The Association of Cesarean Skin Incision Length and Postoperative Wound Complications

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Abstract

Background: Many factors affect the risk of wound complications after Cesarean delivery. Not much research was done on skin incision length and whether it affects wound healing. Understanding the several factors affecting wound healing may help decrease the maternal mortality rate after Cesarean delivery and avoid the occurrence of different wound complications.

Objective: Evaluation of the relationship between cesarean skin incision length and different post-operative wound complications.

Methods: This prospective observational study included 130 women scheduled for Cesarean delivery in Ain Shams University maternity hospital. The skin incision length was measured for all patients who passed the inclusion criteria. Follow-up was done after two weeks and up to six weeks after delivery to observe possible wound complications. Data was collected, and the results were analyzed. Post-operative pain was assessed for its association with skin incision size as a secondary outcome.

Results: The population was divided into two groups. In the group with an incisional length ≤17 cm, the rates of infection, separation/dehiscence, seroma/hematoma, and local cellulitis are 9.5%, 5.4%, 1.4%, and 8.1%, respectively. In contrast, in the group with an incisional length >17 cm, the rates are higher for all complications: 19.6%, 23.2%, 16.1%, and 26.8%, respectively. The statistical test reveals a significantly higher occurrence of separation/dehiscence, seroma/hematoma, and local cellulitis in the larger incisional length group.

Conclusion: Large Cesarean skin incision length was associated with an increased risk of post-operative wound complications.

Keywords: Cesarean section; Incision length; Wound complications; Risk factors.

Introduction

Cesarean delivery, or C-section, is one of the most performed surgeries worldwide, often essential in cases

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where a vaginal birth may pose risks to the mother or child. [1]

New research from the World Health Organization (WHO) reveals that global rates of cesarean sections continue to rise, now representing over 1 in 5 (21%) of all births. This trend is expected to persist, with projections suggesting that nearly one-third (29%) of all deliveries could be by Caesarean section by 2030. [1]

The prevalence rate of cesarean delivery has risen in Egypt, with a rate now exceeding 52%.[2]

While cesarean deliveries can be lifesaving and are considered safe, they are associated with unique challenges and risks that affect maternal recovery. One of the critical concerns in C-section procedures is the potential for post-operative wound complications, which can vary widely in severity and impact [3, 4, 5].

Post-operative wound complications following a C-section include surgical site infections (SSI), dehiscence (reopening of the wound), hematomas (localized blood collection), and seromas (fluid buildup in the wound area). [6]

These complications can hinder the recovery process, prolong hospital stays, increase the need for medical interventions, and negatively affect a new mother's overall health and well-being. SSIs, for example, can lead to systemic infections if not addressed promptly, while dehiscence may require additional surgical procedures to ensure proper wound closure. Hematomas and seromas also pose risks as they can become infected, cause pain, and contribute to delayed healing. In addition to the physical effects, wound complications can cause emotional distress, affecting a mother's ability to care for her newborn child effectively. [7, 8]

Several factors contribute to the risk of wound complications following a cesarean section. Patient-related factors, such as obesity, diabetes, and immune status, can significantly affect the wound healing process. Obesity and diabetes are known to compromise blood circulation and immune function, increasing the likelihood of infections and delayed healing. Age, nutritional status, and history of smoking also play roles, as each can impact the body's ability to heal and fight infections. Procedural factors, including the surgical environment, use of prophylactic antibiotics, and post-operative care, are also crucial in minimizing risks. [9, 10].

However, one factor that has garnered attention in recent years is the length of the incision used during the C-section. Incision length is particularly important because a longer incision may expose more tissue to potential contaminants, increase blood loss, and extend the time needed for healing. [5]

Studying the impact of incision length on post-operative wound complications is essential for understanding how surgical practices might be optimized to improve maternal outcomes.

By examining the relationship between incision length and wound complications, healthcare providers may be better positioned to develop guidelines that minimize risks associated with cesarean deliveries. Reducing wound complications not only benefits maternal health but also lessens the burden on healthcare resources by reducing hospital stays, follow-up procedures, and the need for additional treatments. As C-section rates continue to rise, gaining insight into factors like incision length can lead to safer and more effective surgical practices. [9]

This research is therefore critical to advancing maternal care, improving recovery outcomes, and supporting the overall health and well-being of mothers' post-cesarean delivery.

Methods

This is a prospective observational study. Before the study began, the Faculty of Medicine Ain Shams University Research Ethics Committee (FMASU REC) granted ethical

permission, and all subjects provided verbal agreement.

It was conducted in the Obstetrics and Gynecology Department at Ain Shams University Maternity Hospital, and it took 6 months to collect the required data. This study included 130 pregnant women who were scheduled for a cesarean delivery.

Using the PASS 11 program for sample size calculation, setting the confidence interval at 95% and the level of margin at 5%, it is estimated that a sample size of (111) pregnant women undergoing cesarean delivery will be required to detect an expected incidence of 7.8% of postoperative wound complications after cesarean section regarding Subramaniam et al., 2020. Assuming dropout is 15%, a sample size of at least 130 women undergoing cesarean delivery was needed.

2.1. Inclusion criteria

Pregnant women with gestational age more than 34 weeks, Women admitted for elective cesarean delivery for: previous CS, fetal mal-presentation, feto-pelvic disproportion or macrosomia, previous uterine surgery, advanced maternal age, and hypertension.

2.2. Exclusion criteria

Patients refusing to participate in the study, Women admitted for other gynecological surgeries or procedures, Women admitted for unscheduled cesarean delivery in labor or with membrane rupture for more than 4 hours, Patients with comorbidities that may affect wound healing such as DM, severe anemia, and HIV High pre-pregnancy BMI. (More than 30kg/m2), Long duration of surgery. (More than one hour), Long hospital stay. (More than 3 days), Corticosteroids administration, History of surgical site infection.

2.3. Ethical considerations

An informed oral consent explaining the procedure details was obtained from all patients before the inclusion of this study.

The study was conducted according to the stipulation and after acceptance by the ASU ethical and scientific committee.

The privacy of the participants and confidentiality of data was guaranteed during the various phases of the study.

2.4. Study procedures

- All participants with a recorded cesarean skin incision length (regardless of type of incision) were included.
- All participants received a standard prophylactic antibiotic protocol. (Cefotaxime 1gm intravenous administration 30 minutes before skin incision as a single dose)
- Surgery was conducted by a single team of surgeons at Ain-Shams University Obstetric Hospital.
- The cesarean skin incision length was measured (in centimeters) with a sterile tape just before skin closure.
- Wound depth was measured after the closure of the sheath and before the closure of the subcutaneous fat by finding the deepest point in the wound and measuring the depth using sterile tape from the bottom to the edges of the skin.
- Post-operative pain was assessed using VAS (Visual analog scale). Women were asked to point out how they felt on a scale from 1 to 10, where 1 meant no pain at all and 10 was the worst pain possible.
- Participants were observed for any post-operative wound complications such as:

I. Wound infection: presents with erythema, discharge, and induration of the incision. It could be superficial or deep and includes Abscess formation.

II. Wound separation/dehiscence.

III. Seroma or Hematoma, which is a collection of serous fluid or blood leading to wound breakdown.

IV. Local cellulitis: Diffuse skin infection,

not necessarily related to a surgical site. It can occur anywhere but may involve the area surrounding a surgical incision. Characterized by erythema, warmth, and swelling with poorly demarcated edges and mostly no discharge.

- Follow up for up to two weeks.
- Results were recorded and compared.

2.5. Study outcomes

The primary outcomes are a composite of wound complications, defined as any of the following: wound infection, and non-infectious wound morbidity.

(separation/dehiscence, seroma, hematoma, or local cellulitis) Up to 6 weeks post-partum.

The secondary outcome was postoperative pain and its degree.

Study Parameters were Wound depth, edema of the anterior abdominal wall and its type, extension of wound beyond the Rectus Abdominus muscle, distance of incision in centimeters from the Symphysis Pubis, removal of previous scar, the use of drain and the use of postoperative prophylactic antibiotics and its type.

Statistical Analysis

The collected data was revised, coded, and tabulated using the Statistical Package for Social Science (IBM Corp. Released 2017. IBM SPSS Statistics for Windows, Version 25.0. Armonk, NY: IBM Corp.). The Data was presented, and suitable analysis was done according to the type of data obtained for each parameter. The quantitative data was presented in the form of mean, standard deviation, and ranges. Qualitative variables were also given numerically and as percentages. The Kolmogorov-Smirnov and Shapiro-Wilk tests were used to examine the data for normality.

Results

The current study was executed on 130 women after cesarian section operations. They were divided into two groups according to CS incisional length:

- First group: who had CS incisional length ≤17 cm (n= 74)
- Second group: who had CS incisional length >17 cm (n= 56)

Study groups were compared according to demographic data, lesion characteristics, and relation to post-operative complications during the follow-up period. ROC curve analysis was used to measure the sensitivity and specificity of incisional length in predictions of complications. Regression analysis was performed to detect associated risk factors with postoperative complications.

Table 1: Comparison between studied groups according to obstetric history.

X2: Chi-square test, * for significant p-value (<0.05)

Variable		≤17 cm	>17cm
Number			
Parity	Nulliparous	19(25.7%)	1(1.8%)
	Primiparous	16(21.6%)	15(26.8%)
	Multiparous	39(52.7%)	40(71.4%)
Test Result	X2: 14.021, p=0.001*		

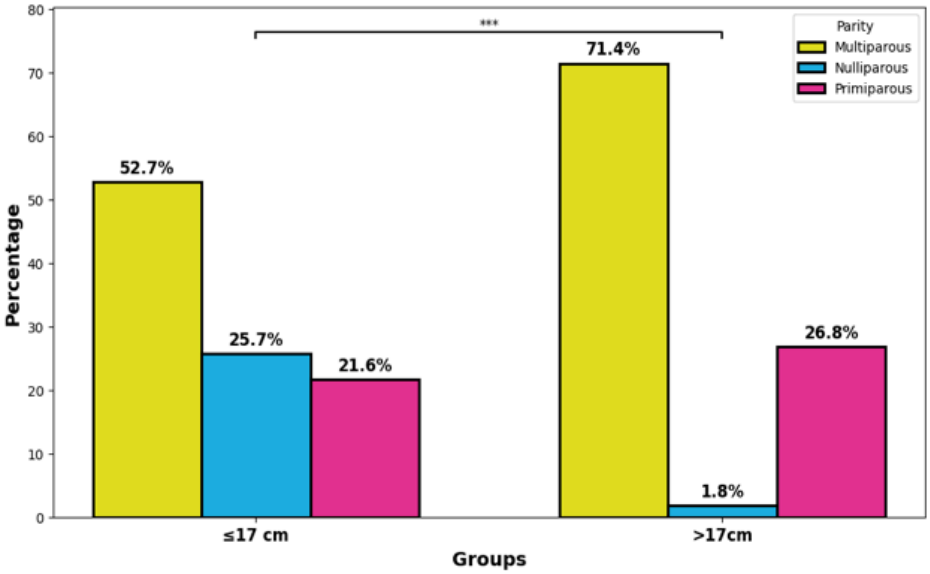

Figure 1: Comparison between groups according to parity.

Table 2: Comparison between study groups according to postoperative wound complications.

X2: Chi-square test, * for significant p-value (<0.05)

Variable		≤17 cm	>17cm	Test Result
Number		n=74	n=56	
Infection	n (%)	7(9.5%)	11(19.6%)	X2: 1.983, p=0.159
Separation/ Dehiscence	n (%)	4(5.4%)	13(23.2%)	FE: p=0.004*
Seroma/Hematoma	n (%)	1(1.4%)	9(16.1%)	FE: p=0.002*
Local cellulitis	n (%)	6(8.1%)	15(26.8%)	X2: 6.889, p=0.009*

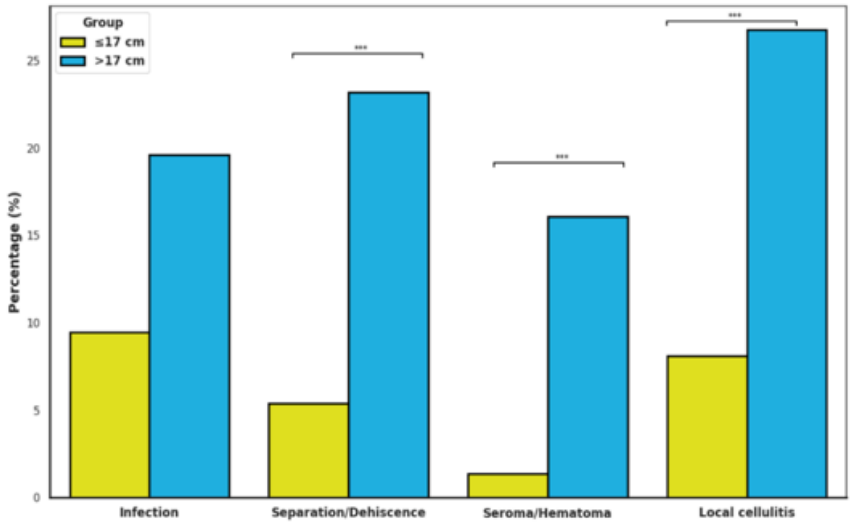

Figure 2: Comparison between study groups according to postoperative wound complications.

Table 3: Comparison between studied groups according to post-operative pain degree.

Z: Mann Whitney test

Variable		≤17 cm	>17cm	Test Result
Number		n=74	n=56	
Post-operative pain degree	Mean ± SD	6.85 ± 1.15	6.86 ± 1.12	Z: 0.056, p=0.955
	Median (Min-Max)	7.00 (4.00-9.00)	7.00 (4.00-9.00)	

Table 4: Comparison between studied groups according to wound depth.

Z: Mann Whitney test, * for significant p-value (<0.05)

Variable		≤17 cm	>17cm	Test Result
Number		n=74	n=56	
Wound Depth (cm)	Mean ± SD	3.49 ± 0.51	3.71 ± 0.57	Z: 2.050, p=0.030*
	Median (Min-Max)	3.50 (2.50-5.00)	4.00 (3.00-5.00)	

Table 5: Comparison between study groups according to wound characters.

X2: Chi-square test, * for significant p-value (<0.05)

Variable		≤17 cm	>17cm	Test Result
Number		n=74	n=56	
Edema of the anterior abdominal wall	No	74(100.0%)	56(100.0%)	X2: 0.000, p=1.000
Extension beyond Rectus Abdominus	n (%)	0(0.0%)	4(7.1%)	FE: p=0.032*
Previous Scar removal	n (%)	45(60.8%)	48(85.7%)	X2: 8.525, p=0.004*
Drain usage	n (%)	7(9.5%)	18(32.1%)	X2: 9.150, p=0.002*

Table 6: Comparison between studied groups according to distance from symphysis pubis.

Z: Mann Whitney test, * for significant p-value

Variable		≤17 cm	>17cm	Test Result
Number		n=74	n=56	
Distance from symphysis Pubis (cm)	Mean ± SD	2.22 ± 0.57	2.43 ± 0.58	Z: 2.233, p=0.015*
	Median (Min-Max)	2.00 (1.00-4.00)	2.50 (1.00-3.00)	

Table 7: Comparison between study groups according to post-operative prophylactic antibiotics.

X2: Chi-square test

Variable		≤17 cm	>17cm	Test Result
Number		n=74	n=56	
Post-operative prophylactic antibiotics	No antibiotic	19(25.7%)	8(14.3%)	X2: 2.522, p=0.283
	Local	28(37.8%)	24(42.9%)	
	Systemic	27(36.5%)	24(42.9%)	

Table 8: Value of incisional length in prediction of post-operative complications.

AUC, area under ROC curve; CI, confidence interval; *: Significant ≤0.05

Incisional length (cm)					
AUC	95% CI	p	Cut off	Sensitivity (%)	Specificity (%)
0.689	0.602 to 0.767	<0.001*	>17	69.05	69.32

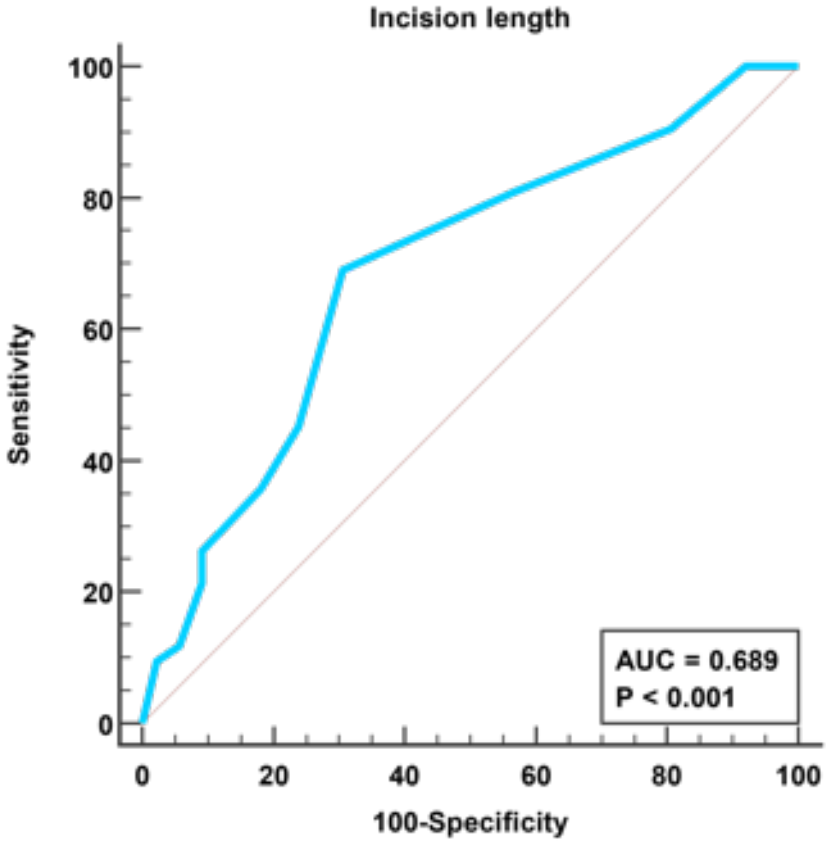

Figure 3: ROC curve analysis for prediction of postoperative wound complications

Table 9: Logistic regression analysis of risk factors associated with complications.

OR odds ratio; CI, confidence interval, *: Significant ≤0.05

Variable	p-value	OR	CI Lower 5%	CI Upper 95%
Age	0.963	1.001	0.951	1.054
Parity	0.810	1.135	0.476	2.708
Incision length	0.001*	1.321	1.148	1.519
Wound depth	0.073	1.871	1.053	3.324

- **Normality of data**

The Shapiro-Wilk test was done to evaluate the normality of data distribution.

- **Descriptive statistics:**

Mean, Standard deviation (± SD), Median, and range numerical data.

Frequency and percentage of non-numerical data.

- **Analytical statistics:**

Student T Test was used to assess the statistical significance of the difference between the two-study group means.

Mann Whitney Test (U test) was used to assess the statistical significance of the difference of a non-parametric variable between two study groups.

The chi-square test or fissure exact was used to examine the relationship between two qualitative variables.

The ROC Curve (receiver operating characteristic) provides a useful way to evaluate the sensitivity and specificity of quantitative diagnostic measures that categorize cases into one of two groups. The optimum cut-off point was defined as that which maximized the AUC value. AUC is that a test with an area greater than 0.9 has high accuracy, while 0.7–0.9 indicates moderate accuracy, 0.5–0.7, low accuracy, and 0.5 a chance result.

- **Regression analysis:**

Logistic regression analyses were used for the prediction of risk factors when the dependent variable is categorical, using generalized linear models.

An odds ratio (OR) is a measure of association between exposure and an outcome. The OR represents the odds that an outcome will occur given a particular exposure, compared to the odds of the outcome occurring in the absence of that exposure.

The 95 % confidence interval (CI) is used to estimate the precision of the OR. A large CI indicates a low level of precision of the OR, whereas a small CI indicates a higher precision of the OR.

- **Probability of results:**

A p-value is considered significant if <0.05 at a confidence interval of 95%.

Discussion

In this study, 130 women who underwent cesarean delivery were divided into two groups based on the length of their skin incision. One group had incisions shorter than 17 cm, while the other had incisions longer than 17 cm.

As shown in Table 2, there was a notable difference in wound complications between the two groups, with longer incisions linked to an increased likelihood of post-operative complications.

Although infection rates between the groups

were similar, with a P-value of 0.159 (not reaching the significance threshold of 0.05), other complications, such as local cellulitis, were significantly associated with incision length, suggesting that while incision size may not significantly affect SSI risk, it does influence the likelihood of other wound issues.

Nagaria et al., however, observed different findings, showing that in a study of 1,215 women, a cut-off incision length of 14.7 cm was associated with sensitivity and specificity rates of 74% and 90.9% respectively for predicting SSI. 12

Subramaniam et al. provided additional insight, indicating no independent correlation between incision length and either infectious or non-infectious wound complications. 5

Their analysis, conducted on a larger cohort of 2,013 women, divided by incision lengths into groups under 14 cm and over 16.5 cm, found no association between incision size and wound issues, suggesting that factors beyond incision length might play a role in wound healing outcomes. 5

De Vivo et al. also explored this factor in 212 women and found that incisions greater than 16.6 cm were associated with higher risks for complications, attributing this to increased tissue exposure and disruption during surgery. 11

Table 4 compares wound depth across study groups. For the group with an incisional length of ≤17 cm, the mean wound depth is 3.49 cm, with a standard deviation of 0.51 cm. Conversely, the group with an incisional length >17 cm shows a higher mean wound depth of 3.71 cm and a standard deviation of 0.57 cm. Statistical analysis indicates a significant difference in wound depth between the two groups.

In Table 5, it highlights a comparison of wound characteristics between the study groups. Both groups exhibit a 100.0% absence of edema in the anterior abdominal wall. However, exact statistical tests reveal significantly higher frequencies in the >17 cm incisional length group for extension beyond the rectus abdominis, previous scar removal, and drain usage.

Meanwhile, a comparison of the study groups according to the distance from the symphysis pubis is shown in Table 6. In the group with an incisional length of ≤17 cm, the mean distance is 2.22 cm with a standard deviation of 0.57 cm. In contrast, in the group with an incisional length >17 cm, the mean distance is slightly higher at 2.43 cm with a standard deviation of 0.58 cm. Statistical analysis indicates a significantly greater distance from the symphysis pubis in the >17 cm incisional length group.

Additionally, Table 7 presents a comparison of postoperative prophylactic antibiotic administration between the study groups. Among participants with an incisional length of ≤17 cm, 25.7% received no antibiotics, 37.8% were given local antibiotics, and 36.5% received systemic antibiotics. Similarly, in the group with an incisional length >17 cm, 14.3% received no antibiotics, 42.9% were administered local antibiotics, and 42.9% received systemic antibiotics. The chi-square test shows no significant difference in the distribution of antibiotic administration methods between the two groups.

Subsequently, Table 8 and Figure 3 demonstrate the value of incision length in predicting possible post-operative wound complications with a cut-off value of 17cm. A sensitivity of 69.05% and specificity of 69.32% is calculated.

On the other hand, the De Vivo study highlighted 16.6 cm as an optimal incision cut-off point for sensitivity and specificity at 68%.11.

Further analyses in this study showed no significant differences in post-operative pain between the incision groups, as shown in Table 3.

Similarly, Nicholls-Dempsey et al. found no correlation between incision length and

pain in a study of 107 women, with incision lengths ranging from 13 to 22 cm.12.

In contrast, Clifford et al. suggested that larger incisions might correlate with higher pain scores, though further validation is needed due to their smaller sample size. 14

Interestingly, patient demographics such as parity influenced incision size; Table 1 and Figure 1 show that women with multiple previous deliveries tended to have longer incisions, a finding consistent with Ulubay et al., who also reported a positive correlation between parity and incision length. 15

In summary, Table 9 underscores incision length as a significant predictor of postoperative wound complications, with parameters such as parity, age, and wound depth showing no significant association. Overall, these findings contribute valuable insights into the role of incision length in post-cesarean wound outcomes, warranting further research to optimize surgical practices and reduce complication rates.

Conclusion

There is an association between longer cesarean incision length and higher rates of post-operative wound complications. While infection rates were unaffected, incision length remains a significant factor in wound management. Future research could refine guidelines to help reduce wound-related risks in cesarean deliveries.

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References

1. WHO, Caesarean section rates continue to rise, amid growing inequalities in access, World Health Organization, 2021.
2. Gad MM, Mohamed AA, Abd El-Galil HM, Mahgoub MM, Ghazy SM, Elsafty MS. Pattern of cesarean deliveries among women in an urban and rural district in Egypt. Afr Health Sci. 2022 Dec;22(4):375-385.
3. Subramaniam A, et al., The Association of Cesarean Skin Incision Length and Postoperative Wound Complications. Am J Perinatol. 2022 Apr;39(5):539-545.
4. Boggess KA, Tita A, Jauk V, Saade G, Longo S, Clark EAS, Esplin S, Cleary K, Wapner R, Letson K, Owens M, Blackwell S, Beamon C, Szychowski JM, Andrews W; Cesarean Section Optimal Antibiotic Prophylaxis Trial Consortium. Risk Factors for Postcesarean Maternal Infection in a Trial of Extended-Spectrum Antibiotic Prophylaxis. Obstet Gynecol. 2017 Mar;129(3):481-485.
5. Słabuszewska-Jóźwiak, A.; Szymański, J.K.; Jóźwiak, Ł.; Sarecka-Hujar, B. A Systematic Review and Meta-Analysis of Wound Complications after a Caesarean Section in Obese Women. J. Clin. Med. 2021, 10, 675. https://doi.org/10.3390/jcm10040675
6. Carbonnel M, Brot D, Benedetti C, Kennel T, Murtada R, Revaux A, Ayoubi JM. Risk factors FOR wound complications after cesarean section. J Gynecol Obstet Hum Reprod. 2021 Sep;50(7):101987.
7. Kawakita T, Landy HJ. Surgical site infections after cesarean delivery: epidemiology, prevention, and treatment. Matern Health Neonatol Perinatol. 2017 Jul 5;3:12.
8. Gillespie BM, Ellwood D, Thalib L, Kumar S, Mahomed K, Kang E, Chaboyer W. Incidence, and risk factors for surgi-

cal wound complications in women with body mass index >30 kg/m2 following cesarean delivery: a secondary analysis. AJOG Glob Rep. 2022 Jul 4;2(3):100069.

9. Armstrong D, Risk factors for impaired wound healing and wound complications, UpToDate, 2023
10. Jahan, F., Begum, F., Islam, F., Pervin, S. and Goodman, A. (2019) Risk Factors for Wound Infection Following Caesarean Section: A Case-Control Study from Sir Salimullah Medical College & Mitford Hospital in Dhaka, Bangladesh. Open Journal of Obstetrics and Gynecology, 9, 904-913.
11. De Vivo A, Mancuso A, Giacobbe A, Priolo AM, De Dominici R, Maggio Savasta L. Wound length and corticosteroid administration as risk factors for surgical-site complications following cesarean section. Acta Obstet Gynecol Scand. 2010 Mar;89(3):355-9.
12. Nagaria T, Kujur A, Thakur N. Incision length: an emerging risk factor for surgical site infection following cesarean section. Int J Reprod Contracept Obstet Gynecol 2017; 6:1829-33
13. Nicholls-Dempsey, Laura; Abenhaim, Haim MD, MPH, FRCSC. Cesarean Section Incision Length and Post-Operative Pain [34R]. Obstetrics & Gynecology 133(): p 200S, May 2019.
14. Clifford J. et al., Does size matter? Correlation between incisional length and post-operative pain for cesarean deliveries. Mesentery and Peritoneum, North America, 6 May. 2022
15. Ulubay, Mustafa, et al. "Skin Incision Lengths in Caesarean Section." Cukurova Medical Journal, vol. 41, no. 1, 2016, pp. 82-86, doi:10.17826/cutf.147190