COLLEGE OF MEDICINE AND HEALTH SCIENCES

SCHOOL OF PUBLIC HEALTH

DETEMINANTS OF SURGICAL SITE INFECTION FOLLOWING CESAREAN DELIVERIES IN HAWASSA UNIVERSITY COMPREHENSIVE SPECIALIZED HOSPITAL, HAWASSA, ETHIOPIA : UNMATCHED CASE –CONTROL STUDY

BY: -HIWOT NIGUSSIE (BSc)

A THESIS TO BE SUBMITTED TO HAWASSA UNIVERSITY COLLEGE OF MEDICINE AND HEALTH SCIENCE SCHOOL OF PUBLIC HEALTH IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTERS IN PUBILC HEALTH IN REPRODUTIVE HEALTH

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Hawassa, Ethiopia

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November 2023

Hawassa, Ethiopia

Declaration

We, hereby affirm that this thesis was entirely original and has not previously been submitted for consideration for a degree from any university. This thesis was given due credit to all informational source

Hiwot Nigussie (BSc)	_____	_____
Student Name	Signature	Date

This is to verify that Hiwot Nigussie worked under our supervision to complete the thesis “On Determinants of Surgical Site Infection following Cesearn deliveries in HUCSH, Hawassa, Ethiopia " As a result, we advise the student to submit the final thesis work to the department for final thesis defense as the student had completed the requirements.

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Examiners' Thesis Approval Sheet

This certifies that the thesis, "Determinants of Surgical Site Infection following Caesarean deliveries in HUCSH, Hawassa, Ethiopia," has been assessed and, as a result, that it has been approved.

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Abbreviations and Acronyms

ANC-Antenatal Follow-up

AOR-Adjusted Odds Ratio

CDC-Center for Disease Control

CD-Cesarean Delivery

CI-Confidence Interval

CS-Cesarean Section

ERB-Ethical Review Board

HCAI-Healthcare-Associated Infection

HIV-Human Immune Virus

HUCSH-Hawassa University Comphranisive Specialized Hospital

PROM –Premature Rupture Of Membrane

SSA-Sub Saharan Africa

SSI-Surgical Site Infection

UCC-University of a Clinical Center

WHO-World Health Organization

ABSTRACT

Background - Globally the incidence of infection following Cesearn delivery was significantly higher in lower-income countries including Ethiopia. Even though surgical site infection is among the leading causes of maternal mortality and morbidity, only a few studies have been conducted on the determinants of surgical site infection following cesarean deliveries.

Objective – This study aimed to identify the determinants of surgical site infection following cesarean deliveries in Hawassa University Comprehensive Specialized Hospital Hawassa, Ethiopia.

Methods – A hospital-based unmatched case-control study was conducted from September 2019- to September 2022 at Hawassa University Comprehensive Specialized Hospital. Data was extracted from April 15 to May 15, 2023. Cases were selected through consecutive sampling, while controls were selected using a systematic random sampling method. A total of 320 participants were included (107 cases and 213 controls). Data were collected by using the Open Data kit (ODK) downloaded and exported to XLS then imported to SPSS version 26. A binary logistic regression model was conducted and a variable with a p-value of < 0.25 was selected as a candidate variable for the final multivariable logistic regression model and a P-value of less than 0.05 was statistically considered as significant predictors.

Results: A total of 320 mothers (107 cases and 213 controls) were included in this study. Women with diabetes mellitus were 3.7 times [AOR: 3.71, 95%CI: 1.18–11.66] at higher odds for surgical site infection compared to women who did not have diabetes mellitus. Vaginal examination [AOR= 2.28 (95%CI, 1.15-4.54)], post-operative hematocrit less than 30% [AOR= 4.12(95% CI 1.97-8.61).women in labour during C/S [AOR= 5.16((95%CI,1.33-20.1)]. more than 5 days duration of hospital stay[AOR=3.42 (95%CI, 1.32-8.89)] were identified factors.

Conclusion and Recommendation ; In this study Diabetes mellitus, Number of vaginal examinations, post-operative hematocrit, labor status during C/S and length of hospital stay were the identified as determinants of surgical site infection following cesarean deliveries. Therefore early detection and risk assessment during certain times in order to reduce these determining factors of surgical site infection is important.

Keywords: Case-Control Study, Surgical Site Infection, Determinants, Cesarean Deliveries

1. INTRODUCTION

1.1 Background

Cesarean section is the delivery of a viable fetus through an abdominal incision (laparotomy) and uterine incision(1).Cesarean section delivery procedure performed during, absolute contraindication to labor, failed induction, and emergency /immediate delivery need (2).cesarean section is performed to prevent life-threatening conditions, Including obstetric fistula, and birth asphyxia, to save maternal and child life(3).

The global and regional projection findings showed that the trend of cesarean deliveries was increasing in all regions and 21.1% of women give birth by Cesarean section worldwide(4). In sub-Saharan Africa(SSA) the overall Cesearn Section rate was 12.4% (range:1.0%–41.9%) (5).In Ethiopia, the rate of cesarean section varies according to different individual studies that range from 11 to 34.4%(2, 6)..

Surgical site infection (SSI) following cesarean section is an infection that occurs in or near the surgical incision within 30 days after surgery. It can be classified as superficial, subcutaneous tissue of the incision and/or the deep soft tissue and/or any part of the anatomy other than the incision that was opened or manipulated during an operation(7).Globally the incidence of infection following Cesearn delivery was 5.6% and the incidence was significantly higher in countries with lower income countries (8). In sub-Saharan Africa(SSA) SSI rates range from 10.3% to 15.6% and it is many times greater than those in high-income countries like United States Emirati and others(5, 9). In Ethiopia, different studies were conducted that showed the magnitude of SSI ranges from 6.8% to 15% (10-15). Also, the pooled prevalence of SSI after cesarean section in Ethiopia was 9.72%(16).

SSI following Cesarean deliveries resulted in 3% of Maternal mortality (17). Surgical site infection has been responsible for prolonged hospital stays, unplanned and growing hospital costs, readmission, neonatal death, maternal morbidity, and mortality. And also a great source of physical, emotional, and significant financial burden on the mother, family, and health care system(17).

1.2 Statement of the problem

Surgical site infections (SSIs) are among the most preventable health-care-associated infections and the highest burden to healthcare systems and service payers worldwide in terms of Patient morbidity, mortality, and additional costs(18).

In Ethiopia The national prevalence of healthcare-associated infection remains high this was 16.96%. The finding showed that the most common type of Healthcare-Associated Infection (HCAI) was surgical site infection and commonly occurred in patients who undergo surgery like obstetrics and gynecological cases(19). The frequently reported Predisposing factors for surgical site infection following Cesearn section were Premature rupture of membrane (PROM) > 12hr, duration of labor> 24 hr, chorioamnionitis, anemia, and having vertical skin incision (16).

Due to the complexity of SSI prevention and it needs to integrate numerous strategies before, during, and after surgery(18). So implementations were done on Preoperative, intraoperative, and postoperative prevention based on the Centers for disease control (CDC) during cesarean section procedures to minimize the incidence of post-Cesearn section SSI (20).

Evidence-based information and the creation of surgical bundles for hospitals to reduce the rate of SSIs after Cesearn deliveries has also been recommended previously(21). The United Kingdom was one of the countries that introduced and implemented the above recommendation and showed an effect on the rate of SSIs and based on the effect of the intervention, the maternal SSI prevention care bundle was considered effective in reducing SSIs after caesarean section and should be offered routinely to women undergoing caesarean section(22).According to WHO 2016 also developed evidence based recommendation towards on surgical site infection based on global perspective and it was aimed to solve inconsistence recommendation(23). Even though Evidence-based methods of preventing and treating SSI were considered as basic for minimizing incidence and complication of Surgical site infection but in Ethiopia the implementation of those recommendation was not consistence and it Was depend on the institution. Therefore this might be leads to increase the burden of surgical site infection.

Despite the foregoing efforts, SSIs continue to be a significant contributor to hospital-acquired infections, and rates are increasing globally both in developed and developing countries with the increasing cesarean section rate. In the study setting the studies finding showed that magnitude of

SSI following Cesarean deliveries increased from 11% to 11.8% and also the rate of cesarean delivery in the study setting was 32.8% which is higher than the WHO recommendation of Cesarean deliveries (10, 24, 25) . Also Ethiopia is one of the countries that have a high burden of maternal mortality. The Sustainable Development Goal (SDG) plan to decrease maternal death less than 70 per 100 000 live births globally by 2030GC (26). Working on the causes of illness and death that can be avoided is crucial for achieving SDG(27). Despite the fact that it is one of the major causes of maternal mortality and morbidity, only a few studies have been done on the determinants of surgical site infection after a Caesarean delivery. Therefore the aim of this study was to identify the determinants of surgical site infection following Cesarean deliveries in Hawassa university comprehensive specialized hospital.

1.3 Significance of the Study

SSI contributes for 3% of maternal deaths globally, making it one of the causes of maternal mortality (17).There have been limited reports on -the factors that influence surgical site infection after caesarean delivery in the study setting despite the fact that surgical site infections are currently rise everywhere, including Ethiopia.

Therefore this study adds input on the determinants of surgical site infection following Cesarean deliveries in the study area and any governmental or non-governmental organizations working on maternal and child health will in consideration during designing and implementing evidence-based interventions in region as well as national programs.

It also supports existing knowledge for health care providers on the determinants of surgical site infections. Helps health care providers to focus and provide appropriate health services to prevent SSI and minimize maternal morbidity & mortality due to SSI. And also suggest to researchers a specific area of study to be undertaken.

2. LITERATURE REVIEW

2.1 Over view of surgical site infection following Cesarean deliveries

According to the World Health Organization (WHO) recent guideline shows that surgical site infection (SSI) is the most surveyed and frequent type of Heath care-associated infection in low- and middle-income countries and affects up to one-third of patients who have undergone surgical procedure. Even though the incidence of SSI is lower in high-income countries but it remains the second most frequent type of health care-associated infection (HAI) in Europe and the United States of America (USA)(18).

According to a cross-sectional study conducted at Lemelem Karl hospital, in Tigray region, showed that the Magnitude of surgical site infection following cesarean section was 6.8%)(11). In a similar Region, a study conducted in Ayder Comprehensive Specialized Hospital (ACSH) Found magnitude of SSI was 11.7%(12). A study conducted, in the Amhara region, in Felegehiwot referral hospital that revealed the magnitude of SSI following cesarean section was 7.8%. (13). In the study setting cross-sectional studies showed that the prevalence of SSI following Cesarean deliveries was 11% and 11.8% in different period of study (10, 25).

2.2 Determinants of surgical site infection following Cesarean delivery

2.2.1 Socio-demographic characteristics

A study conducted in Addis Ababa at the selected governmental hospital found that maternal age more than or equal to 30 years was significant factor for developing SSI(15). In line with another study conducted in Dire Dawa also revealed that the maternal age from 20 to 34 years was 5.4 times more likely to increase SSI and age above 35 was 8.9 times higher in SSI(28).In line with the above the study conducted in Sub-Saharan Africa reveled that younger age increase the risk of SSI (29).

A study conducted in Ayder hospital found that women from rural areas were 5.6 times more likely to develop post-C/S Infection than those from an urban area(12).

2.2.2 Medical Characteristics

According to a study conducted in Kosovo, UCC found that the existing of one more co-morbidity was significantly associated with SSI (30). HIV-positive women had an increased risk of surgical site infection following Cesarean deliveries in the studies conducted at Ayeder hospital

and Debre Markos hospital(12, 14).Matched case-control study conducted in Burkina Faso revealed that Fever on admission (hyperthermia) was 2.3 times higher among women with SSI (31)

According to study conducted in southern Israel also revealed that gestational diabetes mellitus 1.2 times was more likely develop surgical site infection (32). In line with Cross-sectional study conducted in Bahir Dar revealed that diabetes mellitus was 4 times higher in women's with post Cesearn section surgical site infection and Similarly this study also revealed that Urinary tract infection was 7.8 times and Pregnancy induced hypertension 6.4 times higher in SSI(33)

2.2.3. Pregnancy/Intrapartum-related Characteristics

A study conducted in Nepal revealed that women who were already in labor during cesarean section (including all stages of labor) had 6.52 times higher to developed to SSI than those who were not in labor(34). In line with the a Case-Control Study conducted in a Peruvian Hospital women with onset of labor had 1.95 times higher risk of SSI(35).

The above study also revealed that prolonged rapture of membrane >18 hours 8.38 times higher in women's with SSI than women without SSI(34) In line with a case-control study conducted in Dire Dawa prolonged duration of rupture of membrane (> 12 hours) was a determinant of post-cesarean section surgical site infection(28).

A cross-sectional study conducted in Hawassa university comprehensive specialized hospital Premature rupture of membranes (PROM) was 5.83 times increase in the risk of SSI (10).In line the above, studies conducted in lemelem hospital in Tigray, Ayder hospital in Mekelle,felegehiwoit hospital in Bahir dar, Debre Markos hospital, Addis Ababa, and Zewditu hospital were also identified as Premature rupture of membranes as significant factor for Developing SSI after Cesarean deliveries (11-15, 36).

Studies conducted in Hawassa, lemelem hospital in Miyichew, and Zewditu hospital were revealed that prolonged duration labor was significantly associated with SSI (10, 11, 36).The repeated vaginal examination was also significantly associated with outcome variables in the studies performed in Hawassa, Debre Markos hospitals, and Zewditu hospitals (10, 14, 36).In line with a study conducted in Dire Dawa more than 4 repeated vaginal examination 4.2 times higher in a woman with post c/s SSI than their counterparts(28)

A study conducted in University of a clinical center (UCC) of Kosovo showed that history of previous cesarean section increases the risk of surgical site infection by 3.6 times(30).Similarly a study conducted in Debre Markos and Dire Dawa revealed that previous history of cesarean section was determinate of post-C/S SSI (14, 28). A study conducted in Debre Markos also revealed that women who have no ANC follow up an increased risk of SSI following Cesarean deliveries (14).

Gestational age during surgery greater than 40 weeks increased the risk of SSI in a study conducted Jordan university hospital (37). In line with the above, a study conducted in the united states emirates found that as gestational increased by one week the risk of SSI increased by 1.5 folds(9). Another study conducted in Addis Ababa surgery during term pregnancy(37-40 weeks)found that 98.1% protective from SSI(15).

According to a cross-sectional study conducted in Ayder hospital, Women who had chorioamnionitis were 16 times more likely to have a post-C/S infection(12).And also a study conducted in Dire Dawa revealed that the current History of Choriamnionitis 5 times higher in post c/s SSI(28).Matched case-control study conducted in Burkina Faso revealed that Presence of caput 7 times higher among women with SSI(31).

2.2.4 Procedure and post-operative related risk factors

A study conducted at Jordan university hospital found that the duration of hospital stay more than 3.5 days was 2.3 times more likely higher in women's with SSI (37). Another study conducted In Kuwait revealed that the onset infection less than 15 days was significantly associated with SSI(38). A study conducted in UCC of Kosovo, found that duration of surgery less than one hour was negatively associated with SSI following Cesarean delivery(AOR =0.27 (95% C.I, 0.092- 0.793)(30). In line with the above Studies conducted in Hawassa, bahir dar and Addis Ababa found that increased duration of surgery time was found to be significantly associated with the risk of developing SSI following Cesarean delivery (10, 13, 15).

A case-control study in Dira Diwa showed that Pre-operative hematocrit level <30% was 6.9 times higher in women who had post-Cesearn section infection than the controls (28). In line with another studies conducted in Hawassa and Addis Ababa also revealed that post-operative (hemoglobin<11mg/dl) was significantly determined post-C/S SSI (10, 36).

A cross-sectional study conducted in lemelem hospital in mayichew showed that vertical abdominal incision type of CS was 5.7 times increased risk of SSI after Cesarean delivery than transverse abdominal incision(11).in line with the above a studies conducted in felegehiwot hospital and Debre Markos hospital also revealed that vertical abdominal incision type of CS was more likely increased the risk of SSI after Cesarean delivery than transverse abdominal incision(13, 14). Interrupted types of suturing were 6.2 times more likely to increase the risk of SSI following Cesarean delivery in a study conducted in felegehiwot hospital (14).

A case control study conducted in Ireland's Cork University showed that emergency Cesarean delivery , as independent factors for SS(39)I. In similar to above finding a study conducted in bahir dar also revealed that emergency types of CS was higher risk of developing SSI(14).

A study conducted in Kuwait found that the risk of SSI following Cesarean delivery was less likely in women who took prophylaxis before surgery(38).In Line a study conducted in UCC, Kosovo found administration of antibiotics had protective for SSI(30).The above studies supported by a study conducted in Jordan university hospital found that the weight-adjusted ceftriaxone dose decreases the risk of SSI(37). In the study conducted in Dire Dawa women who did not got prophylaxis of antibiotics were 3.2 times more likely to develop post-Cesearn section infection than women who got prophylaxis perioperative (28).

A study conducted in Hawassa revealed that the risk of SSI following Cesarean delivery was 8.3 times increased when the procedure was done by MSc students and 7 times more likely increased when the procedure was done by GPs than seniors (10) Matched case-control study conducted in Burkina Faso also revealed that difficult extraction (difficult delivery) was 3.7 times higher among women with SSI(31). A hospital-based case-control study at Hauke land University Hospital revealed that Blood transfusion during or following CS was 5.1 times higher in women with post-c/s SSI(40).Even though different studies conducted in different countries there is inconsistent finding and most of the studies were done cross sectional design .therefore this study will conducted in case control study design and aims to identify the determinants of post CS SSI.

2.3 CONCEPTUAL FRAMEWORK

There is a relation between surgical site infection and the associated factors. Those factors were reviewed from different studies which include socio demographic factors, Medical characteristics Pregnancy and intrapartum related factors and Procedure and post-operative related characteristics directly or indirectly influence the occurrence of surgical site infection.

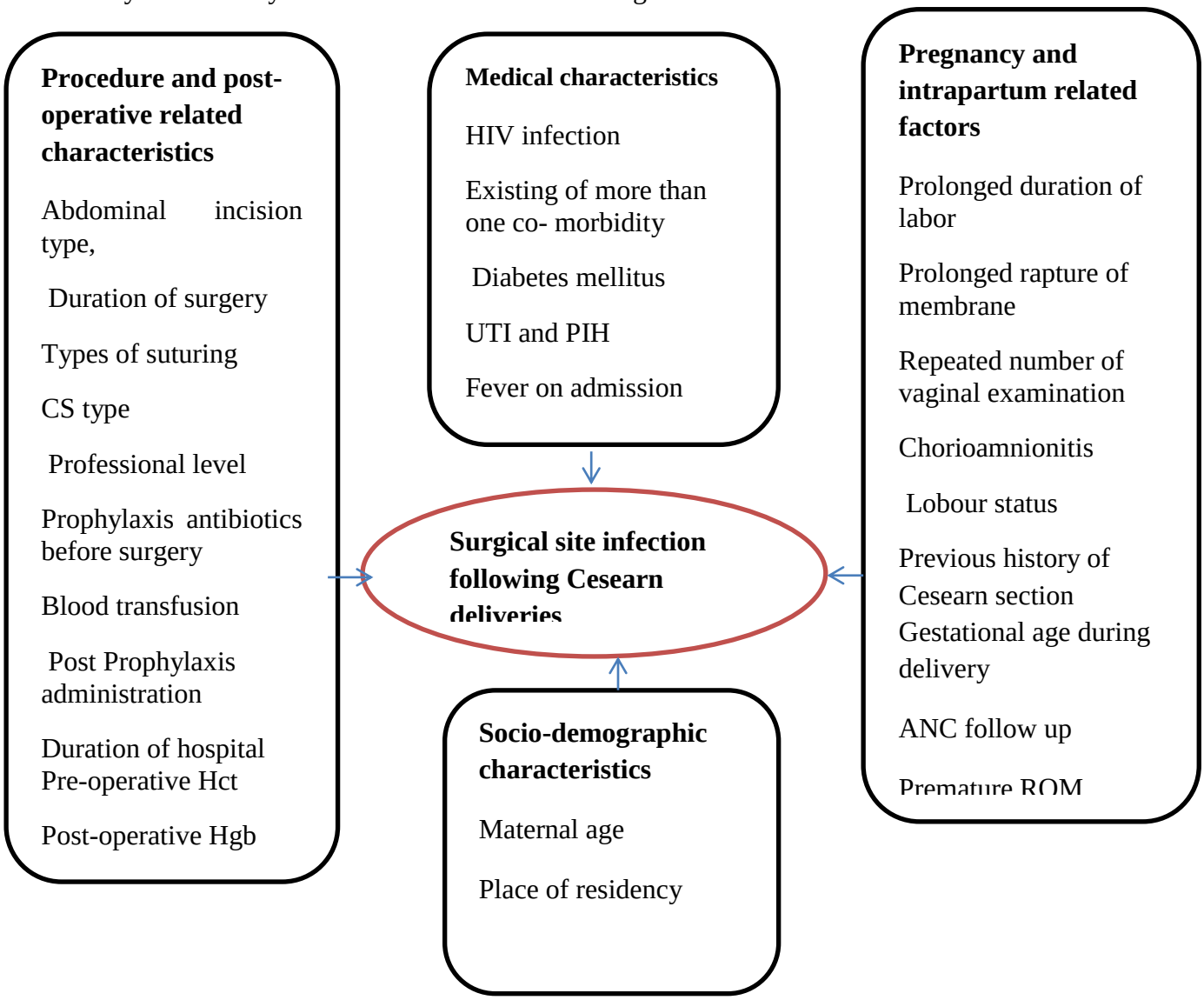

Figure 1 Conceptual framework was adapted by reviewing different literatures that conducted and showed the determinants of surgical site infection following CD 2023**(11-13, 15, 36)**

3. OBJECTIVE

The aim of this study was to identify the determinants of surgical site infection following cesarean deliveries in HUCSH, Hawassa, Ethiopia 2023

4. METHODS AND MATERIALS

4.1 Study setting and Period

The study was carried out at Hawassa University Comprehensive Specialized Hospital between September 2019 and September 2022 and Data was retrieved from April 15 to May 15 of 2023. Hawassa is situated 130 kilometers east of Wolayita Sodo town and 273 km south of Addis Abeba (A.A.). The city has six private hospitals, seven health centers, 47 private clinics, and 15 health posts and four public hospitals (1 comprehensive specialized hospital, 1 general hospital, and 2 primary hospitals). Hawassa University Comprehensive Hospital (HUCSH) offers services for around eighteen million people. The hospital was opened in 2005GC and Hawassa College of Medicine and Health Sciences; it functions as a teaching hospital. The hospital comprises 8 departments, including obstetrics and gynecology. The OBGYN department has five case teams that serve for labor and delivery, inpatient service, outpatient, sexual assault unit and operation service. The gynecology and Obstetrics department has 12 Gynecologists and Obstetricians (1 sub specialist 2, sub specialist follower and 9 specialist), 34 OBGY residents' and 99 midwives. HUCSH provides maternal and child health (MCH) services like ANC care, labor and delivery services, family planning services, safe abortion services, VIA services, sexual assault services, PMTCT services, immunization services and gynecologic problems treatment services. There are about 350–400 deliveries per month in this hospital (41, 42). The study period was September 2019 to September 2022 and data extracted from Aprils 15 to May 15, 2023.

4.2 **Study design**

A hospital-based unmatched case-control study was conducted in HUCSH

4.3. **Population**

4.3.1 Source population

The source populations were all medical Charts of women who had undergone caesarean sections in Hawassa University's comphranisive specialized hospital.

4.3.2 Study population

Cases was defined as all medical Charts of women who were diagnosed with SSI following cesarean delivery based on clinical signs &symptoms, history, and laboratory investigation and

confirmed (by gynecologist and obstetrician, residents, and General practitioners) in Hawassa University comphranisive specialized hospital during the study period

Controls were defined as all medical records of women without SSI following caesarean delivery at the Hawassa University Comprehensive Specialist Hospital during the study period. The sample populations were drawn from women who underwent caesarean section. To select the study participant's medical chart total cesarean deliveries were considered and by using Operation room registration, admission and discharge book and applying systematic random sampling were used.

4.4. Inclusion and Exclusion criteria

4.4.1 Inclusion Criteria

All charts of women undergone CS and confirmed diagnoses of SSI in the study period were included as cases and all charts of women undergone Cesarean section and without a diagnosis of SSI in the study period were included as controls

4.4.2 Exclusion Criteria

An incomplete chart of Women who undergone Cesarean section were excluded

4.5. Sample Size determination

The sample size was estimated using earlier, comparable literature as a guide and the proportion of exposure among control groups of reviewed factors (P2) and AOR are taken and calculated by using the Open EPI INFO 7.2 STAC CALC double population proportion formula. For each factor's power of 80%, a confidence level of 95% and a 1:2 case –to- control ratio was considered (Table 1)

Table 1 sample size estimation for the determinants of SSI among women who undergone CS in Hawassa referral hospital, Hawassa, Ethiopia, 2023

Variables	CI	Power %	proportion of exposure among	AOR	Case to controls ratio	No of cases	No of controls	Total sample size	Reference
Maternal Fever on admission	95%	80%	33%	2.37	1:2	72	144	216	(31)
Blood transfusion during or following CS	95%	80%	2.7%	5.1	1:2	94	188	282	(40)
Duration of labor >24 hrs.	95%		19.2%	3.48	1:2	42	83	125	(11)
Provision of antibiotics prophylaxis	95%		35.98%	3.2	1:2	41	82	123	(28)
Diabetes mellitus(DM)	95%	80%	3.7%	3.99	1:2	107	213	320	(33)
Chorioamnionitis	95%	80%	5.4%	3.73	1:2	87	173	260	(33)
Duration of rupture of membrane(>12 hrs)	95%	80%	4.2%	5.4	1:2	59	118	177	(28)

Among the factors the one which gives a larger sample size was Diabetes mellitus (DM) which was 320(107 cases and 213 controls).

4.6. Sampling techniques and procedure

The sample included all records of women who delivered by CS at HUCSH during the study period. In the hospital the total number of caesarean deliveries in the last three years was 4,656 and this study has a total sample size of 320.

Schematic presentation of the sampling procedure

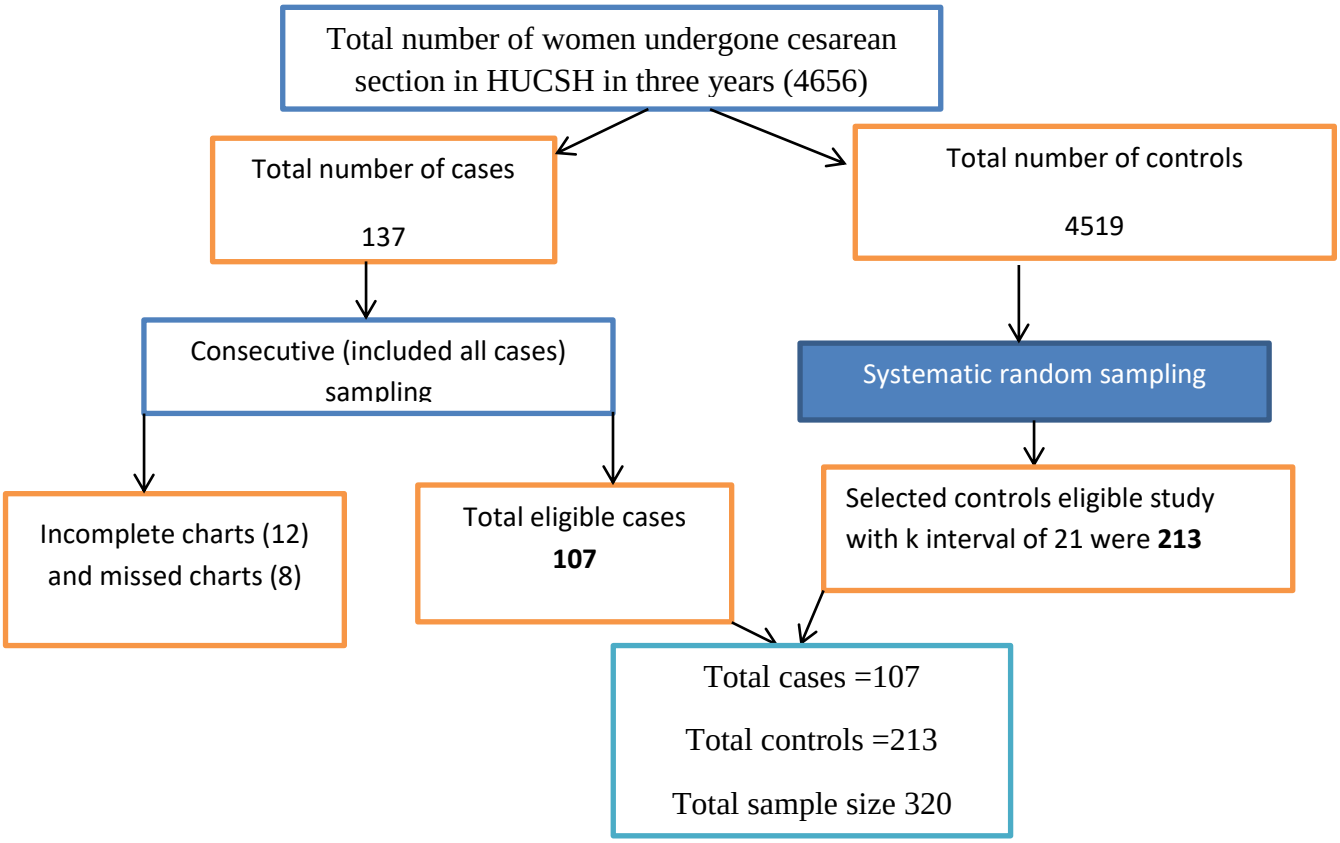

Figure 2 Schematic presentation of the sampling procedure for Determinants of surgical site infection following cesarean deliveries in HUCSH, Ethiopia 2023.

4.7. Study Variables

4.7.1 Dependent variable

Surgical sit infection following caesarean deliveries

4.7.2 Independent variables

Socio-demographic variables- Maternal age and Place of residency

Medical characteristics variables -Existing co- morbidity, HIV infection, diabetes mellitus, UTI, PIH and maternal fever

Pregnancy and intrapartum related factors variables - Prolonged duration of labor, Prolonged rapture of membrane, Repeated number of vaginal examination, Chorioamnionitis, Previous history of Cesearn section, Gestational age during delivery and ANC follow up

Procedure and post procedures related factors variables -abdominal incision type, Duration of surgery, Types of suturing, CS type. Professional level, Prophylaxis administration, blood transfuse, Duration of hospital stay, Pre-operative HCT, Post-operative HCT

4.8. Operational Definitions

Surgical site infection (SSI) following cesarean section : Is an infection occurs at surgical site within 30 days after the operation and have at least one of the following signs and symptoms: Purulent discharge from the incision site, Localized swelling at the operation site, Wound dehiscence, Tenderness/pain, Redness Hotness and Fever (>38°C) and confirmed by gynecologist and obstetrician, residents, and General practitioners)(18).

Anemia: considered when hematocrit count is less than 30%(HGB<11g/dl) or clinically diagnosed as an anemic patient by symptom and sign(43).

Prolonged operation time: when the total time taken is greater than one hour**.**

4.9 Data collection tools and procedure

The data collecting tools was developed based on a review of the literature carried out in different countries and prepared by the English version (11-13, 15, 36). The data were collected using a pre-tested structured checklist from the selected charts of women who gave birth by Cesarean section and data was collected by mobile application ODK (open data kit).To collect the data two BSc midwives were assigned as data collectors, while one MPH was assigned for supervising and coordinating. Following assignment, information was provided about the data collection

instruments in-depth and the supervisors were supervising the day-to-day data collection activity together with the principal investigator. The data was collected from the selected mothers' medical records in HUCSH.

4.10. Data quality assurance

Two days training was given to the data collectors and supervisor on how to collect and extract data from the records. The principal investigator and supervisor were daily followed for data completeness and provided daily feedback for data collectors. A pre-test was conducted in outside of the actual data collection site at Yirgalem general hospital, on 5% of the sample size prior to the actual data collection period.

4.11. Data analysis and processing

The collected data were checked for completeness and consistency, and from the kobo toolbox user server data was downloaded, exported to XLS then download. Finally, the data was imported into SPSS Version 26 for further analysis. Frequencies and with percentages were computed for categorical variables. Cross tabulation was also performed to test the relation of variables against with outcome variable. A chi-squared test was used to compare categorical variables between cases and controls. Binary logistic regression model was used to see the crude relationship between the outcome variable and each predictor variable and to select variables candidate variable for multivariable logistic regressions model. An odds ratio with a 95% confidence interval was reported. Hosmer-Lemeshow test was used to cheeked models fitness and test p-value=0.277. Bi variables with P- value less than or equal to 0.25 was a candidate for multivariable analysis. Multicollinearity test was checked collinearity among predictors using variance inflation factors (VIF<10).The predictors <10 VIF was considered as no significant collinearity among predictors. In multivariable analysis p-values <0.05 were declared as statically significant with corresponding AOR and confidence interval.

4.12. Ethical Clearance

The HU College of Medicine and Health Science's ethical review committee (IRB Ref. No. IRB/ 159/15) granted its permission. A formal supporting letter was received from the school of public health and delivered to the Hawassa University’s comprehensive specialized hospital. All collected data were kept private.

5. RESULTS

5.1. Socio-Demographic Characteristics

In this study, three hundred twenty mothers were enrolled (107 cases with SSI diagnosis and 213 controls without SSI diagnosis) with a 100% retrieval rate. The majority of the cases 82(76.64%) and the majority of the controls 179(84.04 %) ranged in age (20-35 years. The median age of the mothers were 27(IQR=24-30).around thirty percent of the cases were rural residence and seventy percent of cases were urban residency (Figure 2 $3).

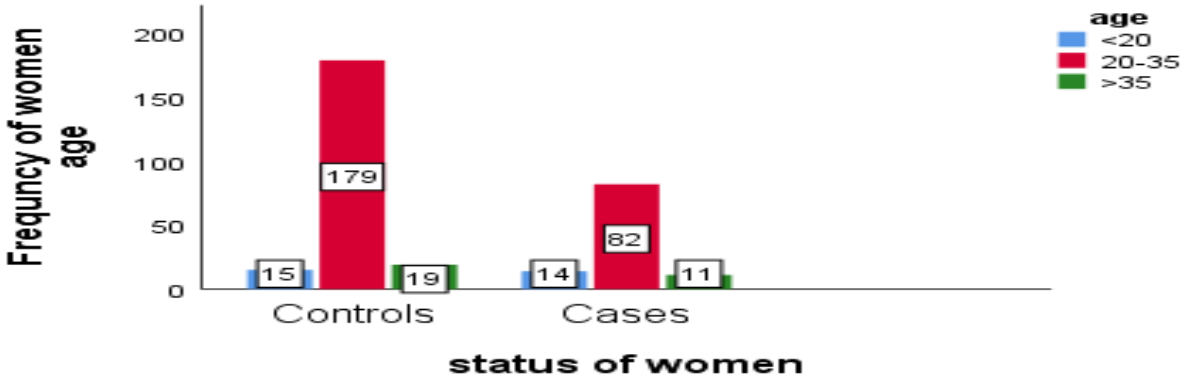

Figure 3 Socio-Demographic characteristics of women's who delivered by cesarean section in HUCSH, Hawassa, Ethiopia 2023

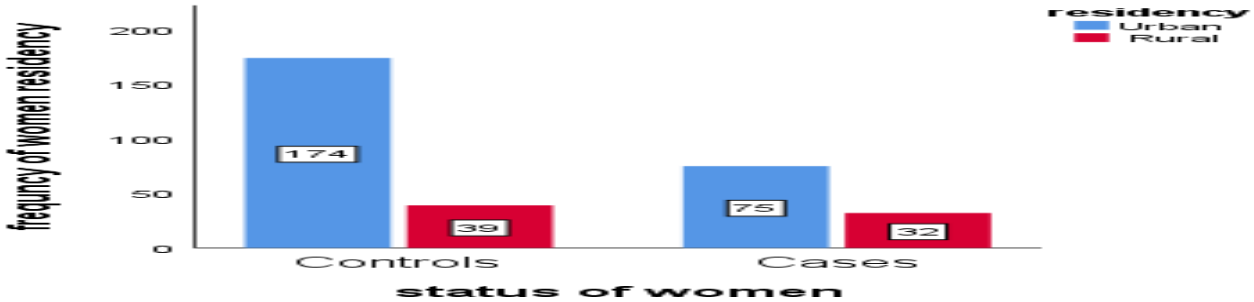

Figure 4 Socio-Demographic characteristics of women's who delivered by cesarean section in HUCSH, Hawassa, Ethiopia 2023

5.2 Medical disorder characteristics of mothers

Mothers who were included in this study 13 (12.15%) of mothers in cases and 9(4.23%) in controls had Diabetic Mellitus. women who had more than one existing comorbidity 18 (16.82%) were developed SSI and 16(7.51%) were not developed surgical site infection (Table 2).

Table 2 Medical disorders characteristics of women who undergone cesarean section in HUCSH, Hawassa, Ethiopia 2023

Variables	Category	Surgical site infection status		
		Cases N (%)	Controls N (%)	Total
Diabetes Mellitus	yes	13(12.15%)	9(4.23%)	22(6.88%
	No	94(87.85%)	204(95.77%)	298(9.12%)
Pregnancy Induced Hypertension	yes	19(17.76%)	22(10.33%)	41(12.81%)
	No	88(82.24%)	191(89.67%)	279(87.19%)
Did patient have UTI?	Yes	5(4.67%)	14(6.57%)	19(5.94%)
	No	102(95.33%)	199(93.43%)	301((94.06%)
HIV status	Positive	5(4.67%)	6(2.82%)	11(3.44%)
	Negative	102(95.33%)	207(97.18%)	309(96.56%)
Have Fever on admission	yes	6(5.61%)	5(2.34%)	11(3.44%)
	No	101(94.39%)	208(97.65%)	309(96.56%)
More than one existing comorbidity	yes	18(16.82%)	16(7.51%)	34(10.63%)
	No	89(83.18%)	197(92.49%)	286(89.37%)

5.3 Pregnancy and intrapartum related characteristics of mothers

The majority of mothers in cases 92 (85.98%) and 175(82.16%) in controls surgery were done in gestational age 37 to 40 weeks. Regarding maternal parity 47(43.93%) were Primipara mothers had surgical site infection and 60((56.07%) multipara mothers were developed surgical site infection following cesarean deliveries (table 3).

Table 3 Pregnancy and intrapartum related characteristics of mothers women who undergone cesarean section in HUCSH, Hawassa, Ethiopia 2023

Variables	Category	Surgical site infection status		
		Case N (%)	Controls N (%)	Total
Maternal parity	Primipara	47(43.93%)	76(35.68%)	123(38.44%)
	'Multipara	60((56.07%)	137(64.32%)	197(61.56%)
Gestational age during surgery	<37 weeks	10(9.35%)	12(5.63%)	22(6.88)
	37-40 weeks	92(85.98%)	175(82.16%)	267(8.44%)
	>40weeks	5(4.67%)	26(12.21%)	31(9.68%)
	Total	107(100%)	213(100%)	320(100%)
Duration of lobour	Prolonged	6(6.06%)	7(4.73%)	13((5.22%)
	Normal	93(93.94%)	141((95.27%)	236(94.78%)
Status of membrane before C/S	Intact	41(38.32%)	120(56.34%)	161(50.31%)
	ruptured	66(61.68%)	93(43.66%)	159(49.89%)
If ruptured Length of membrane rupture(in hour)	>=12 hours	61(92.42%)	81(87.1%)	142(89.31%)
	<12hours	5(7.58%)	12(12.9%)	17(10.69%)
Premature ROM	Yes	10(9.35%)	20 (9.39%)	30(9.38%)

	No	97(90.65%)	193(90.61%)	290(90.62%)
Status of lobour during cs	Not in lobour	8(7.48%)	65(0.52%)	73(22.81%)
	In lobour	99(92.52%)	148(69.48%)	247(77.19%)
Chorioamnionitis	Yes	6(5.61%)	7 (3.29%)	13(4.06%)
	No	101(94.39%)	206((96.71%)	307(95.94%)
ANC follow up	Yes	93(86.92%)	202(94.84%)	295(92.19%)
	No	14(13.1%)	11(5.16%)	25(7.81%)
Presence of caput	Yes	12(11.21%)	8(3.76%)	20((6.25%)
	No	95(88.79%)	205(92.24%)	300((93.75%
Number of vaginal examination	<= 4 times	57(53.27%)	177(83.1%)	234((73.12%)
	> 4 times	50(46.73%)	36(16.9%)	86(26.88%)
Pervious history of CS	Yes	27(25.23%)	69(32.4%)	96(30%)
	No	80(74.77%)	144(67.6%)	224(70%)

5.4 Procedure and post-operative related characteristics

More than 90% of in cases and more than seventy percent of controls delivered by emergency C/S. More than 90 percent of women who undergo cesarean section who develop surgical site infection duration surgery were <=60minte and less than ten percent of cases duration of surgeries were >60minte (Table4).

Table 4 Procedure and post-operative related characteristics of women who undergone cesarean section in HUCSH, Hawassa, Ethiopia 2023

Variables	Category	Surgical site infection status		
		Cases N (%)	Controls N (%)	Total
Types of C/S	Elective	8(7.47%)	59(27.7%)	67(20.94%)
	Emergency	99(92.53%)	154(72.3%)	253(79.06)
Types of abdominal incision	Transverse	99(95.53%)	202(94.84%)	301((94.06%)
	Vertical	8(7.47%)	11(5.16%)	19(5.94%)
Duration of C/S	<=60minte	99(92.52%)	189(88.73%)	288(90%)
	>60minte	8(7.48%)	24(11.27%)	32(10%)
Operation was performed by	Resident(R1 and R2)	48(44.86%)	100(46.95%)	148(46.25%)
	Resident(R3 and R4)	54(50.47%)	98(46.01%)	152(47.5%)
	Specialist	5(4.67%)	15(7.04%)	20(6.25%)
Preoperative antibiotic prophylaxis provided?	Yes	102(95.33%	203(95.31%)	305(95.31%
	No	5(4.67%)	10(4.69%)	15(4.69%)

Was Post-operative antibiotic given	Yes	31(28.97%)	52(24.41%)	83(25.9)%
	No	76(71.03%)	161(75.59%)	237(74.1%)
Pre-operative hemoglobin or Hct	Less than 30	10(9.35%)	7(3.29%)	17(5.31)%
	More than 30	97(90.65%)	206(96.71%)	303(94.69%)
Post operation hemoglobin or Hct	Less than 30	42(39.25%)	24(11.27%)	66(20.6%)
	More than 30	65(60.75%)	189(88.73%	254(79.4%
Did the women transfused blood	yes	12(11.21%)	10(4.69%)	22(6.89%)
	No	95(88.79%)	203(95.31%)	298(93.1%)
Duration of hospital stay	≤3 days	56(52.34%)	129(60.56%)	185(57.81%)
	3-5days	22(20.56%)	65(30.52%)	87(27.19%)
	> 5 days	29(27.1%)	19(8.92%)	48(15%)
Difficulty of extraction was happen	Yes	13(12.15%)	10(4.69%)	23(7.2%)
	No	94(87.85%)	203(95.31%)	297(92.8%)

5.5. Bi variable & multivariable Binary logistic regression model

Bi-Variable logistic regression was performed for each independent variables and variables with p-value <0.25 were included into a multivariable logistic regression. variables candidate for Multivariable logistic regression were the age of mothers, place of residency , Diabetes mellitus , more than one existing comorbidity ,Status of membrane before C/S, Status of labour during cesarean section , ANC follow up, Presence of caput ,Number of vaginal examination, Types of C/S, Pre-operative hematocrit , post operation hematocrit , women who transfused blood ,Duration of hospital stay and Difficulty of extraction and among them Diabetes mellitus, lobour status during C/S Number of vaginal examination, post-operative hematocrit, and duration of hospital stay were determinant factors (Table 5).

Women with Diabetes mellitus who had gave birth by cesarean section were 3.7 times [AOR= 3.71 (95% CI, 1.18-11.66)]at a higher odds for surgical site infection following cesarean deliveries as compared to women who did not had Diabetes mellitus. Women with in labour during C/S were 5 times [AOR= 5.16((95%CI, 1.33-20.10)] at a higher odds for surgical site infection following cesarean deliveries as compared to women who had surgery done without labour. Women with more than four times vaginal examination were 2.3 times [AOR= 2.28((95%CI, 1.15-4.54)]. at a higher odds for surgical site infection as compared to women who had four or less times vaginal examination.

Women with post-operative hematocrit less than 30% were 4 times [AOR= 4.11 (95% CI 1.97-8.61)] at a higher odds for surgical site infection as compared to women who had post-operative hematocrit more than 30%. Women with hospital stay of more than 5 days were 3.4 times [AOR=3.42 (95%CI 1.32-8.89)] at a higher odds for surgical site infection as compared to women who had duration of hospital stay of three or less days.

Table 5 Bi variable & multivariable logistic regression model for the determinants of surgical site infection following cesarean delivery in HUCSH, Hawassa, Ethiopia 2023.

Variables	category	SSI status		OR (95% CI)	
		Cases N	Controls N	COR (95%CI)	AOR(95%CI)
Age of mothers	<20	14	15	2.04(0.94-4.42)	2.35(0.96-5.76)
	20-35	82	179	1	1
	>35	11	19	1.26(0.58 -2.78)	1.13(0.40- 3.16)
Place of residence	Urban	75	174	1	1
	Rural	32	39	1.9(1.11-3.27)	0.99(0.49-2.02)
Diabetes mellitus	yes	13	9	3.14(1.30-7.59)	**3.71(1.18-11.66)***
	No	94	204	1	1
more than one existing comorbidity	yes	18	16	2.49(1.21-5.11)	1.83(0.66-5.09)
	No	89	197	1	1
Status of membrane before C/S	Intact	41	120	1	1
	ruptured	66	93	2.08(1.29-3.34)	1.14(0.6-2.17)
Status of labour during c/s	Not in lobour	8	65	1	**1**
	In lobour	99	148	5.44(2.5-11.82)	**5.16(1.33- 20.10)***
ANC follow up	Yes	93	202	1	
	No	14	11	2.76(1.21 -6.32)	1.19(0.43-3.31)

Presence of caput	Yes	12	8	3.24(1.28-8.18)	1.67(0.55-5.11)
	No	95	205	1	1
Number of vaginal examination	<=4times	57	177	1	
	>4 times	50	36	4.31(2.56-7.27)	**2.28(1.15-4.54)***
Types of C/S	Elective	8	59	1	1
	Emergency	99	154	4.74(2.17-10.35)	1.41(0.389-5.14)
Pre-operative hemoglobin Hct	Less than 30	10	7	3.03(1.12-8.21)	0.92(0.22-3.84)
	More than 30	97	206	1	1
post operation hemoglobin or Hct	Less than 30	42	24	5.09(2.86-9.05)	**4.11(1.97-8.61)***
	More than 30	65	189	1	1
Did the women transfused blood	yes	12	10	2.56(1.07-6.14)	1.69(0.41-6.89)
	No	95	203	1	1
Duration of hospital stay	<3 days	56	129	1	1
	3-5days	22	65	0.780(0.44-1.39)	0.51(0.24-1.06)
	>5 days	29	19	3.52(1.82-6.79)	**3.42(1.32-8.89)***
Difficulty of extraction was happen	Yes	13	10	2.80(1.19-6.63)	1.90(0.57-6.41)
	No	94	203	1	1

COR; crude odd ratio; AOR, Adjusted odd ratio; * significant at p-value of <0.05

6. DISCUSSTION

This hospital based unmatched case-control study was conducted in Hawassa university Comprehensive specialize hospital and aiming to identity the determinants of surgical site infection following cesarean deliveries. Diabetes mellitus, labour status during C/S Number of vaginal examination, post-operative hematocrit, and duration of hospital stay were the identified determinates of surgical site infection following cesarean deliveries.

In the current study Women with Diabetes mellitus who had given birth by cesarean section were increased the risk of surgical site infection following cesarean deliveries as compared to women who did not have Diabetes mellitus. This finding agreed in the study conducted in Bahir Dar(33) and study conducted in southern Israel also revealed that gestational diabetes mellitus as risk factor of surgical site infection(32). It also supported with the study conducted in University of Gondar comprehensive specialized hospital(44).This might be due to evidence showed that Implement perioperative glycemic control and use blood glucose target levels less than 200 mg/dL in patients with and without diabetes for privation of surgical site infection (20). Women who have diabetes, facing difficulty of effective control of blood glucose level. Therefore uncontrolled blood glucose end up with problems with poor wound healing process since it affects circulation, nerves and immune system. In diabetic women the risk of infection higher since hyperglycemic environment that caused immune dysfunction that leads to damage to the neutrophil function, depression of the antioxidant system, and humoral immunity.

Women with in labour during C/S who undergone by cesarean section were a higher risk for surgical site infection as compared to women who had surgery done without labour. This finding supported by the studies conducted Nepal(34)and in Peruvian Hospital (35)and)in University of Pittsburgh(45). Another study conducted in Ethiopia also revealed that prolonged labour as significant predictor for surgical site infection(46).This might be due to as women in lobour exposed for risk factors like repeated vaginally examination and labour abnormality that increase the chance of post-operative surgical site infection

Another finding of the current study revealed that Women with more than four times vaginal examination who undergone by cesarean section were significantly associated with surgical site infection following cesarean deliveries as compared to women who did had less number of vaginal examination. This finding supported in the study conducted supported in Dira Diwa vaginal

examination more than four times as significant factors (28). And also another studies conducted in Hawassa, Debre Markos hospitals, and Zewditu hospitals finding showed that repeated vaginally examination increase the occurrence of Post Cesearn section surgical site infection (10, 14, 36).The possible explanation even though vaginal examination recommended every four hours in during active lobour in low risk women since during lobour the cervix is open and loss its protective of introducing different bacteria's to intrauterine cavity and that may risk for ascending infections. According to WHO recommendation multiple vaginal examinations for routine assessment of labour progress not encourage for women's with high risk like prolonged duration of labour or prolonged rupture of membranes. since multiple vaginal examinations increased risk of maternal peripartum infections(47, 48)

This study finding also showed that Women with post-operative hematocrit less than 30% who undergone by cesarean section were higher odds to surgical site infection following cesarean deliveries as compared to women who had post-operative hematocrit more than 30%. This finding was supported by the studies conducted in Dira Diwa (28).Hawassa and Addis Abeba (10, 36).and also it supported by the study conducted in gonder anemia(post-operative hematocrit<33) more likely develops SSI (44).The possible reason might be due to low RBC or low hematocrit level results decreased oxygen delivery to organs that may leads to slow wound healing and also women with low post hematocrit may be exposed for prolonged hospital stay for treatment this also another determinate for the occurrence of surgical site infection.

The other finding of the current study was Women with hospital stay of more than 5 days of who undergone by cesarean section were significantly increase surgical site infection following cesarean deliveries as compared to women who had duration of hospital stay of three days or less .This finding agree with a study conducted at Jordan university hospital (37) , Hospital Pulau Pinang, Malaysia(49) and in Ethiopia (50) The possible explanation might be as women exposed to prolonged hospital may acquire different microorganism that leads to post-operative surgical site infection.

Limitation

The limitation of this study since the data was extracted from women chart that leads to data incompleteness and the generalizability of this study was limited due to the study conducted in single Institution based.

Strength of study

The strength of study was used discharge surveillance registration book in addition to registration book to minimize Misclassification of controls.

7. CONCLUSION AND RECOMMENDATION

7.1 CONCLUSION

This study revealed that Diabetes mellitus, Number of virginal examination post-operative hematocrit, labour status during C/S and duration of hospital stay were the identified determinates of surgical site infection following cesarean section.

7.2. RECOMMENDATION

To Hawassa referral Hospital

In this study, the factors that were found to be associated with surgical site infections following cesarean section were related to post-operative, intraoperative Intrapartum and Antepartum situations. The hospital should strengthen and monitor healthcare personnel for early detection and risk assessment during certain times in order to reduce these determining factors.

To health professionals

Since the identified determinants of surgical site infection following cesarean section was related; to Antepartum, Intrapartum, postpartum maternal related conditions health professionals have to: Working antennal care, Intrapartum care, and postnatal units should identify those who are at this risk and take appropriate action.

For Researchers

If this study is conducted using a follow-up study design, it will be beneficial to include mothers who do not come in for follow-up following C/s in order to determine the status of the women whose result is uncertain

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APPENDICES

Annex 1 Subject information sheet

Introduction -Good morning/afternoon, My name is _____ I am working in research team which is conducted by Hawassa University master's degree in Reproductive health student .I am collecting data from mothers giving birth by cesarean delivery HUCSH.

The objective of the study is to identify the determinants of surgical site infection among cesarean deliveries in HUCSH.

The benefit of the study: there is no financial gift for the participants of the study. But in the long run, the result of the collected data will help local maternal health programmers in planning surgical site infection prevention & control strategies that decrease maternal morbidity & mortality due to surgical site infection.

Risk of the study: since the proposed research does not have any inhuman treatment it has no harm, social discrimination, psychological trauma, and economic loss.

Confidentiality: To establish a secure safeguard of the collected data was used codes during the data collection period instead of using the name. All information will be kept strictly confidential.

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Name of the medical director of the hospital _____

Signature _____

ANNEX II: - English Version checklist

This is a data collection format checklist to identify Determinants of surgical site infection among cesarean deliveries. Hawassa, Ethiopia, 2023

Name of Data collector_____Date_____Qualification_____

Checked by supervisor for completeness: - Supervisors Name_____ signature _____

Part I: Socio-demographic Characteristics			SKIP TO
S.no	Questions	Response	
101	Age of the participant		
102	Residence	1. Urban 2. Rural	
	PART II Medical related Characteristics		
201	Did patient have Diabetes mellitus?	1. Yes 2. No	IF No go to QNO.203
202	when it diagnosed	1. Before pregnancy 2. During pregnancy	
203	Did patient have Hypertension before pregnancy	1.Yes 2.No	
204	Did patient have pregnancy Induced Hypertension	1. Yes 2.No	
205	Did patient have UTI?	1. Yes 2. No	
206	HIV status	1. Positive 2. Negative	

207	Did the women have Fever on admission	1.Yes 2.No	
208	Did women have more than one existing comorbidity	1.Yes 2.No	
	Part III pregnancy and intrapartum related characteristics		
301	Parity		
302	Gestational age during surgery		
303	Duration of labour (in hour)		
304	Status of membrane before C/S	1, Intact 2. ruptured	
305	If ruptured Length of membrane rupture(in hour)		
306	Premature ROM	1.Yes 2.No	
307	Status of lobour during C/S	1. Not in lobour 3. Active first stage 2 .Latent 4. Second stage	
308	Chorioamnionitis	1. Yes 2. No	
309	ANC follow up	1. Yes 2. No	
310	Presence of caput	1. Yes 2. No	
311	Number of vaginal examination	1.<=4 times 2. >4 times	
312	Pervious history of CS	1. Yes 2. No	

	Part IV procedure and post-operative Related characteristics		
401	Types of C/S	1.Elective 2.Emergency	
402	Types of abdominal incision	1.Transverse 2.Vertical	
403	Duration of C/S	1.less than 30minte 2.30-60 minute 3.>60minte	
404	Operation was performed by	1.MSc Student 2.Resident(R1 and R2) 3. Resident(R3 and R4) 4.Specialist	
405	Does preoperative antibiotic prophylaxis provided?	1.Yes 2.No	If no go to Q407
406	Time antibiotics prophylaxis given	1. < 30 min. 2. 30– 60 min 3. > 1 hour	
407	Antiseptic used for perioperative skin preparation	1.Aqueous butadiene (Iodine) 2.2%Chlohexidine/Alcohol 3.Other specify	
408	Skin closure type	1.Interrupted sutures 2. Continuous	
409	Was Post-operative antibiotic given	1.Yes 2.No	

410	Post operation hemoglobin or Hct		
411	Pre-operative hemoglobin or Hct		
412	Did the women diagnosed SSI	1.Yes 2.No	
413	Did the women transfused blood	1.Yes 2.No	If yes answer 419
414	Time of transfusion	1.During operation 2.post operation time	
415	Duration of hospital stay		
416	Did Difficulty of extraction was happen	1. Yes 2. No	