Shacho et al. BMC Infectious Diseases (2025) 25:457
https://doi.org/10.1186/s12879-025-10857-y

BMC Infectious Diseases

RESEARCH

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Incidence and risk factors of surgical site infection following cesarean section: a prospective cohort study at Jimma university medical center

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Abstract

Background Surgical site infection (SSI) after cesarean section (CS) is one of the contributors for high maternal mortality and morbidity rates.

Aim This prospective cohort analysis assessed the incidence rate and risk factors of time to SSI following CS among women who were admitted to Jimma University Medical Center (JUMC).

Method Data was gathered from CS patients who were admitted to the maternity ward at JUMC. The study included women who were admitted to the JUMC maternity ward, had CS, and agreed to participate. The study excluded women who died soon after or during the CS surgery. 417 of the 1,081 women who had CS throughout the study period fulfilled the criteria. We have used the Kaplan-Meir estimator and the Cox proportional hazard model for the analysis and model building.

Results The study included 417 women out of 1,081 who underwent CS between March and August 2022. The incidence rate for SSI following CS among women was 19.7%. The survival curve shows that the contaminated and dirty wound classification have significantly lower survival rates than other surgical wound classifications. The Cox proportional model result indicates; body mass index (BMI) (HR: 1.08, 95% CI: 1.01-1.15), time to give antibiotic prophylaxis (HR: 1.03, 95%CI: 1.01- 1.06), duration of operation (HR: 1.02, 95% CI: 1.01- 1.03), admission status (HR: 1.65, 95% CI: 1.05 -2.59), and duration of labor (HR: 1.04, 95% CI: 1.01- 1.08) (HR: 1.08, 95% CI: 1.01-1.15), time to give antibiotic prophylaxis (HR: 1.03, 95% CI: 1.01- 1.06), duration of operation (HR: 1.02, 95% CI: 1.01- 1.03), admission status (HR: 1.65, 95% CI: 1.05 -2.59), and duration of labor (HR: 1.04, 95% CI: 1.01- 1.08) covariates are significant at a 5% level of significance.

Conclusion The magnitude of SSI following CS is high. The duration of labor, BMI, procedure time, and the timing of treatment were risk factors of SSI after CS. Women with a high BMI and referring-admitted patients should also receive extra care. Therefore, strict treatment is required, along with close observation and follow-up. Finally, increased awareness of these risk factors, continuous training in infection prevention techniques may minimize and prevent the

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high SSI rate after CS. Furthermore, to effectively prevent surgical site infections (SSIs) in cesarean section (CS) patients, action-oriented measures such as strengthening antibiotic prophylactic guidelines and enhancing surveillance of vulnerable women are essential.

Clinical trial number Not applicable.

Keywords Kaplan-Meier curve, Cox proportional model

Introduction

Surgical site infection (SSI) following cesarean section (CS) is defined as an infection occurring within 30 days after the surgical operation, affecting either the incision or deep tissues at the operation site [1]. SSI is a common consequence and is mainly responsible for high maternal mortality and morbidity rates, unhappiness among patients, prolonged hospital stays, and higher treatment expenses [2]. Common indications for C-section include fetal distress (62% for emergency C-sections), previous cesarean (33% for elective C-sections), maternal request, and malpresentation. These factors significantly influence the decision to perform a C-section in the studied population [3].

Maternal infectious disease increases eight times more after cesarean delivery compared to vaginal births [4]. SSI has reported that it ranges from 3 to 20% globally. A wide variety of SSI rates described after CS were 2.94% in Libya [5], 4.3% in Uganda [6], and 18% in Pakistan [7]. SSI following CS causes a significant burden on both the mothers and the healthcare system [8].

SSI after CS the incidence rate ranged from 3.34 to 19 per 100 surgical procedures LMICs [9]. In Africa, up to 20% of cesarean section patients develop a wound infection, compromising their health and ability to care for their newborns [10]. The post-CS rate of surgical site infection were 15.6–10.9% [11, 12] in Tanzania, 25.4% in North-west Ethiopia [13], 11.6% in Addis Ababa [14] and 7.74% in eastern Ethiopia [15].

A wide variety of SSI rates were described after CS. SSI following CS causes a significant burden on both the mothers and the healthcare system [8]. SSI following CS have significant implications, including increased morbidity, mortality, hospital costs, and length of stay [16]. In southwestern Ethiopia JUMC is the only referral hospital because of the substantial effects on patient health and the regional healthcare systems. It is imperative to examine SSI after CS. An increased risk of postpartum infections, which can result in longer hospital stays and greater medical expenses, is correlated with the rising prevalence of cesarean deliveries. Understanding the variables that contribute to SSI can help guide preventative initiatives and improve patient outcomes.

Existing research on SSI following CS in the study area identifies several weaknesses that the current study aims to fix. These include insufficient geographical representation of infection rates, inconsistencies in methodology, and a lack of detailed risk factor analysis. The new study aims to fill these gaps by conducting a more comprehensive and inclusive analysis of SSI in JUMC. This study used a standardized approach to improve the results' comparability and reliability. Time-to-event analysis, especially using Kaplan-Meier and Cox models, is important for investigating SSI following CS since it can provide data on incident timing. These methods allow researchers to quantify the period until an incident occurs, which is essential for understanding the dynamics of SSI following CS [17]. The Cox model estimates hazard ratios, allowing us to investigate the impact of various risks [18]. Kaplan-Meier curves can visually represent the probability of being SSI-free over time, allowing for comparisons between patient wound classifications [19]. Therefore, the objective of this study was to assess the incidence rate and risk factors of time to SSI following CS in mothers who were admitted to JUMC during the study period using the Cox model.

Material and methodology

Study design

We conducted a prospective longitudinal study between March, to August, 2022 on all women who underwent elective or emergency surgery at the Obstetrics and Gynecology Department of JUMC. We included patients who had a cell phone number for reporting their circumstances and were willing to participate in the study [20, 21]. Only women who survived a Cesarean Section (CS) and the immediate post-operative period were included in the study; any women who passed away during or soon after the CS procedure or had medical disorder were not taken into account for analysis [22, 23].

Data collection

Following surgery, SSI after CS occurred within 28 days, and the patient was discharged on the third day. However, our patients come from all over the region; the only way to follow their status was to contact them by phone. The data was gathered by the trained nurses. The nurses were selected for data collection based on their ward experience and infection prevention training.

Eligible women were enrolled within 24-h post-CS and assessed for SSI daily during inpatient stay and followed for 30 day at 3rd, 5th, 7th, 14th day and day 30 using the

Centers for Disease Control and Prevention (CDC) Classification [24].

Days 3–7 Regarded as the most crucial time for the early identification of superficial incisional SSIs, during which the incision site should be closely watched for infection-related symptoms such as redness, swelling, warmth, drainage, or discomfort [21, 25].

Day 14 It's also critical to check for deeper infections because symptoms might not show up right away [21].

Day 30 Considered the last evaluation point for the majority of superficial incisional SSIs, while more intricate procedures can necessitate ongoing observation for more serious infections [21].

The data were obtained using a structured questionnaire that was documented at each follow-up session. All data relating to the surgical technique and post-surgical management were extracted from the surgical records on the first day after CS during the inpatient stay. Antenatal cards, medical records, structured interviews, and clinical examinations have been used to collect demographic and clinical information. Health workers used telephone to assess the wound condition of patients on the specified day if women were discharged from the hospital to determine whether they had SSI or not.

The study enrolled 417 patients undergoing cesarean sections, monitored for 30 days post-surgery for surgical site infections. Data on risk factors were collected, and statistical analyses, including the Cox proportional hazard model, were performed to evaluate associations with SSI.

Operational definition

SSI following CS Infection that occurs within 30 days of the operation and has at least one of the following symptoms: Purulent discharge from the incision site or at least one sign of irritation (pain, fever, localized swelling, induration, dehiscence, overlying skin changes, and exudative purulent discharge) or a wound deliberately opened by the surgeon for drainage or the surgeon declaring that wound is infected [24].

Time to SSI following CS Time (in days) between the ends of operation to the development of SSI following CS.

Event development of SSI following CS.

Censoring patients not developing SSI and those who lost follow-up.

Duration of operative procedure interval (in hours and minutes) between the CS start time, and the CS finish time [24].

Post-discharge period The period from discharge to the end of the follow-up period (Day 30).

Follow-up period The 30-day period in which symptoms meeting the case definition will attribute to the surgical procedure.

Elective procedure A scheduled surgical procedure, usually performed with standard pre-procedure activities (also called a 'routine procedure').

Emergent procedure An unscheduled surgical procedure, often performed without standard pre-procedure activities.

Methods of data analysis

Survival analysis The study focused on time to event (time to SSI following CS), so the appropriate method for this particular study we used survival analysis. The research practiced R.

software version 4.3.1 for investigation. We used the Kaplan-Meir estimator and the Cox proportional hazard model for the analysis and model building. Kaplan-Meier analysis has been used to study the survival pattern; the KM plot, which is a step function, gives some indications about the shape of the survival distribution. The log-rank test is used in Kaplan-Meier analysis to analyze survival distributions between two or more groups. It assesses the statistical significance of variations among the survival curves, determining if each curve is statistically different [26].

The Cox proportional hazards model evaluates the simultaneous effects of multiple covariates on survival, allowing researchers to assess how specified factors influence the hazard rate of an event occurring over time, accommodating complexities such as mediation and confounding variables [27].

The proportional hazard model

The study applied the proportional hazard model of multivariate analysis to identify factors associated with infection from SSI following CS and Cox proportional hazards (PH) model given by:

$$\lambda\ (t/z) = \lambda_{\,0}\,(t)\,e^{Z^T\beta}$$

,

Where $Z=(Z_1, Z_2,..., Z_p)^T$ and $\beta=(\beta_1,..., \beta_p)$ Z is a p x 1 vector of covariates such as demographic and surgical intervention related variables and β is a px1 vector of regression coefficient.

The parameter has been estimated by using partial likelihood functions. We used three different.

tests to assess the significance of the coefficients in the Cox proportional hazards model: the partial likelihood ratio test, the Wald test, and the score test.

Selection of covariates

We followed the recommendations of Hosmer and Lemeshow [28] and Collett [29], for the variable selection process. This included taking into account all variables that show significance at the 20–25% level in the univariable analysis as well as any additional variables that are thought to be clinically significant in order to fit the original multivariable model.

Assumption checking

For each covariate in the Cox proportional hazards model, the study used "scaled Schoenfeld residuals" to visually and statistically evaluate whether the proportional hazards assumption is being met.

Overall goodness of fit

According to Arjas's suggestion [16], the cumulative observed versus the cumulative predicted number of occurrences for patients with observed survival times should be shown to evaluate the overall goodness of fit of a Cox proportional hazards regression model. If the model fit is adequate, the points should follow a 45-degree line beginning at the origin.

Table 1 Socio-demographic characteristics of patients experience Cesarean section

Variables	Category	Infection Status	
		Infected (%)	Non-infected (%)
Age	15–20	8(14.3)	48(85.7)
	21–27	39(20.3)	153(79.7)
	28–34	25(20.0)	100(80.0)
	35–41+	10(22.7)	34(77.3)
Education	Illiterate	34(16.7)	169(83.3)
	Able to read and write	21(23.9)	67(76.1)
	Primary education	9(18)	41(82)
	Secondary and above	18(23.7)	58(76.3)
Religion	Muslim	34(17.9)	156(82.1)
	Orthodox	31(19.9)	125(80.1)
	Protestant	12(23.1)	40(76.9)
	Others	5(26.3)	14(73.7)
Occupation	Housewife	57(20.2)	225(79.8)
	Not housewife	25(18.5)	110(81.5)
Residence	Urban	29(21.1)	102(77.9)
	Rural	53(18.5)	233(81.5)

Results

Socio-economic characteristics of the respondents

Based on the medical records of 1,081 women who underwent CS from March 2022 to August 2022, 417 women met the criteria. In the age group of 21 to 27 years, the most infected women were 39 (47.6%) of the 82 infected women and 153 (45.7%) of the 335 non-infected women. Out of 82 infected samples, illiterate women, 34 (41.5%), were the most infected, while 169 (50.5%) of 335 samples were non-infected. 34 (41.5%) of the 82 infected women and 156 (46.6%) of the 335 non-infected women were Muslim. Housewives accounted for 57 (69.5%) and 225 (67.2%) of the 82 infected and 335 non-infected women, respectively. Women in rural areas accounted for 53 (64.6%) and 233 (69.6%) of the 82 infected and 335 non-infected women, respectively.

(Table 1).

Validity of telephone calls in detection of SSIs following CS

381 patients were interviewed over the phone during the study period, and within 48 h of the interview, they were evaluated by healthcare providers. 41 of the 51 patients diagnosed with SSI by a nurse during an outpatient visit were determined to have SSI during their phone interview. Five of the 376 outpatient patients who were assessed by a clinician and determined to have no SSI were later found to have SSI during their phone interview. According to these data, phone calls had 98.6% specificity (95% CI: 97.4, 99.7%) and 80.4% sensitivity (95% CI: 69.62%, 91.18%).

Table 2 Shows that the incidence of SSI after CS was 19.7, 95%CI: (15%, 24%) per 100 surgical procedure; 67 (19.8%) out of 338 women with term and post-term gestational ages were infected. Before CS, 21.8% of patients had ruptured membranes and were infected. Out of a total of 331 women who underwent CS, 19.03% had infected wounds instead of clean ones. On the skin suturing, 96.4% of the sutures were continuous skin sutures. Of the women who became infected during the study period, 13 (27.1%) underwent surgery under the care of specialists, while the rest were treated by residents. The majority of infected women (95%) had received anesthesia via the spinal anesthetic technique. Among the women who had previous CS, 25 (21.9%) were infected. About 75 (91.5%) infected patients required emergency CS. In the healthy category of BMI, the most infected women were 71 (86.6%) of the 82 infected women and 289 (86.3%) of the 335 non-infected women.

Survival analysis

Kaplan-Meier curve

According to the Kaplan-Meier curve, the surgical wound classification ($p = 0.0052$) (Fig. 1) shows a significant difference between wound classification.

Table 2 Clinical and operational characteristics of patients experience cesarean section

Variables	Category	Infection status	
		Infected (%) $n=82(19.7)$	Non-infected (%) $n=335(80.3)$
Gestational age	Very preterm & Preterm	15(19.0)	7(64(81.0)
	Term & Post term	67(19.8)	271(80.2)
Parity	0–1	28(20.3)	110(79.7)
	2–3	36(17.9)	165(82.1)
	Greater or equal 4	18(23.1)	60(76.9)
Rupture of membrane before CS	Yes	42(21.8)	151(78.2)
	No	40(17.9)	184(82.1)
Surgical wound classification	Clean	19(22.1)	67(77.9)
	Clean contaminated	43(15.9)	228(84.1)
	Contaminated & Dirty	20(33.3)	40(66.7)
Types of skin suturing	Continuous	79(19.7)	323(80.3)
	Interrupted sutures	3(20.0)	12(80.0)
Surgical procedure by	Specialist	13(27.1)	35(72.9)
	Resident	69(18.7)	300(81.3)
Anesthetic techniques	Spinal	78(19.8)	316(80.2)
	General	4(17.4)	19(82.6)
Presence of previous CS	Yes	25(21.9)	89(78.1)
	No	57(18.8)	246(81.2)
Type of CS	Elective	7(22.6)	24(77.4)
	Emergency	75(19.4)	311(80.6)
Types of incision	Transverse	79(19.6)	325(80.4)
	Vertical	3(23.1)	10(76.9)
BMI	Underweight (< 18.5)	3(42.9)	4(55.1)
	Healthy (18.5–24.5)	71(19.7)	289(80.3)
	Overweight (25–29.9)	10(20)	40(80)
	Minimum	Maximum	Mean (SD)
Number vaginal examination	0	14	2.13(1.96)
Duration of labor	0	32	6.02(6.01)
Duration of operation time given	13	105	43.52(13.45)
Time of prophylactic is given	10	52	19.84(7.5)

Cox proportional hazards model

According to multivariate Cox PH regression analysis results BMI ($p=0.02$), time of prophylactic administration ($p=0.04$), duration of operation ($p=0.02$), admission status ($p=0.04$), and duration in labor ($p=0.01$) are identified as significant risk factors for the SSI following CS based on single covariate analysis at the 5% significance level. However, the presence of previous CS ($p=0.49$), type of operation ($p=0.77$), type of anesthesia ($p=0.95$), surgical wound classification, and other factors showed no significant association. The multivariable Cox PH analysis includes the significant covariates identified in the univariate analysis (Table 3).

Diagnosis of the model

Assessment of the proportional hazards assumption The tests of all variables in Table 4 were not significant. Therefore, we do not have enough evidence to reject the proportionality assumption of all covariates at a 5% level of significance. The plots of the scaled Schoenfeld residuals are shown in Figs. 2 (a)–(e). A non-random pattern over time indicates a violation that reinforces the assumption of proportional hazards for each of the five covariates. Each subplot in the figure is random, smooth, and approximates a horizontal line through zero or a slope close to zero. This indicates that none of the five covariates had an interaction with the log of time, and the plots also support the assumption of proportional hazards.

Checking for overall goodness of fit The cumulative hazard plot of the Cox-Snell residuals is shown in Fig. 3. We have observed that the hazard function forms a reasonably straight line with a unit slope and zero intercept. It closely approximates the 45-degree line, except for a large time value. Overall, we conclude that the final model fits the data very well. Therefore, the model estimated in Table 4 is the final model.

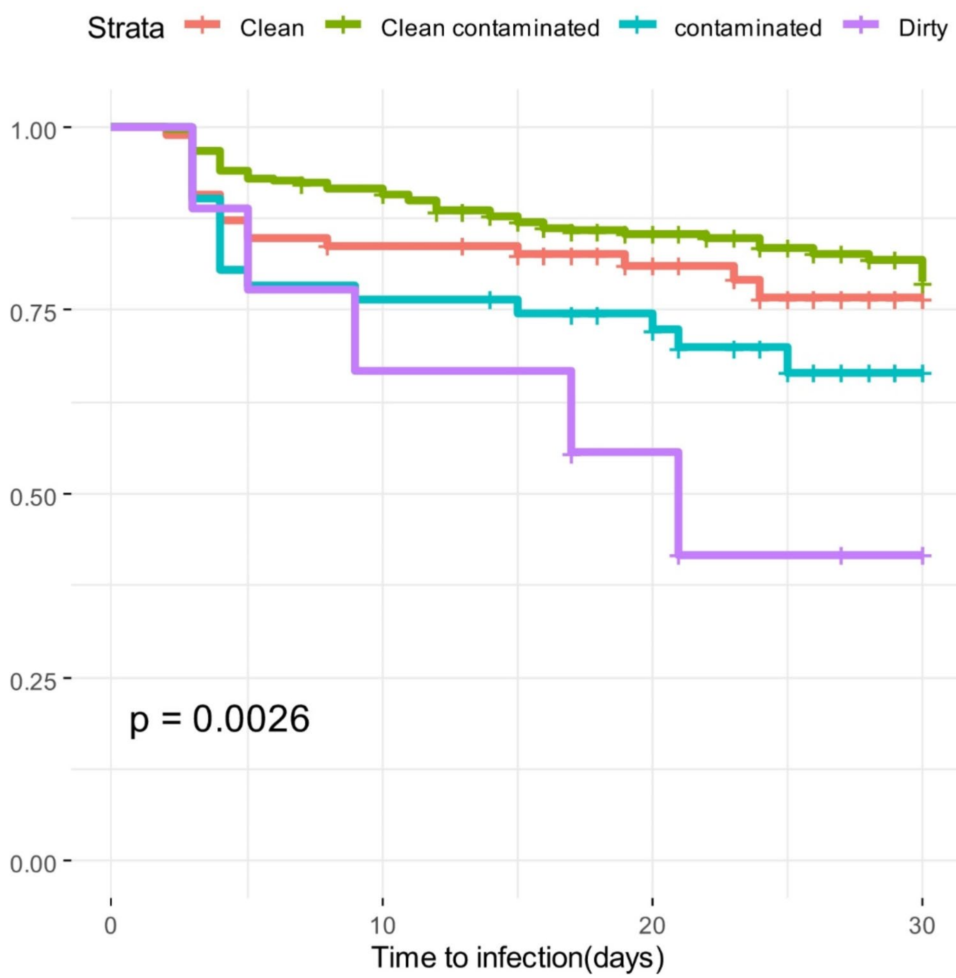

Fig. 1 Kaplan-Meier curve for time to SSI following CS by surgical wound classification with Log-rank test *p*-value

Table 3 The multivariate proportional hazards Cox regression model of patients who underwent Cesarean section

Covariates	DF	Parameter estimate	Standard error	Chi-Square	Pr > ChiSq	HR	95% HR Conf. limit
DL	1	0.039	0.017	2.31	0.021	1.04	1.006 1.075
DOT	1	0.018	0.008	2.31	0.021	1.02	1.003 1.033
BMI	1	0.073	0.035	2.08	0.037	1.08	1.004 1.153
TAPG	1	0.029	0.013	2.19	0.028	1.03	1.003 1.057
AS	1	0.498	0.231	2.15	0.031	1.65	1.046 2.590

The value of – 2LL for the model is 962.74

DL: duration in labor, DOT: Duration of operation time, BMI: body mass index, TPG: Time of antibiotic prophylactic is given, and AS: Admission status

Table 4 Checking proportional hazard assumption

Covariates	Chi-square value	Df	*P* value
Duration in labor	1.047	1	0.31
Duration of operation time taken	0.647	1	0.42
Body mass index	2.211	1	0.14
Time of prophylactic is given	0.525	1	0.47
Admission status	0.001	1	0.98
GLOBAL	4.289	5	0.45

Discussion

Recent studies in Africa's regions reinforce our result that SSI rates can be quite high, highlighting the need for improved infection control techniques, such as in Malawi (9.61%) [30], Cameroon (11.11%) [31], Uganda (14%) [32], and Ethiopia (12.32%) [33]. In this study, the incidence of SSI following CS was 19.7% (82) from this 43 was clean-contaminated. The studies in JUMC reveal a concerning prevalence of bacterial contamination among caregivers and food utensils, with high rates of antimicrobial resistance observed in common pathogens like 33.3% of

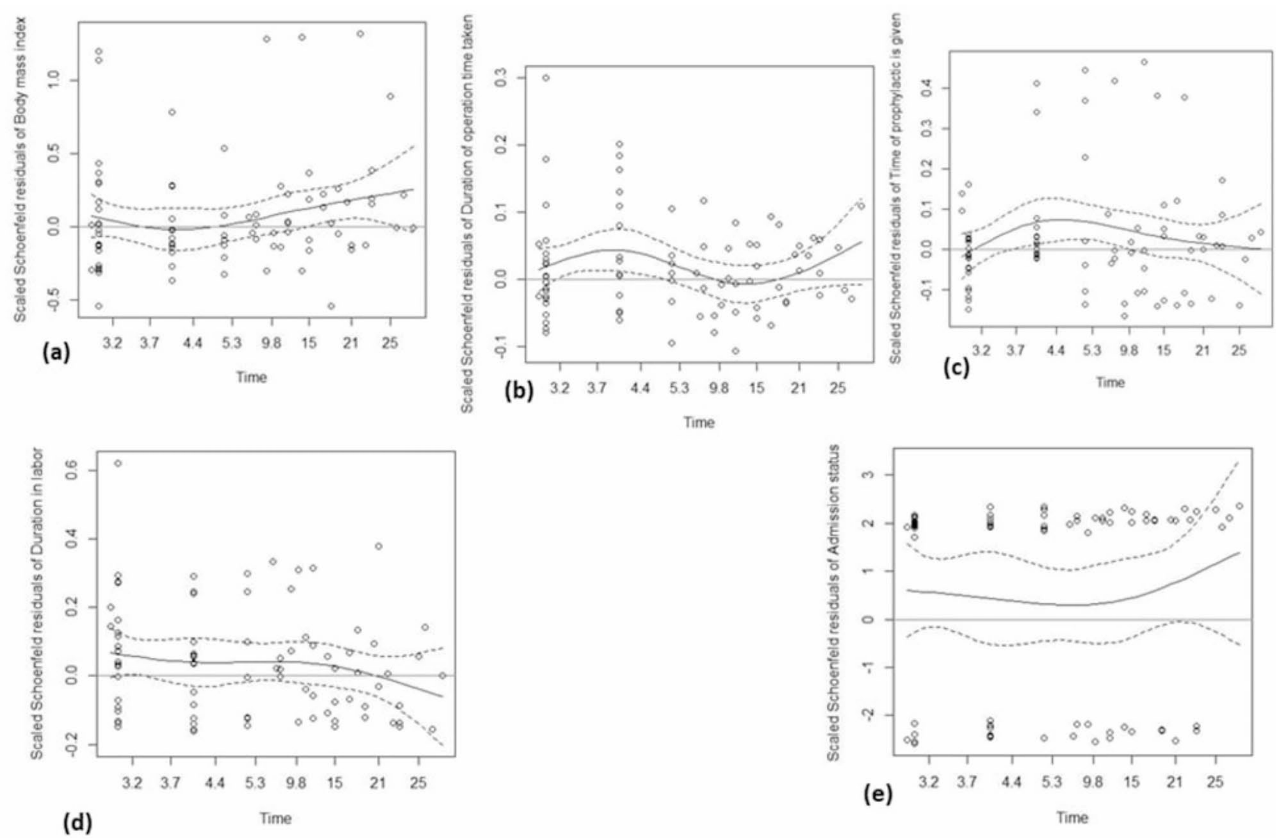

Fig. 2 Scaled Schoenfeld residuals of BMI (**a**), duration of operation time taken (**b**) prophylactic is given time(**c**), duration of time in labor (**d**), and admission status (**e**)

caregivers were contaminated with S. aureus and 23.3% with E. coli [34]. Two significant barriers to successful infection prevention were a lack of personal protective equipment and an unstable water supply [35]. Additionally, SSI prevention practices are hindered by barriers such as inadequate resources and training, despite high compliance with certain protocols [36].

386 (92.6%) of our study participants underwent emergency procedures, with 75 of them developing SSIs. The most prevalent reasons for emergency CS are fetal distress, problems from previous cesarean births, and abnormalities such as placenta previa. Understanding these causes is critical to enhancing mother care and outcomes [37, 38]. Furthermore, myomectomy history is associated with a rise in emergency cesarean Sect. [39].

We found in the Kaplan-Meier survival estimates that there was a significant difference in survival based on surgical wound classification. After the first three days, the clean-contaminated wound following the CS curve consistently remained above the other surgical wound classification curves. Our finding indicates that the clean-contaminated wound had notably higher survival rates compared to the other wound classifications. On the other hand, after the first three days, the contaminated and dirty wound following the CS curve consistently remained below the other surgical wound classification curves. This suggests that the survival rate of the dirty wound was significantly lower compared to the other surgical wound classifications. Previous studies conducted in Ethiopia, where wound classification had a statistically significant association with SSI following CS [40, 41], and at Kuwait General Hospital [8], have documented related outcomes. The study revealed that surgical sites that were dirty and contaminated had a greater rate of SSI, indicating that a higher risk of SSI is correlated with higher degrees of gross contamination [42].

Another study emphasizes how the degree of bacterial contamination affects surgical site infections (SSI), with dirty and contaminated wounds providing a greater risk because of the increased introduction of pathogens. As a result, adequate pre-, intra-, and post-operative care is necessary to reduce infection [43].

Studies have identified various risk factors contributing to SSI post-CS, including subcutaneous hematoma, tobacco use during pregnancy, high body mass index, prolonged labor, lack of antibiotic prophylaxis, and previous cesarean deliveries [44, 45].

According to Corcoran et al. [46] in Ireland, the BMI was identified as a statistically significant risk factor for SSI in patients who underwent CS. A study in Egypt

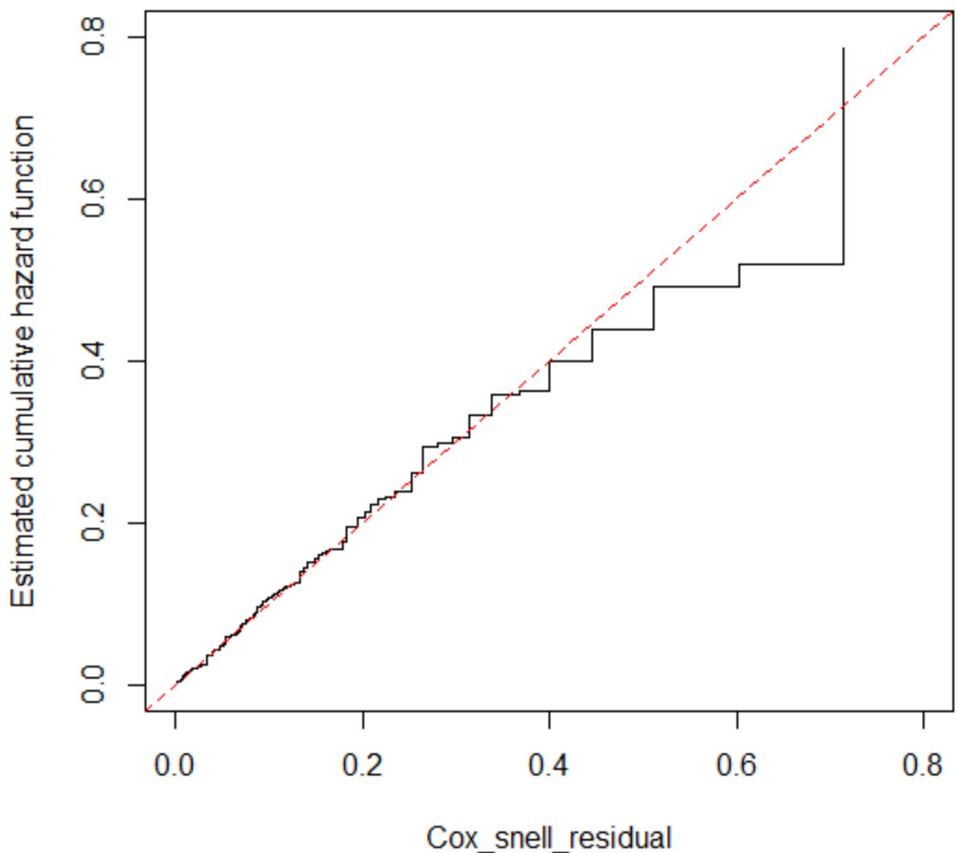

Fig. 3 Cumulative hazard plot of the Cox-Snell residuals of the proportional hazards Cox regression model

indicated that obesity had a significant association with SSI following CS [9]. The current study reported that, according to the Cox model, women with high BMI had an 8% greater chance of developing SSI after CS than those with low BMI. This suggests a clear association between women with higher BMIs and a significantly higher risk of SSI following CS. The intricate interplay of obesity with various factors like prolonged rupture of membranes, labor status during CS, and multiple vaginal examinations contributes to the increased susceptibility to SSI, emphasizing the multifaceted nature of this risk factor in the context of cesarean deliveries [47].

According to the current study, women who were admitted after being referred from another health center had a 65% higher chance of receiving SSI after undergoing CS than women who were admitted directly. This is due to the complexity of cases referred from peripheral facilities often involves patients with pre-existing conditions or complications that elevate their susceptibility to infections [48]. In the current study, women with longer labor duration had a 4% higher risk of SSI following CS than those with shorter labor duration. A prolonged duration of labor is linked to decreased survival rates. Studies conducted in Ethiopia indicated that mothers with prolonged labor had a significantly higher risk of SSI [41]. Similar findings have been reported in various African countries [12, 49, 50]. Prolonged labor contributes to amniotic fluid colonization by the normal flora of the lower genital tract, leading to surgical wound and peritoneal cavity contamination [51].

Adequate tissue concentrations of the antibiotic should be present at the time of the incision and throughout the procedure for SAP to be effective [52]. Along with reducing febrile morbidity, prophylaxis decreases the risk of SSI, endometritis, and other maternal infectious complications [53]. The timing of antibiotic prophylaxis is crucial to ensure that all patients receive prophylaxis before the initial incision [46]. This necessitates administration before to incision. Our findings indicate that the time used to deliver antibiotic prophylaxis was significantly associated with SSI. It shows that women who had antibiotic prophylaxis and underwent surgery after a long period of time had a 3% higher risk of SSI following CS than those who met a surgeon within a short period of time. Based on a study conducted at Uganda's Mbale Regional Referral Hospital, the timing of preventative antibiotic administration has a crucial role in lowering surgical site infections (SSIs) following cesarean sections (CS). From the study, they found that immediate administration, between 30 and 60 min prior to incision, was linked to a lower risk of SSIs [6]. A similar study showed that at India's Shri Ram Murti Smarak Institute of Medical Sciences, the timing of prophylactic antibiotic administration is significant for surgical site infection (SSI) after cesarean section. Administering antibiotics within 30 min of skin incision effectively reduces infectious morbidity, particularly in women with specific demographic factors like age, parity, and BMI [54]. Further evidence shows that low tissue concentrations of antibiotics are associated with higher SSI rates [55, 56].

In this investigation, the duration of surgery was significantly associated with the risk of SSI following CS, suggesting that prolonging the operation increased the risk of SSI following CS. A case-control study in Nigeria found that 55% of SSI cases, compared to 31.7% in the control group, had a prolonged duration of surgery [49]. In Tanzania, the prolonged duration of surgery was significantly associated with the outcome, with a hazard ratio of 2.3 [12]. A study in China reported a similar finding [57]. Prolonged operating time is associated with SSI due to increased duration of exposure to microorganisms in the operating theatre [12, 58]. Implementing prevention bundles that focus on patient preparation, strict skin preparation techniques, and appropriate antibiotic prophylaxis has shown significant success in reducing SSI rates post-CS. These interventions not only decrease the occurrence of SSIs but also contribute to shorter hospital stays and improved patient outcomes, highlighting the importance of evidence-based practices in reducing post-CS SSIs [47, 59]. According to Fajriyah et al. [60] study, the timing of prophylactic antibiotic administration (30–60 min before surgery) is crucial. However, surgical techniques and patient factors also significantly influence SSI rates, suggesting a multifaceted approach is necessary for improvement.

In this study, a statistical model was used to analyze the incidence rate and risk factors of the time to surgical site infection after cesarean section. The results of this study suggest that identifying and modifying risk factors for surgical site infections post-caesarean section can inform hospital policies. Implementing enhanced preoperative measures and further prospective research could help reduce infection rates and improve maternal health outcomes. The study's results on the incidence of SSIs and antibiotic use can help hospitals make policies that encourage timely antibiotic use, better staff training on guidelines, and the use of protocols for post-CS care. This will reduce the number of infections and improve patient outcomes.

However, the study had a limitation in that it was conducted in a medical center setting at a university with a high CS rate. Single-center studies often have limited sample sizes, diverse patient populations, and specific treatment protocols, which can affect the generalizability of findings. This may lead to biased conclusions regarding prognosis and treatment outcomes for SSI following CS compared to multicenter studies. Thus, our SSI rate of 19.7% might not be representative of patients with SSI diagnosed in general hospitals, primary healthcare clinics, or other healthcare facilities. Understanding and addressing these risk factors are crucial for healthcare providers to implement preventive measures, enhance patient care, reduce morbidity and mortality rates, and optimize health outcomes following cesarean deliveries. In order to improve hospital policies, we propose that more research be done on risk factors for SSI after CS in various healthcare center levels, as well as on microbiological elements and customized interventions.

Conclusion

The paper emphasizes integrating evidence-based preventive practices during preoperative, intraoperative, and postoperative periods to reduce SSI. Clinicians and hospital managers should prioritize these practices, as approximately half of all infections are preventable through proper protocols. Maintaining nutritional status and controlling blood glucose are crucial strategies for overweight women post-cesarean section to prevent SSI. Implementing pre-operative and post-operative interventions, including proper education and antibiotic prophylaxis, is also recommended.

Strengthening infection prevention and control (IPC) measures is essential to reduce SSIs after CS. Robust IPC can improve surgical outcomes, lower morbidity and mortality, and enhance healthcare system resilience, particularly in low- and middle-income countries. Additionally, special attention should be given to referring admitted patients and women with a high body mass index. Finally, increased awareness of these risk factors, continuous training in infection prevention techniques, and the development and strict implementation of protocols may minimize and prevent the high SSI rate after cesarean section.

Abbreviations

SSI	Surgical site infection
CS	Cesarean section
JUMC	Jimma university medical center
HR	Hazard ratio
BMI	Body mass index
LMICs	Low middle income countries
CDC	Centers for disease control
IRB	Institutional review board
PH	Proportional hazard

Acknowledgements

The Jimma University Institute of Health funded the study, which we acknowledge. The authors highly appreciate the patient's openness to offer information about the study subject. Additionally, data collectors are acknowledged for their considerable efforts.

Author contributions

E.S., A.A., A.T., and D.Y. developed and planned the study. E.S. gathered information. E.S. and A.A. are preparing a paper. E.S., A.A., A.T., and D.Y. performed an overall revision of the manuscript. E.S., A.T., and D.Y. revised the statistical assessment and discussion of the findings; all authors read and approved the final paper.

Funding

The Jimma University Institute of Health provided financial support for this work.

Data availability

The paper includes the original contributions to the study. If you have any further inquiries, please contact the corresponding author.

Declarations

Ethics approval and consent to participate

This study is adhered to the declaration of Helsinki. Ethical approval was obtained from the Institutional Review Board (IRB) of the Institute of Health Jimma, Jimma University with reference number IHRPG1/459/21. Participants were included in the study after every respondent gave their informed consent.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

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Received: 18 January 2025 / Accepted: 26 March 2025
Published online: 02 April 2025

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