sac (Firdausi & Jayanti, 2023). *Cesarean section* is performed electively (planned) if the pelvic diameter is too small for vaginal delivery, the baby is in *a breech position*, *there is placenta previa,* a previous *cesarean section* scar, or the patient requests a cesarean section without medical

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indication (de Morais Filho & de Morais, 2021). *Cesarean section* may also be performed urgently *(emergency cesarean section*), which is a *life-saving* procedure for emergency patients. In cases of emergency cesarean section, special care is required to prevent infection (Asiyanbola, Ohaeri, & OJO, 2022). Surgical site infection is an infection that occurs after surgery, affecting the incision or surgical site (Seidelman, Mantyh, & Anderson, 2023). This infection is likely to occur due to the surgery itself, which intentionally damages tissue and provides an entry point for bacteria. The occurrence of infection is an important indicator of patient safety and is a major complication experienced by patients after cesarean section, potentially hindering wound healing, causing deformities, or even leading to death (Childs, Sandy-Hodgetts, Broad, Cooper, Manresa, & Verdú-Soriano, 2020).

According to *the World Health Organization* (WHO), the global rate of *cesarean section* (CS) procedures ranges from 5–15%. Based on the WHO's *Global Survey on Maternal and Perinatal Health* in 2021, approximately 46.1% of all deliveries were performed via CS. Data from the 2021 RISKESDAS survey indicates that in Indonesia, CS deliveries accounted for 17.6% of all births. The implementation of CS is generally triggered by several medical conditions that complicate pregnancy, with a distribution of approximately 23.2%, including breech or transverse presentation (3.1%), hemorrhage (2.4%), eclampsia (0.2%), preterm rupture of membranes (5.6%), prolonged labor (4.3%), umbilical cord entanglement at 2.9%, *placenta previa at* 0.7%, retained placenta at 0.8%, hypertension at 2.7%, and other factors at 4.6%. Meanwhile, the results of the 2021 Indonesia Demographic and Health Survey (SKDI) also noted that 17% of all births in health facilities in the National Health Service (NHS) used the cesarean section (CS) method. One of the most common complications following a CS procedure is Surgical Site Infection (SSI), with a global prevalence of 11.7% in 2022. According to WHO research data from 2021, the rate *of cesarean section* continues to rise globally, currently accounting for more than 1 in 5 (21%) of all births. This trend indicates that the use of *cesarean section* (CS) is increasing (Komarijah & Waroh, 2023).

Data from RSKDIA Pertiwi Makassar shows that in 2020, 1,351 women gave birth via cesarean section, while in 2021, there were 1,081 cesarean section births. The 2022 review report indicates a decrease to 1,006 cesarean section births (Maulidya, Yulia, & Herawati, 2022). The high rate of cesarean sections is associated with a high prevalence of postoperative surgical site infections. According to medical literature, various factors can influence the occurrence of postoperative infections following cesarean sections. These factors can be preoperative (before surgery), intraoperative (during surgery), and postoperative (after surgery) (Kartikasari & Apriningrum, 2020). Some preoperative factors that can influence the risk of infection include pregnancy conditions, maternal nutritional status, and relevant medical history. Intraoperative factors such as surgical technique, duration of surgery, and wound closure technique can also contribute to the risk of infection. Additionally, postoperative care, including wound management and wound care, can influence the occurrence of post-cesarean section wound infections (Widiarti & Novita, 2024).

Analyzing and identifying these factors can help in effective prevention to reduce the incidence of post-cesarean section wound infections. Additionally, further research will provide additional insights into the management of *cesarean section* patients, which can reduce the risk of post-surgical complications. With this background understanding, a comprehensive analysis of the factors contributing to post-cesarean section wound infections can be conducted, providing a strong foundation for improving clinical practices and patient management in obstetrics and surgery.

## RESEARCH METHOD

This study is an observational analytical study with a cross-sectional approach aimed at analyzing risk factors influencing the occurrence of postoperative wound infections following cesarean section. The study was conducted at RSIA Sitti Khadijah 1 Muhammadiyah Makassar from March to June 2025. The study population consisted of all

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patients who gave birth via cesarean section, while the sample comprised medical records of patients who underwent cesarean section between January and December 2024 and experienced postoperative wound infections.

The sample was determined using total sampling, where all individuals in the population meeting the inclusion criteria were included as samples. Inclusion criteria included all medical records of patients who experienced post-SC wound infections, while exclusion criteria were patients with conditions that could affect wound healing, such as diabetes mellitus and immunodeficiency. The independent variables in this study were nutritional status, hemoglobin (Hb) levels, and wound care, while the dependent variable was wound infection in patients after Cesarean section.

Data analysis was performed univariately to describe the characteristics of each variable in the form of frequency distributions, and bivariately using the Chi-square test with a significance level of p<0.05 to determine the existence of a significant relationship between independent and dependent variables. This research obtained ethical approval with No.201/A.1/KEP-UMI/IV/2025

## RESEARCH RESULTS

Based on the study conducted on patients who underwent *Cesarean section* from January to March 2024 at RSIA Sitti Khadijah 1 Muhammadiyah Makassar, which included secondary data collection, processing, and univariate and bivariate analysis. Data analysis was conducted using SPSS software with the *Chi-square* method to determine whether there was a relationship between nutritional status, Hb levels, wound care, and the occurrence of surgical wound infections. The results are as follows.

**Table Characteristics of the Respondents (N=170)**

| Variables | Results | Sig. |
|---|---|---|
| **Infection (n/%)** | | |
| Yes | 72/42.2 | |
| No | 98/57.6 | |
| **Anemia (n/%)** | | |
| Yes | 60/35.3 | |
| No | 110/64.7 | 0.000 |
| **Nutritional Status (n/%)** | | |
| Normal | 17/20 | |
| Obesity 1 | 75/4 | |
| Obesity 2 | 53/31.2 | |
| Overweight | 25/14.7 | 0.033 |
| **Wound Care (n/%)** | | |
| Routine | 103/60.6 | |
| Non-routine | 67/39.4 | 0.000 |

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| Variables | Results | Sig. |
|---|---|---|
| **SC Type (n/%)** | | |
| Cito | 69/40.6 | |
| Elective | 101/59.4 | 0.000 |
| | | |
| **Duration of Surgery (n/%)** | | |
| 60– utes | 167/98.2 | |
| 85 minutes | 1/0.6 | |
| 120 minutes | 1/0.6 | |
| 180 minutes | 1/0.6 | 0.000 |

Based on the frequency distribution results of the research variables, it is known that most respondents in this study did not experience infection, namely 98 people (57.6%), while respondents who experienced infection numbered 72 people (42.4%). Regarding the anemia variable, respondents who did not experience anemia were more dominant, with 110 people (64.7%), while those who experienced anemia numbered 60 people (35.3%). Regarding nutritional status, the highest proportion was found in the category of obesity level 1, with 75 people (44.1%), followed by obesity level 2 with 53 people (31.2%), overweight with 25 people (14.7%), and those with normal nutritional status only 17 people (10.0%). Meanwhile, in terms of wound care, the majority of respondents underwent routine wound care, totaling 103 people (60.6%), while those who did not undergo routine wound care numbered 67 people (39.4%). These findings indicate that most respondents were compliant with wound care, although a significant proportion still experienced infection, anemia, and abnormal nutritional status. Regarding the type of cesarean section (SC), the majority underwent elective SC, totaling 101 individuals (59.4%), while those who underwent emergency SC numbered 69 individuals (40.6%). This indicates that most SC procedures in this study were planned in advance (elective). Data on the duration of surgery showed that the majority, approximately 167 people (98.2%), underwent cesarean section within 60 minutes.

Based on the results of the chi-square test, the significance value (Sig.) of 0.033 indicates that there is a statistically significant relationship between nutritional status and the incidence of infection among respondents in this study's, because the p-value is <0.05. Descriptively, there is variation in the incidence of infection in each nutritional status group. Respondents with normal nutritional status had the lowest infection rate, with only 2 individuals (11.8%) experiencing infection, while the majority (15 individuals or 88.2%) were not infected. Conversely, in the *overweight* group, 11 people (44%) experienced infection, and 14 people (56%) did not experience infection. For respondents with obesity 1, 33 people (44%) experienced infection and 42 people (56%) did not experience infection. Meanwhile, in the obesity 2 group, the infection rate was slightly higher, with 26 people (49.1%) experiencing infection and 27 people (50.9%) not infected. Although the proportion of infection rates varied across nutritional status groups, these differences were statistically significant overall, indicating that nutritional status does indeed influence infection rates in the studied population.

Based on the results of the chi-square test, it was found that there was a significant relationship between the incidence of anemia and the presence of infection in the respondents (p-value = 0.000 < 0.05). Descriptively, of the 72 respondents who had an infection, 41 (68.3%) had anemia and 31 (28.2%) did not have anemia. Meanwhile, among the 98 respondents without infection, 19 (31.7%) had anemia and 79 (71.8%) did not have anemia. The percentage of anemia incidence in the groups with and without infection was significantly different,

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indicating that infection significantly influences the occurrence of anemia among the respondents in this study.

Based on the results of the chi-square test, a significance value (Sig.) of 0.000 was obtained, indicating that there is a statistically significant relationship between wound care and the incidence of infection in the respondents in this study ($p < 0.05$). Descriptively, it can be seen that respondents who routinely performed wound care had a significantly lower incidence of infection, with only 11 people (10.7%) experiencing infection, while 92 people (89.3%) did not experience infection. Conversely, among respondents who did not perform routine wound care, the number of those who experienced infection was much higher, at 61 people (91%), and only 6 people (9%) did not experience infection. This finding indicates that the absence of routine wound care significantly increases the risk of infection in the studied population.

Based on the results of the Chi-square test, a significance value of 0.000 was obtained, indicating a statistically significant relationship between the type of cesarean section (SC) and the incidence of infection in the respondents ($p < 0.05$). Descriptively, it can be seen that in the emergency cesarean section procedure, the majority of respondents experienced infection, namely 53 people (76.8%), while only 16 people (23.2%) did not experience infection. Conversely, in elective cesarean section procedures, the majority of respondents did not experience infection, with 82 people (81.2%), and only 19 people (18.8%) experienced infection.

These results indicate that emergency cesarean sections (SC) have a significantly higher risk of infection compared to elective cesarean sections (scheduled). This difference may be attributed to various factors, such as urgent maternal and fetal conditions, limited preparation time, and the possibility of suboptimal hygiene and sterilization conditions during emergency procedures. Therefore, the type of cesarean section plays a crucial role in determining the post-operative infection risk in patients.

Based on the results of the Chi-square test, a significance value of 0.000 was obtained, indicating a statistically significant relationship between the duration of surgery and the incidence of surgical wound infection in the respondents ($p < 0.05$). Descriptively, it can be seen that in surgical procedures lasting 60 minutes, 72 people (43.1%) experienced infection, and 95 people (56.9%) did not experience infection. Meanwhile, in surgeries lasting more than 60 minutes (i.e., 85, 120, and 180 minutes), no cases of surgical wound infection were found; all respondents in this group did not experience infection (100%).

Although statistical tests showed a significant relationship, the number of respondents with a duration of more than 60 minutes was very small (only 1 person each), so the interpretation of these results must be done with great caution. In addition, the duration data used in this study was obtained from medical records without detailed recording of the start and end times of the operation, so its accuracy cannot be fully confirmed. These results indicate that while there is a statistically significant association between surgical duration and wound infection incidence, the data are not sufficiently robust from a clinical and methodological standpoint to support valid conclusions. The limitations of the data and the imbalance in sample sizes between groups prevent this analysis from accurately reflecting the influence of surgical duration on wound infection incidence.

## DISCUSSION

Based on the research findings, a significant association was found between nutritional status and the incidence of postoperative surgical wound infections (PSWIs) in patients who underwent cesarean section (CS). These findings align with the study conducted by (Kartikasari & Apriningrum, 2020), which stated that obesity is one of the risk factors for postoperative wound infections, as fatty tissue is more difficult to heal, heals more slowly, and is more susceptible to microbial contamination. Similarly, a study conducted by (Oktafian, 2020) at Dr. Moewardi General Hospital in Surakarta found that post-SC patients with obesity had a higher risk of developing SIO compared to those with normal nutritional status.

Physiologically, obesity can affect various aspects of the wound healing process. One of these

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is tissue hypoxia, a condition characterized by insufficient oxygen supply to local tissues due to impaired blood perfusion. This occurs because excess adipose tissue restricts oxygen distribution to the wound area. Additionally, obesity is associated with adiponectin deficiency, an anti-inflammatory hormone that plays a crucial role in angiogenesis and re-epithelialization. Adiponectin deficiency inhibits the activation of AMP and ERK signaling pathways required for cell regeneration, thereby slowing down the proliferation phase and increasing the risk of wound infection (Oktafian, 2020).

Obesity also creates a chronic low-grade inflammatory environment characterized by increased production of proinflammatory cytokines such as TNF-α and IL-6. Excess adipose tissue alters the function of macrophages from the M2 (anti-inflammatory) phenotype to the M1 (pro-inflammatory) phenotype, disrupting the inflammatory control mechanisms that should subside during the healing phase. The activation of immune cells such as invariant natural killer T cells in adipose tissue also contributes to the increased inflammatory response. As a result, wounds remain longer in the inflammatory phase and do not promptly enter the proliferative and remodeling phases (Crosby & Kronenberg, 2018).

Mechanically, obesity can also lead to the formation of hematomas or seromas (collections of blood or fluid) in tissues, impairing the hemostasis phase. This causes surgical incisions to reopen more easily (dehiscence), and the opening of wounds increases the risk of bacterial pathogens entering and causing infection. Additionally, tissue hypoxia reduces leukocyte activity, thereby lowering the body's ability to fight infections.

Considering these mechanisms, nutritional status, particularly obesity, has a significant impact on the risk of postoperative wound infection following a cesarean section. Therefore, management of cesarean section patients should also consider nutritional status, both in preoperative preventive measures and in postoperative care to prevent infectious complications.

Based on the study results, a correlation was found between hemoglobin (Hb) levels and the incidence of postoperative wound infections following a cesarean section (SC). These findings align with the studies by (Kartikasari & Apriningrum, 2020) and (Dewi, Kabuhung, & Hidayah, 2024) which state that a decrease in Hb levels in the blood (anemia) reduces arterial oxygen supply to peripheral tissues, including surgical wounds, thereby impairing tissue healing processes.

Cesarean section is generally a major surgical procedure that can result in significant blood loss. This often leads to postoperative anemia, especially if the patient had low Hb levels before surgery. When hemoglobin levels are low, the blood's ability to bind and transport oxygen to wound tissues also decreases. As a result, tissue regeneration processes and cellular immune activities such as phagocytosis by neutrophils become suboptimal.

Hemoglobin is a protein molecule found in red blood cells that plays a crucial role in transporting oxygen from the lungs to body tissues and carrying carbon dioxide back to the lungs. If hemoglobin levels are <11 g/dL (mild anemia according to WHO criteria for pregnant women), hemodilution occurs, leading to reduced blood viscosity and impaired tissue perfusion. This impaired oxygen circulation disrupts cell regeneration and prolongs the inflammatory phase of wound healing.

Wound healing begins with the inflammatory phase, during which neutrophils and macrophages migrate to damaged tissues to perform phagocytosis and release pro-inflammatory mediators that stimulate healing. Adequate hemoglobin levels support oxygen perfusion to the wound tissue, enhance the phagocytic capacity of immune cells, and aid in the formation of healthy granulation tissue. This reduces the risk of secondary infection and accelerates the proliferation and remodeling phases of wound healing.

These findings are supported by (Erliani, 2023) study, which showed that postpartum women with hemoglobin levels <10 g/dL had a twofold higher risk of surgical wound infection compared to those with hemoglobin levels ≥11 g/dL. Research by (Robiatun & Romadhon, 2023) also supports this, where low hemoglobin levels are associated with an increased risk of delayed wound healing in postoperative patients.

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Therefore, hemoglobin levels are an important parameter that must be monitored before and after cesarean section, as they directly impact wound healing effectiveness and the prevention of surgical wound infection complications.

Based on the results of this study, a significant association was found between wound care quality and the occurrence of postoperative wound infections (PWI) in patients after cesarean section. Mothers who received routine and standard wound care, such as regular wound care records, absence of complications, and standard procedures like antibiotic/topical administration and monitoring of wound improvement signs, had a lower risk of wound infection compared to mothers who did not receive optimal wound care.

This study aligns with research by (Himatusujanah & Rahayuningsih, 2008) at Dr. Moewardi General Hospital, which stated that consistent implementation of wound care protocols significantly reduces the incidence of SSI in post-SC patients. Proper wound care helps prevent bacterial contamination, accelerates granulation tissue formation, and minimizes the risk of secondary complications such as cellulitis or gangrene. Wound complications can prolong healing time and increase the risk of systemic infections, such as sepsis. *Post-cesarean section* sepsis is a serious complication resulting from systemic infection following obstetric surgical procedures. *Cesarean section,* as a major surgical procedure, carries a high risk of infection, both at the incision site and in internal organs such as the endometrium. If the infection is not detected and treated promptly, bacteria can enter the bloodstream and trigger an uncontrolled systemic inflammatory response. This is supported by (Dirgantini, 2020), who stated in their literature review that proper wound care documentation and appropriate care measures are directly associated with a reduction in ILO rates.

Furthermore, proper wound care is typically followed by the administration of prophylactic antibiotics. (Wibowo, Utamiasih, & Juwita, 2019) found that patients who received antibiotics according to guidelines (type, dose, timing) experienced a reduced risk of ILO. Therefore, well-documented wound care in medical records not only reflects the accuracy of procedures but also the overall quality of care. Thus, routine, documented, and SOP-compliant wound care is a crucial factor in preventing postoperative surgical site infections following SC. These findings reinforce the importance of evaluating the quality of wound care services as a preventive measure against postoperative complications.

Based on the results of the study conducted, a relationship was found between the incidence of postoperative wound infections and the type of cesarean section, as patients who underwent emergency cesarean sections (emergency cases) were more prone to infections compared to those who underwent elective cesarean sections. This is attributed to the shorter preparation time for emergency surgeries, which results in suboptimal sterilization processes. Emergency cesarean sections are typically performed due to life-threatening conditions for the mother and fetus, such as premature rupture of membranes*, fetal distress,* preeclampsia, prolonged labor, placenta previa, placental abruption. These factors lead to microbial contamination, impaired maternal immune function, and massive bleeding, resulting in post-operative care focusing on these conditions, thereby compromising infection prevention efforts (Anggraeni, Kusmindarti, & Wahyuningrum, 2024).

According to (Mehzabin, Elahi, Bar, Sinha, Akter, & Alam, 2019) in the International Journal of Reproduction, Contraception, Obstetrics and Gynecology, it is stated that the incidence rate of ILO in patients undergoing emergency cesarean section (SC) reached 10.53%, significantly higher than the rate of elective cesarean section (SC) at 2.61%. This is attributed to several factors inherent in emergency cesarean section, such as limited preparation time, delayed administration of prophylactic antibiotics, and the mother's pre-existing risk factors, such as prolonged rupture of membranes or the presence of intrauterine infection prior to the procedure.

Research by (Supriyatin, Melani, Jubaedah, Susanti, & Susiarno, 2025) in the journal Eduvest also adds that emergency cesarean sections are often performed on pregnant women with severe obstetric complications, such as preeclampsia, fetal distress, or placental abruption, which physiologically

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increase the risk of infection due to a weakened maternal immune response. This condition is exacerbated if labor has been prolonged or if the membranes have been ruptured for more than 12 hours, increasing the likelihood of bacterial contamination entering the uterine cavity.

The duration of surgery is one of the factors often associated with an increased risk of surgical site infection (SSI). Theoretically, the longer the duration of surgery, the higher the risk of microbial contamination of the surgical site due to prolonged exposure of open tissue, as well as potential disruption of the patient's homeostasis. However, in this study, it was found in patients' medical records that the duration of cesarean section (CS) procedures was relatively consistent, with an average of ±60 minutes, both in elective and emergency cases. Some literature suggests that surgeries lasting ≥1 hour can increase the risk of infection, especially when accompanied by other risk factors such as bleeding, sterility issues, or suboptimal patient condition. According to (Supriyatin, Melani, Jubaedah, Susanti, & Susiarno, 2025) a surgical duration of ≥1 hour is an important risk factor for ILO occurrence, especially in emergency procedures performed without adequate preparation. Additionally, (Mehzabin, Elahi, Bar, Sinha, Akter, & Alam, 2019) also noted that a surgical duration of ≥45 minutes is significantly correlated with ILO occurrence in CS procedures.

However, since the medical records indicate that the average surgery duration for patients in this study was approximately 60 minutes, a bivariate analysis to assess the relationship between surgery duration and ILO occurrence could not be conducted. The lack of variability in the duration variable hindered statistical testing, so the influence of surgery duration on ILO occurrence cannot be directly inferred from this study's results.

Although the chi-square test results indicate a significant relationship between surgery duration and the occurrence of surgical site infections (SSIs), these results should be interpreted with caution. This is because nearly all respondents in this study were recorded as having undergone surgery with a duration of 60 minutes based on medical records, and only three individuals had a duration of ≥60 minutes. The imbalance in the number of respondents across duration categories resulted in data heterogeneity. The duration of surgery recorded in medical records may not have been based on actual time documentation but rather estimated by the medical recorder. This raises doubts about the accuracy of the surgical duration data used in this study. The uneven distribution between surgical duration groups reduces the strength of the analysis, both statistically and in terms of the ability to draw conclusions. Therefore, although there is a statistically significant association, the effect of operation duration on ILO occurrence cannot be conclusively determined from this study.

## CONCLUSION

Based on the results of bivariate analysis, there is an influence of nutritional status on the occurrence of post-cesarean section infection. Based on the results of bivariate analysis, there is an influence of Hb levels on the occurrence of post-cesarean section infection. Based on the results of bivariate analysis, there is an influence of wound care on the occurrence of post-cesarean section infection. Based on the results of bivariate analysis, there is an influence of the type of cesarean section on the occurrence of post-cesarean section infection. Based on the results of the study, the duration obtained did not vary, so it was not possible to determine the relationship between the duration of the operation and the occurrence of post-cesarean section infection, although a statistical relationship was found.

## SUGGESTION

Further research should be conducted using a prospective design or incorporating broader variables such as parity, age, immunological status, albumin levels, prophylactic antibiotic use, as well as environmental factors and personal hygiene to obtain a more comprehensive understanding of the causes of post-cesarean section infections. The limited variability of data in this study should be considered for future research with a more diverse sample and larger sample size.

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