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Incidence of surgical site infection following caesarean section and its associated factors in a Tikrit Teaching Hospital, Iraq

Incidence of caesarean section infection

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Abstract

Objective

The rate of delivery by caesarean section has increased greatly. This increase has been attributed to wide variety of factors related to mother, child, medical and legal climate. Post-operative caesarean section infection is an important of maternal febrile morbidity. It leads to prolongation of hospital stay and add extra cost to patient charge for hospitalization.

Materials and Methods

The present work was conducted on 500 patients with caesarean sections.. Their ages ranged from 15-45 years. The majority of these patients were from rural areas or referred to this hospital from other town's hospitals. General information such as including demographic survey was listed. Wound infection was assessed by culture.

Results

Caesarean wound infections ranged from grade 0 to grade 5c. The highest percentage (48.8) of wounds was of grade 0. The high incidence of caesarean infection was among the age group 21-30 years old. The present study showed that 46.7% of patients with body weight more than 85 kgs developed wound infection. The present study revealed that 62.4% of patients come from rural areas. Wound infection rates for elective, emergency and caesarean after trail were 13.6, 18.5 and 22.4 percent respectively.

Conclusions

Chi-squared test showed a significant difference strong association between weight group and infection rate ($P < 0.00001$). On bacteriological examination of caesarean wounds, grade 4, 5s and grade 5c showed 100% positive bacterial cultures. The present attempt showed that the pooled infection rate was 18.4% with 95% confidence limits.

Keywords: wound, caesarean section, infection, grades, predisposing factors, residence origin

PRECIS: The rate of local delivery by caesarean section has increased greatly particularly among women of rural origin. The present study was an attempt to evaluate surgical site infection after caesarean section and its related risk factors.

Introduction

A wound is a discontinuity of tissue and distruption of anatomical continuity. Wound healing is the restoration of discontinuity. This process is accomplished by cell proliferation and collagen production, and on certain anatomical sites by regeneration [1,2]. Wounds generally have been classified as surgical and traumatic or physiologic. Wounds can be classified into clean, clean-contaminated, contaminated and dirty [3,4]. The infection rate in wounds varied from one

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country to another and from hospital to another. The overall infection rate in clean surgical wounds should be less than 5%, as was performed in Canada, Denmark, Sweden and Australia[5,6]. It has been concluded a notable increase in the number of caesarean sections performed recently[7]. Wounds and uterine infections after caesarean section are the most common problem occur even in the most advanced obstetric units. The rate of caesarean infections commonly ranged between zero to almost 20% [8,9]. After operation, patient with wound infection spent extra days, which will add to the patient charge for hospitalization. Routinely giving prophylactic antibiotics in case of caesarean section will not only reduces the rate of infection , but also reduces the cost of therapy[10]. Definition of caesarean wound infection for purposes of different studies of caesarean section morbidity has varied. Wound infection characterized shortly by redness, tenderness, increased heat, and oedema of the wound[11]. In another study, wound infection was diagnosed by fever, cellulitis and exudate from wound[12]. In another study, the wound infection was characterized by cellulitis and exudate with positive bacteriological culture obtained from incision site with or without fever[13]. Some others considered wound infected when positive culture was obtained from material taken from wound with or without inflammation or sepsis. There are several factors which could predispose to wound infection. These factors include extreme ages, origin of residence, presence of medical illness, diabetes mellitus, obesity, malnutrition, malignancy, steroid therapy, patients who are carrier of infecting organisms, longer preoperative period of hospitalization, razor shaving of operative site day before operation, longer operation time, careless surgical technique, contamination of wound at operation, haematoma and foreign bodies in the wound [1,14,15,16,17,18].

Materials and Methods

Patients

This study was carried out in teaching hospital of Tikrit. The present work was conducted on 500 patients with caesarean sections. Three hundreds were hospitalized the other two hundreds were non-hospitalized attended the outpatients clinic after operation for removal of stitches. Their ages ranged from 15-45 years. The majority of these patients were from rural areas or referred to this hospital from other town's hospitals. General informations such as including demographic survey were listed. The acceptance for participation in the present study was taken from all the participants whose native language is Arabic. They were not mentally retarded and they were completely healthy considering hearing and speaking. A pilot study to ensure the questionnaire and identification of the most frequent pathogens causing caesarean wound infection was carried out on 50 patients with caesarean section before the start of the present study.

Definitions used for caesarean wound infections

Caesarean wound infection is defined according to Moire-bussy et al into following categories[8]:

1. Emergency caesarean section, one performed for immediate and compiling reasons and which had not been planned in advance.
2. Elective caesarean section, one which scheduled in advance before the onset of the labour and the staff and patient were optimally prepared.
3. Post 'trail or labour' caesarean section, one performed after the patient had been allowed to go into labour in order to attempt delivery of the child by natural means.

Methods for evaluating wound infection

Wound infection was evaluated according to Dionigi[19] as following:

Grade 0: no evidence of infection.
Grade 1: erythema, induration and pain without serous fluid.
Grade 2: same as grade 1 and/ or serous fluid.
Grade 3: contaminated fluid in less than half of the wound.
Grade 4: same as grade 3 , in more than half of the wound.
Grade 5s: suspected facial dehiscence.
Grade 5c: certain facial dehiscence.

Sampling

Wound swab was taken on the third postoperative day from hospitalized patients and on the seventh postoperative day from patients attended outpatient clinic. Samples were taken by using sterile cotton swabs moistened with nutrient broth carried in test tubes contained 2 ml broth liquid[20]. Wound swabs were enriched in nutrient broth at 37 ^{0}C for 18 hours. Each sample was sub-cultured on blood agar , MacConkey agar and mannitol salt agar and incubated at 37 ^{0}C for 24 hours. Pure cultures were obtained after isolation on appropriate selective media. The suspected colonies of different organisms were purified twice then sub-cultured on nutrient agar slants and kept at 4 ^{0}C for full identification and further studies.

Statistical analyses

All statistical analyses were performed using IBM SPSS Statistics for Windows, Version 26.0 (IBM Corp., Armonk, NY, USA). Descriptive statistics such as means, standard deviations, and frequency distributions were computed to summarize the data. To examine the relationships between variables, linear regression and multivariate linear regression models were applied. Where appropriate, interaction terms were included to evaluate the effect modification between predictors. An exponential decay model was used to describe the decreasing trends in the outcome variable over time, and the model was linearized using natural logarithm transformation for compatibility with linear regression frameworks. The significance of individual coefficients in the regression models was assessed using t-tests, with a p-value < 0.05 considered statistically significant. Assumptions of normality, linearity, homoscedasticity, and multicollinearity were checked prior to model interpretation. All graphical outputs and residual diagnostics were also generated using SPSS. In addition, for confirmation of model robustness, selected analyses were repeated using R version 4.3.1 (R Foundation for Statistical Computing, Vienna, Austria).

Results

Evaluation of wound infection among patients with caesarean section

According to the method of evaluation of wound infection previously described, the caesarean wounds of 500 patients were classified as shown in Table 1. Caesarean wound infections ranged from grade 0 to grade 5c. The highest percentage (48.8) of wounds was of grade 0 and only 0.8% of wounds of grade 5c wounds. On bacteriological examination of caesarean wounds, grade 4, 5s and grade 5c showed 100% positive bacterial cultures, whereas almost 15% of wounds of grade 0 showed positive culture.

Table 1. Frequency of bacterial isolation in relation to grading of caesarean wounds.

Grade of wound infection	Caesarean wound		Wounds with positive culture	
	No.	%	No.	%
Grade 0	244	48.8	39	15.9
Grade 1	182	36.4	30	16.4
Grade 2	48	9.6	38	79.1
Grade 3	19	3.8	17	89.4
Grade 4	29	0.4	2	100
Grade 5s	1	0.2	1	100
Grade 5c	4	0.8	4	100
Total	500	100	131	26.2

Distribution of caesarean wound infections according to age, body weight and residence of patients

Table 2 shows that 51.2% of patients with caesarean section were among the age group of 21-30 years, whereas only 3% of the patients of age group >41 years. The high incidence of caesarean infection was among the age group 21-30 years old. Table 2 also shows that more than 46% of patients were with body weight ranged between 55 to 64 kgs, whereas only 6% of patients had body weight of more than 85 kgs. The present study shows that 46.7% of patients with body weight more than 85 kgs developed wound infection, whereas 12.4% of patients examined were with body weight ranged from 55-64 kgs developed wound infection. The present study revealed that 62.4% of patients come from rural areas. Whereas 37.6% of patients where come from urban areas. The incidence of caesarean infection among patients from rural and urban areas were 20.2 and 15.4 % respectively. The present study Suggested that older patients are at higher risk of wound infection post-caesarean.

Table 2. Distribution of caesarean wound infections according to demography.

Character	Measurement	Patients examined		patients with infection	
		No.	%	N0.	%
Age (years)	15-20	73	14.6	11	15
	21-30	256	51.2	39	15.2
	31-40	156	31.2	38	24.3
	≥ 41	15	3	4	26.6
	total	500	100	92	18.4
Weight (Kg)	45-54	35	7	6	17.1
	55-64	234	46.8	29	12.4
	65-74	129	25.8	25	19.3
	76-84	72	14.4	18	25
	≥ 85	30	6	14	46.7
	Total	500	100	92	18.4
Residence	Urban	188	37.6	29	15.4
	Rural	312	62.4	63	20.2
	Total	500	500	92	18.4

The present study revealed that the infection rate increases with age when was peaking at ≥41 years (26.7%). This demonstrated that older patients are at higher risk of wound infection post-caesarean. While Infection rate elevated steeply in higher weight brackets, reaching a maximum of 46.7% in patients ≥85 kg, indicating obesity was a significant risk factor for infection. Rural patients showed a higher infection rate (20.2%) compared to urban patients (15.4%) which might be due to possible differences in standards of contributing factors like access to healthcare, hygiene practices, or follow- up care (Figure 2,3,4). The elective was below the average infection rate whereas after trial revealed the highest infection rate nearing the upper confidence limit (Figure 5)

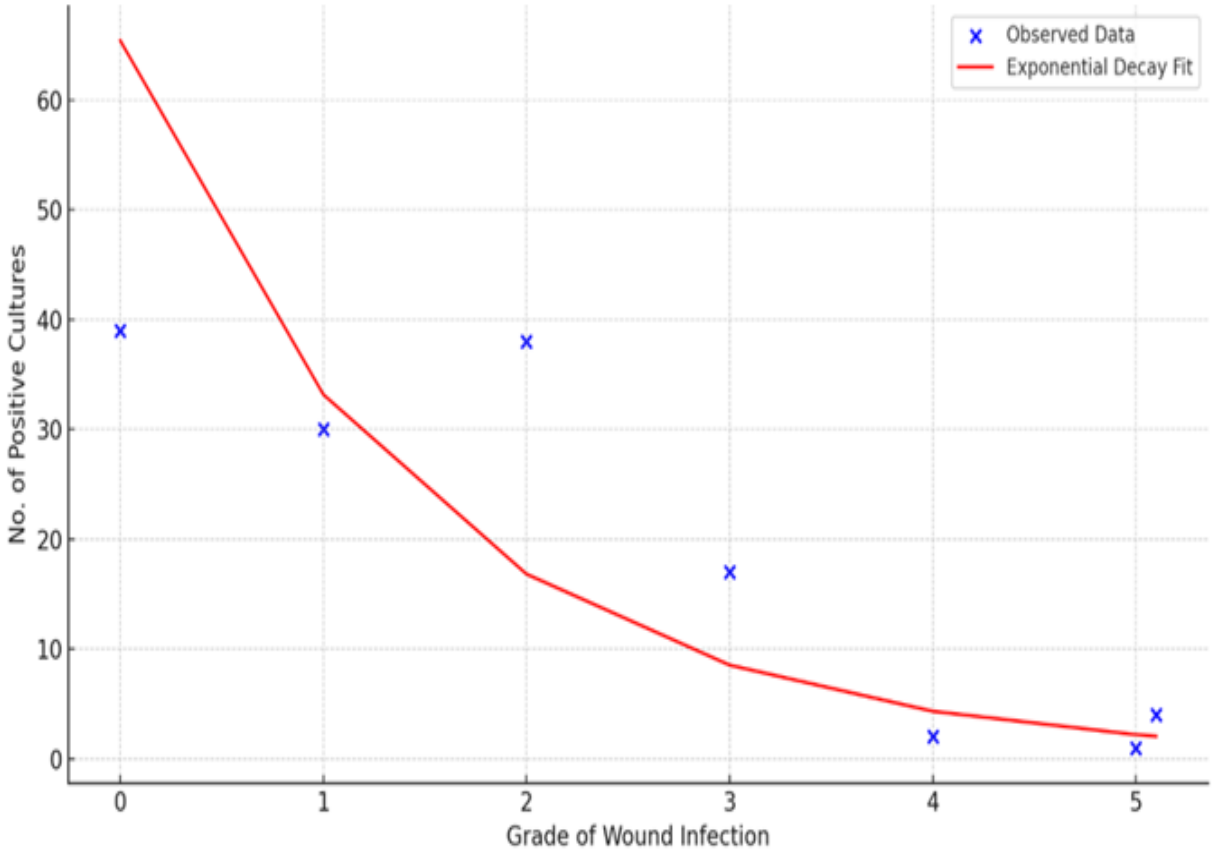

Figure 1. Exponential decay curve shows positive culture vs wound grade.

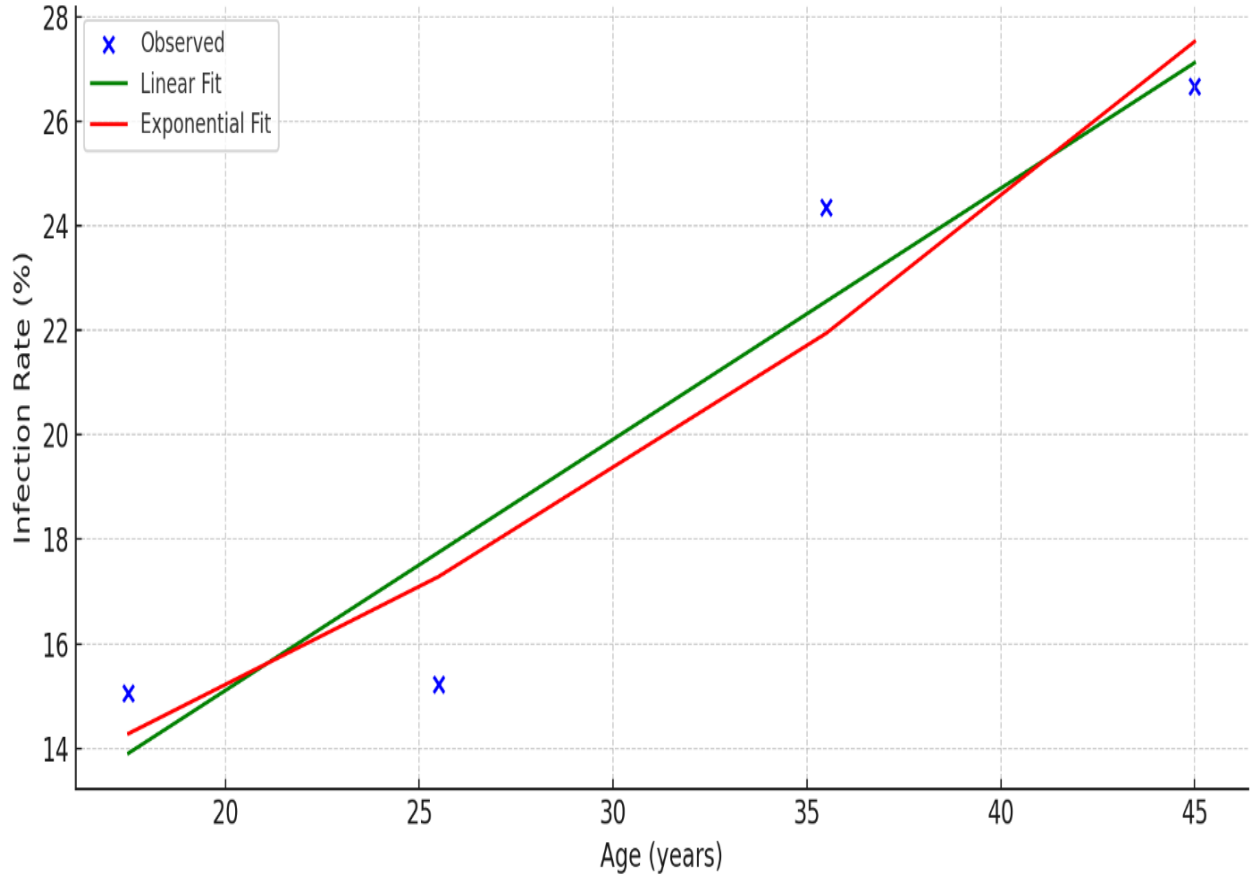

Figure 2. Linear and exponential fit chart shows infection rate vs age of the patients.

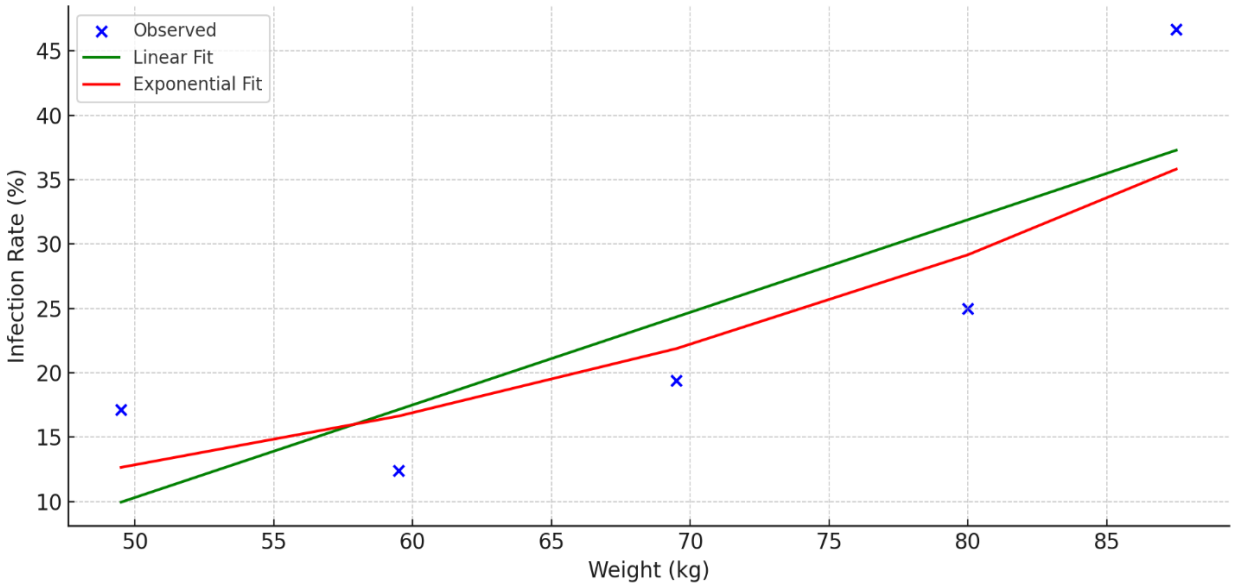

Figure 3. Linear and exponential fit chart shows infection rate vs weight of the patients.

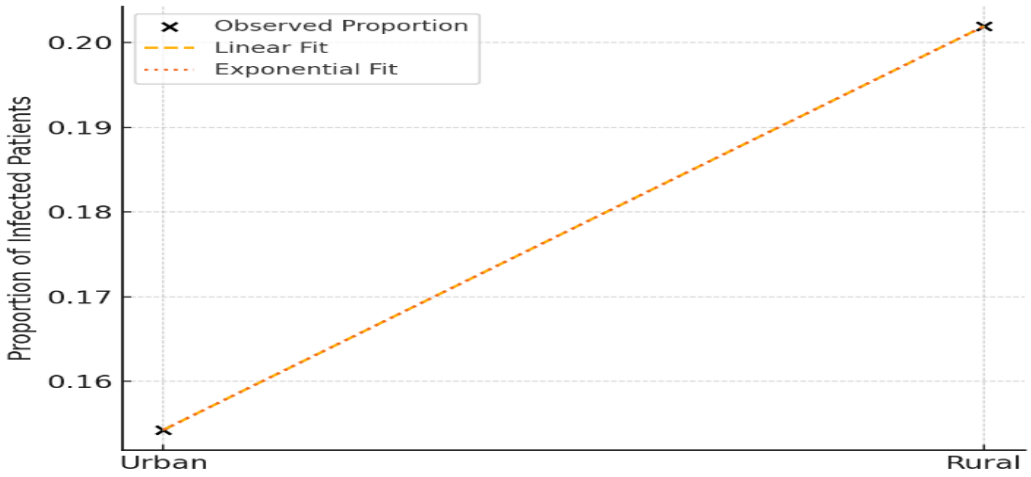

Figure 4. Linear and exponential fit of infection proportion by residence.

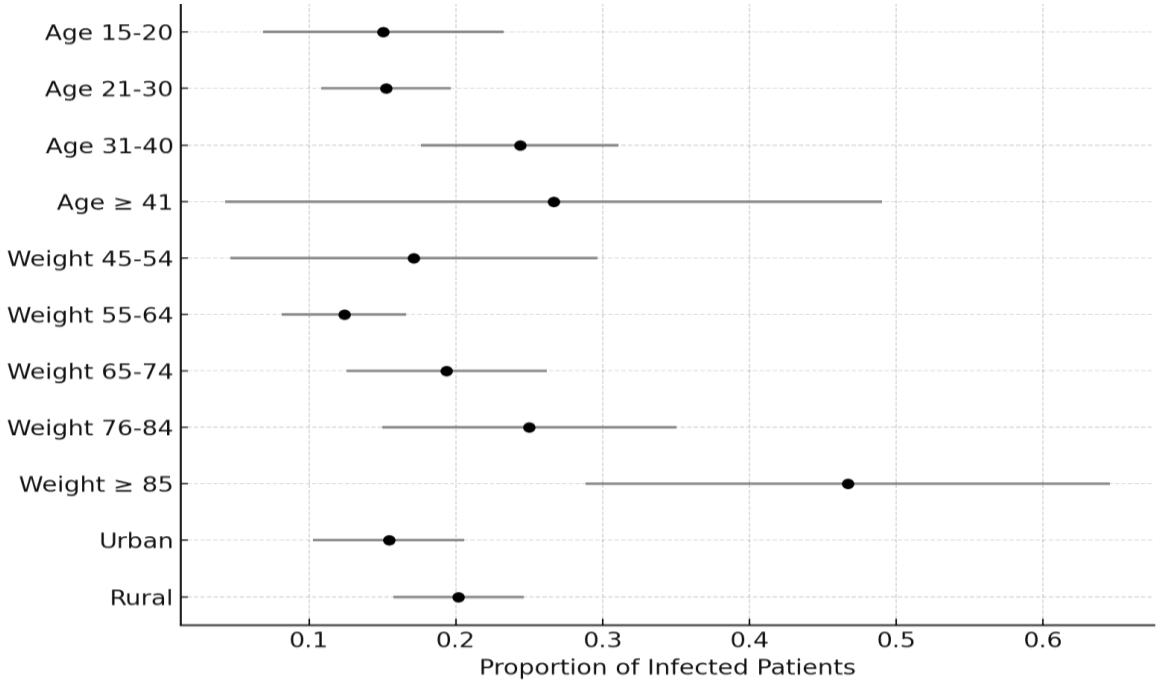

Figure 5. Forest plot of the caesarean wound infection by demographic group.

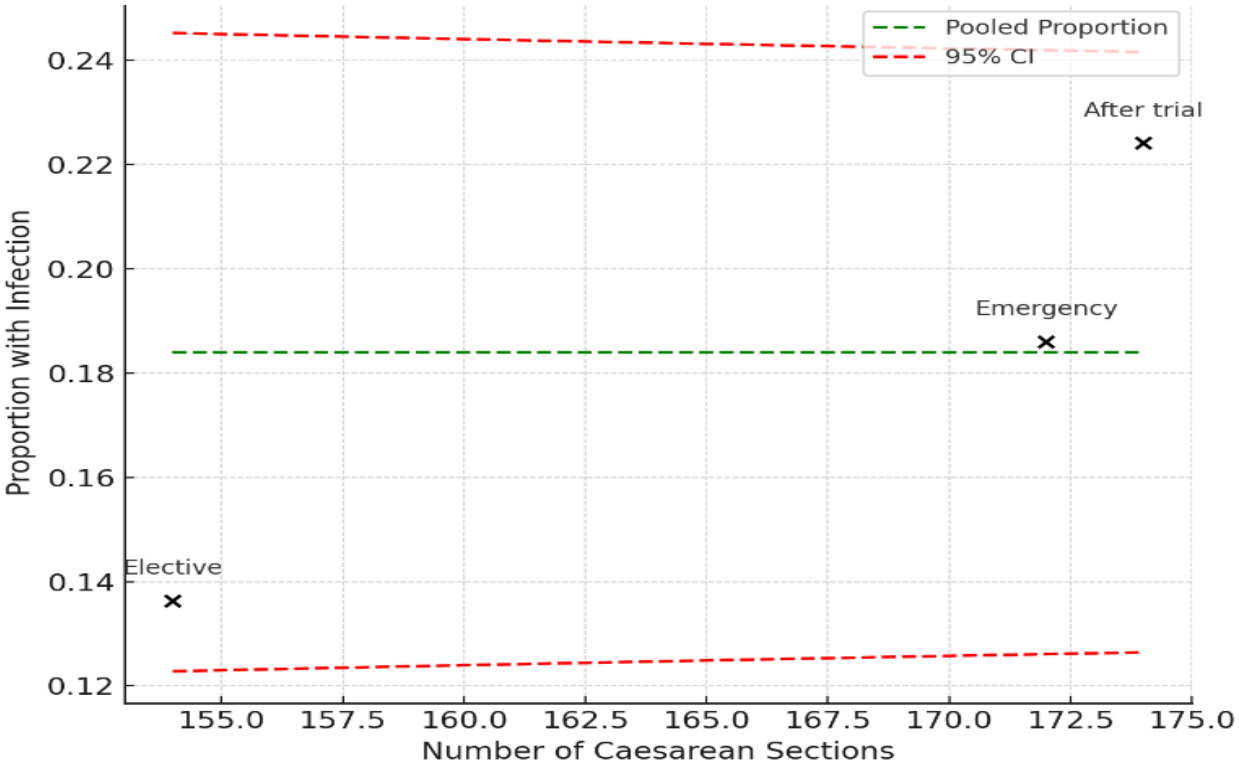

Figure 6 . Funnel plot for caesarean wound infection by operation category.

Distribution of caesarean wound infection according to category of operation

The distribution of caesarean sections performed in relation to the category of operation is shown in Table 3. Wound infection rates for elective, emergency and caesarean after trail were 13.6, 18.5 and 22.4 percent respectively. The statistical analysis showed that the coefficient of determination (R^2) value was 0.91 which indicated that a very strong linear relationship between number of caesarean wound and number of infection. Chi-squared test revealed that there was no significant difference in infection rates among the three categories of caesarean section ($p > 0.05$). The funnel plot showed that the pooled infection rate was about 18.4% with 95% confidence limits. After trail group showed the highest infection rate which almost nearing the upper confidence limit (Figure 6).

Table 3. Number of patients with caesarean wound infection according to category of operation.

Category	caesarean section		Section with infection	
	No.	%	No.	%
Emergency	172	34.4	32	18.5
Elective	154	30.8	21	13.6
After trail	174	34.8	39	22.4
Total	500	100	92	18.4

Discussion

Post caesarean wound infections one of the main causes of maternal febrile morbidity leading to prolongation of hospital stay and enormous increase in the cost of hospital care for patients with infected wounds[21-24]. The incidence of

caesarean wound infections varied from region to region and from country to country and even from hospital to hospital[1]. It was found that 5-20-fold of women acquired infection due to caesarean section compared to vaginal delivery [25]. Post operation infections could be associated with fever, puerperal sepsis and endometritis[26].

The present study was carried out on 500 patients with caesarean section, 300 of them were hospitalized , whereas 200 patients attended the outpatient clinic for removal of the stitches of operation. The overall incidence of wound infection was 18.4% and incidence of wound infection for inpatients and outpatients was 16.7% and 21% respectively. At the same time the linear regression estimation shows that R-squared value was 0.86 which means that about 86% of the variance in the number of positive cultures was explained by the linear model relating it to wound grade. The correlation coefficient (r) value was 0.927 which revealed a strong negative correlation between grades of wound infection and number of positive bacterial cultures. The present analysis showed that as the wound grade increases, the number of infections tends to decrease. At the same time the linear regression estimation showed that R-squared value was 0.86 which means that about 86% of the variance in the number of positive cultures was explained by the linear model relating it to wound grade. This suggested a strong linear relationship. Exponential decay model (y=65.41·e−0.68xy = 65.41 \ cdot e^{-0.68x}y=65.41·e−0.68x) fits the decreasing trend of positive cultures with increasing wound grade. The decay model appeared to capture the sharp decline better than the linear model, especially at higher grades which was shown by exponential decay curve (Figure 1).Furthermore, it was found recently that the overall wound infections in a cohort study were 4.7% in a study carried out in Saudi Arabia [4]. In a study conducted in Rwanda revealed a low rate of caesarean infections compared to other sub-Saharan Africa which was almost 7% as meta-analysis shown that [22]. On the other hand, the overall incidence of wound infection was less found in other study carried out by Al-Jebouri and his co-workers who found that the incidence of wound infection after caesarean section was 50% in a study done in maternity hospital at Mosul city[20]. On the other hand, the incidence of post caesarean wound infection was 47.3% in a study conducted in Ethiopia [27]. The result of the present study was higher than other studies carried out in developed countries e.g. the incidence of caesarean wound infection was 6% in a national study carried out elsewhere [28].However, it was concluded that there was a significant correlation between length of hospitalization and the prevalence of wound infection[29]. Moreover, Mugford and his co-workers found that 8.4% of caesarean wounds developed infection and 50-70% of wound infection might be reduced by giving prophylactic antibiotics at caesarean section[29]. In studies previously carried out the incidence of caesarean wound infection in Sweden, United States, and Denmark were 4.3, 11.1 and 5% respectively [3,14]. Furthermore, it was found elsewhere that the incidence of caesarean section infection following emergency caesarean section was 13.7% which is almost similar to that concluded in in Mara and Kagera region of Tanzania. This similarity might be due to the same environment under study. However, in studies carried out in the same country of Tanzania was found that the rate of infection of caesarean wounds was as high as 48% which was almost similar to that of Al-Jebouri and his co-workers [20]. This means that the results of any study on caesarean infection could be differ from time to time even at the same locality and this usually depends on women demography like the origin come from, techniques used and environmental health prepared under which operations done [2].

Caesarean wounds were classified clinically into six grades according to the method described by Dionigi[19]. The high percent of wounds (48.8) were of grade 0 and there was similar study available to compare the present results. Wounds with grades 4, 5a and 5c showed 100% positive culture, whereas others found that 53.4% of wounds with sepsis showed positive cultures [1]. These results indicated that the clinical grading is an important parameter to predict development of

wound infection. The funnel plot of the present study showed that the pooled infection rate was about 18.4% with 95% confidence limits (Figure 6). After trail group showed the highest infection rate which almost nearing the upper confidence limit. The elective was below the average infection rate whereas after trial revealed the highest infection rate nearing the upper confidence limit. The study conducted by Singh et al.[7] underscores the burden of superficial surgical site infection of post-caesarean section in a resource-constrained, tribal-dominated setting, and the infection rate was 13.4% per 1000 women-days. The predictors of duration of caesarean section, skin closure techniques, and post-operative care are critical.

The importance of age as predisposing factor for development of wound infection has been described by large number of investigators [30]. In the present study, there was a higher correlation between the incidence of wound infection and the age of patients i.e. high incidence of wound infection (26.6%) was seen with age group more than 41 years old. Linear R^2 was 0.899 whereas exponential R^2 was being 0.896 and both models fit the age data very well which were almost equally. The linear model performed slightly better. The present analysis of the data collected (Table 2) revealed that linear R^2 was 0.673 compared to exponential R^2 whose value was 0.750. The exponential model fitted better than the linear model, which was capturing the sharper rise in infection rate at higher weights. Chi-squared test was also utilized for testing the differences between different groups listed in Table 2, Figures 2,3,4. This test showed a significant difference strong association between weight group and infection rate ($P < 0.00001$) but no significant differences were seen within groups of age and residence when the P value was more than 0.05.

However, Maclaw and his collages found that infection rate increases with the age and highest infection rate has been found among those over 55 years of age. The reason for this could be simply explained by that the aging process affects body's ability to prevent growth of infecting organisms(5).`The present study showed the weight as another important predisposing factor for development of wound infection since high percent of wound infection was found among patients with body weight more than 85 kgs. The differences in in the present results were statistically highly significant ($P < 0.01$). This is almost similar to the results found by Moire-bussy who found that mean weight/height ratio of mothers who were infected was greater than that without infection and the difference was statistically significant too[1]. Moreover, the present study showed that the patients come from rural areas revealed higher percent of wound infections compared to those of urban area origin which almost similar to results concluded elsewhere[16313233343536], which reported that the prevalence of both nosocomial and community-acquired infections was higher in rural (11.5%) than in metropolitan hospitals (8.7%).

Limitations:

The fact that the present study was carried out in a single hospital.

Conclusion

The present study showed a significant difference strong association between weight group and infection rate ($P < 0.00001$) but no significant differences were seen within groups of age and residence when the P value was more than 0.05. The high incidence of caesarean infection was among the age group 21-30 years old. On bacteriological examination of caesarean wounds, grade 4, 5s and grade 5c showed 100% positive bacterial cultures, whereas almost 15% of wounds of grade 0 showed positive infection. Chi-squared test revealed that there was no significant difference in infection rates among elective, emergency and after trail types of caesarean section ($p > 0.05$).

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Statement of Ethics

All the procedures involving human participation were conducted in strict accordance with ethical standards of Institutional Research Committee, Department of Scientific Research, Tikrit University as well as the 1964 Helsinki Declaration and its subsequent amendments or equivalent ethical norms.

Data Availability Statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.

Conflict of Interest Statement

The author declares that he has no conflicts of interest, financial or otherwise.

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Financial disclosure

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Author contributions

Mohemid Maddallah Al-Jebouri, suggested the protocol, reading, correction and supervision of the study; Hana Salman Al-Bayati, collection and analyses of data and manuscript draft writing.

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