Original Article

Original Article

Prevalence of surgical site infections in Gulf Cooperation Council countries: A systematic review and meta-analysis

Seba T. Al-Gunaid[1*], Derren DCH. Rampengan[2], Jomana B. Khadra[3], Aya T. Elgohari[4], Rim M. Mouzhir[5], Abdulrahman A. Alzahrani[6], Mousab MAH. Osman[7], Zahra A. Alabbad[8], Muhammad A. Adista[9], Sami A. Al-Dubai[10] and Layan K. Aleid[11]

[1]Faculty of Medicine, Universitas Syiah Kuala, Banda Aceh, Indonesia; [2]Faculty of Medicine, Universitas Sam Ratulangi, Prof. Dr. R. D. Kandou Central General Hospital, Manado, Indonesia; [3]Ministry of Health, AL Khobar, Saudi Arabia; [4]Department of Emergency, Al-Yossif Hospital, AL Khobar, Saudi Arabia; [5]Department of Emergency Medicine, Dr. Sulaiman Alhabib Medical Center, AL Khobar, Saudi Arabia; [6]Ministry of Health, Eastern Health Cluster, Dammam, Saudi Arabia; [7]Department of Emergency Medicine, Wecare Hospital, Dammam, Saudi Arabia; [8]Faculty of Medicine, University of Jeddah, Jeddah, Saudi Arabia; [9]Department of Medical Education, Universitas Syiah Kuala, Banda Aceh, Indonesia; [10]Postgraduate Program, Department of Preventive Medicine, Al Madinah Health Cluster, Al Madinah Al Munawarah, Saudi Arabia; [11]Department of Central Sterile Supply, King Fahad Specialist Hospital, Dammam, Saudi Arabia

*Corresponding author: sebagunaid@gmail.com

Abstract

Surgical site infections (SSIs) rank among the most prevalent healthcare-associated infections, leading to higher patient morbidity, extended hospitalizations, and increased healthcare expenses. Despite advancements in surgical practices within the Gulf Cooperation Council (GCC) nations, information on SSI prevalence remains fragmented and inconsistent. The aim of this study was to determine the overall prevalence of SSIs in GCC countries and to assess variations according to surgical procedure type. A systematic search of PubMed, PubMed Central (PMC), ScienceDirect, and Google Scholar was conducted for studies reporting SSI prevalence in the six GCC countries up to May 2025. The quality of the study was evaluated using the Newcastle-Ottawa Scale. Pooled prevalence estimates were calculated using a random effects model, with subgroup analyses performed based on surgical procedure type. A total of 23 studies involving 32,366 patients were included in the analysis. The overall pooled prevalence of SSIs was 7% (95%CI: 4–10%; I^2=92.9%), which suggests a significant level of variability. The highest SSI prevalence was observed in coronary artery bypass graft (CABG) procedures (42%), followed by colorectal surgeries (28%) and coronary artery surgeries (18%). Lower prevalence rates were reported for laparotomies (2%) and cholecystectomies (1%). Caesarean section, the most frequently reported procedure (n=12,419), had an SSI prevalence of 3% (95%CI: 2–4%; I^2=84.5%). Smaller studies tended to report higher SSI prevalence estimates. In conclusion, the elevated incidence of SSIs in high-risk procedures, particularly CABG and colorectal surgeries, highlights the necessity for enhanced regional surveillance systems and targeted preventive measures across GCC healthcare settings.

Keywords: Surgical site infections, Gulf Cooperation Council, single-arm meta-analysis, caesarean section, surgical procedures

Introduction

Surgical site infections (SSIs) continue to be a leading cause of postoperative morbidity and mortality worldwide, affecting approximately 9.9% of surgical procedures, with over 141,000

Received: December 5, 2025 - Revised: December 29, 2025 - Accepted: January 21, 2026 - Published online: January 27, 2026

infections documented annually in studies encompassing more than 1.4 million operations. Notably, 60.1% of SSIs occur after hospital discharge, contributing to prolonged hospitalization, increased healthcare expenses, and poor patient outcomes [1-3]. While global efforts have focused on improving surgical care and infection control protocols, the prevalence of SSIs varies significantly among locations, owing to disparities in healthcare infrastructure, surgical techniques, and infection prevention strategies [1,4-6].

The Gulf Cooperation Council (GCC) countries, which include Saudi Arabia, the United Arab Emirates, Kuwait, Oman, Qatar, and Bahrain, have seen remarkable advances in healthcare delivery in recent decades [7,8]. However, the area continues to encounter obstacles in systematic reporting and surveillance of healthcare-associated infections, including SSI [9-13]. Existing research from the Gulf nations reveals that SSI rates vary, with some studies showing prevalence rates equal to worldwide norms and others revealing higher-than-expected rates, frequently due to unclear definitions, inadequate resources, and underreporting [14,15].

While individual studies in the GCC countries have reported varying SSI rates, a pooled estimate has not been established. For example, SSI prevalence in Ethiopia was found to be as high as 25.22%, while a study in Pakistan reported an incidence of 8.84% [16,17]. These differences highlight the need for a focused analysis of SSI prevalence, particularly in the GCC countries. The aim of this study was to analyze and synthesize current data on the prevalence of surgical site infections in Gulf nations, allowing for a better understanding of the regional burden and identifying possible areas for targeted intervention and study.

Methods

Study design and protocol registration

This study was conducted as a systematic review and meta-analysis in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. A pre-established protocol was created prior to study initiation to guide the search strategy, study selection, data extraction, and quality assessment processes. The protocol was prospectively registered in the International Prospective Register of Systematic Reviews (PROSPERO) under the registration number CRD420251165318.

Literature search strategy

A comprehensive search was conducted across multiple electronic databases, including PubMed, PubMed Central (PMC), ScienceDirect, and Google Scholar. The search approach utilized relevant terms such as “surgical site infection,” “SSI,” “GCC,” and “prevalence” combined with Boolean operators (AND/OR) to enhance sensitivity and guarantee a comprehensive collection of qualifying studies. The search was completed on May 20, 2025, and additional pertinent articles were identified through manual screening of the reference lists of the included studies.

Inclusion and exclusion criteria

This review included observational studies reporting the incidence of SSIs and related clinical results in GCC nations. Eligible study designs comprised cohort, cross-sectional, case–control, and case series studies. Review papers, editorials, individual case reports, and conference abstracts were excluded.

Screening and selection

After automatic removal of duplicate records using EndNote 19, study screening was carried out in two stages. The initial stage involved screening of titles and abstracts, followed by full-text assessment in the second stage. Two independent reviewers (SA and AA) performed the screening and eligibility assessments. Discrepancies were resolved through discussion, and when consensus could not be reached, a third reviewer (JK) was consulted to make the final decision.

Data extraction

Data were collected from the selected studies, including author names, year of publication, study setting, and study design, as well as information on surgical procedures and reported SSI prevalence. All reported outcomes were extracted as presented, without additional data transformation. Statistical significance was interpreted based on the analyses reported in the original study, with a p-value<0.05 considered statistically significant.

Critical appraisal

Two reviewers (AA and MO) independently assessed the methodological quality of the included studies. For observational studies, quality assessment was performed using the Newcastle-Ottawa Scale (NOS), which evaluates studies across three domains: selection, comparability, and outcome. Discrepancies between reviewers were resolved through discussion, and when necessary, a third reviewer (RM) was consulted to reach a final decision.

Qualitative synthesis

Given the substantial heterogeneity across studies (I^2=92.9%), a random-effects meta-analysis was applied to account for between-study variability. Subgroup analyses by surgical procedure were conducted to explore potential sources of heterogeneity. Although high heterogeneity persisted within several subgroups, this approach is consistent with methodological recommendations for prevalence meta-analyses involving heterogeneous observational data. Hence, the results were summarized through qualitative methods.

Results

Search results

The initial search across four electronic databases identified 2,089 records, including 603 from PubMed, 1,005 from Google Scholar, 204 from ScienceDirect, and 277 from PMC. Following titles and abstracts screening, 978 records were excluded, and 816 articles were retrieved for full-text review. Of these, 295 articles underwent detailed eligibility assessment. Ultimately, 23 studies met the inclusion criteria and were incorporated into the qualitative synthesis [9-12,18-35]. The study selection process is outlined in the PRISMA flow diagram (**Figure 1**).

Characteristics of the included studies

The characteristics of the included studies investigating SSI prevalence across different surgical procedures and countries in the Gulf region are presented in **Table 1**. Most studies employed a cohort design, with two case series and one case-control study. Sample sizes varied widely, ranging from 48 to 8,301 participants. The surgical procedures evaluated included general surgery, caesarean sections, cardiac and vascular surgeries, and orthopedic operations. Reported SSI prevalence ranged from 0.9% to 42%, with higher rates observed in procedures such as colorectal cancer surgery and CABG, particularly in case-control and smaller cohort studies.

Quality of included studies

The methodological quality of the included studies, assessed using the NOS, is presented in **Table 2**. A total of 23 cohort studies were evaluated, the majority of which employed a cohort design. Seven studies were rated as "Good quality," achieving NOS scores of 7 out of 9. These included AlRiyami *et al.* (2022) [18], Zaky *et al.* (2020) [24], Gadeer *et al.* (2020) [25], Dhar *et al.* (2014) [10], Alfouzan *et al.* (2019) [9], Almajed *et al.* (2024) [32], and M. Al Majid *et al.* (2020) [33]. The remaining studies received NOS scores ranging from 5 to 6 and were considered "Fair quality", including studies by Alotaibi *et al.* (2020) [19], Alwehibi *et al.* (2024) [20], and Garcell *et al.* (2025) [11], among others. Two studies–Alsiddiky *et al.* (2013) [26] and Abuzaid *et al.* (2015) [30]– used cross-sectional and case-control designs, respectively. The majority of included cohort studies demonstrated acceptable methodological quality, supporting the reliability of the findings.

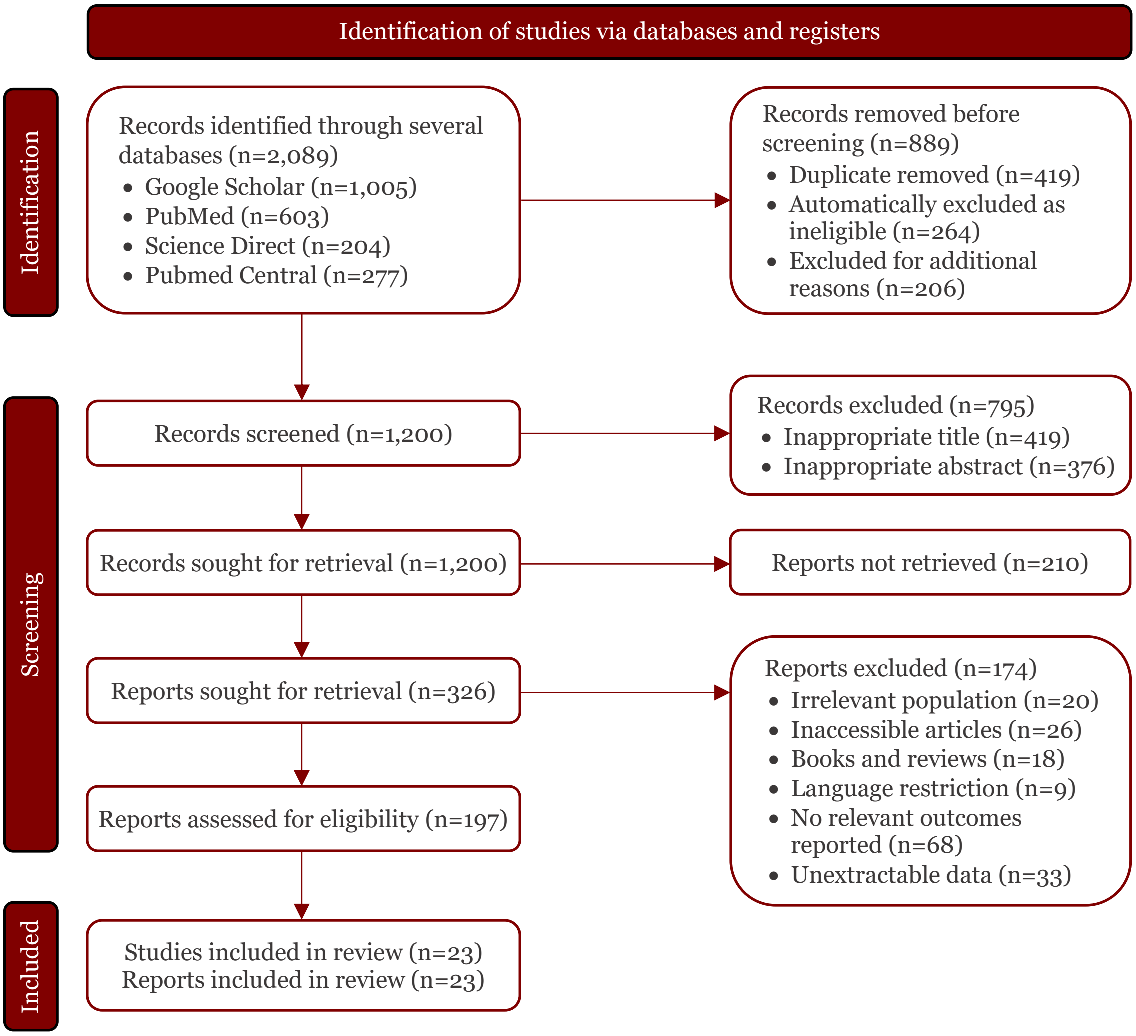

Figure 1. PRISMA flow diagram of the study selection process.

Prevalence of SSIs

Across 23 studies (n=32,366), the pooled prevalence of SSIs was 7% (95%CI: 4–10%) using a random-effects model, with substantial heterogeneity observed (I^2=92.9%; τ^2=0.0052; p<0.0001) as presented in **Figure 2**. Significant differences were observed between surgical procedures (χ^2=216.59; df=16; p<0.0001). Procedure-specific pooled or single-study prevalence estimates were as follows: general surgery, 5% (95%CI: 2–8%; I^2=84.4%; n=1,639); vascular surgery, 11% (95%CI: 9–14%; I^2=0%; n=717); appendectomy, 3% (95%CI: 1–4%; I^2=68.4%; n=3,066); herniorrhaphies, 3% (95%CI: 2–4%; n=751); caesarean section, 3% (95%CI: 2–4%; I^2=84.5%; n=12,419); oral and maxillofacial surgery, 10% (95%CI: 8–13%; n=493); orthopedic surgery, 6% (95%CI: 0–12%; I^2=97.5%; n=4,018); spinal fusion, 4% (95%CI: 1–14%; n=48); stoma-related procedures, 12% (95%CI: 7–19%; n=123); laparotomy, 2% (95%CI: 2–2%; n=7,235); colorectal cancer surgery, 28% (95%CI: 19–39%; n=92); CABG, 42% (95%CI: 32–54%; n=80); mixed cardiac surgery, 3% (95%CI: 2–4%; n=1,241); cholecystectomy, 1% (95%CI: 0–3%; n=340); and coronary artery surgery (non-CABG), 18% (95%CI: 11–27%; n=104). Funnel plot inspection demonstrated visible asymmetry suggestive of small-study effects; however, given the substantial heterogeneity, this finding should be interpreted cautiously rather than as publication bias alone.

Table 1. Bassline characteristics of the included studies

Author, year	Country	Study design	Intervention	Sample size	Outcomes SSI (%)
AlRiyami *et al.* 2022 [18]	Oman	Cohort	Coronary artery surgery	104	17.5
Alotaibi *et al.* 2020 [19]	Saudi Arabia	Cohort	General surgery	120	1.7
Alwehibi *et al.* 2024 [20]	Saudi Arabia	Cohort	Vascular surgeries	624	11.4
Garcell *et al.* 2025 [11]	Qatar	Cohort	Appendectomies	2,463	2.19
Garcell *et al.* 2025 [11]	Qatar	Cohort	Herniorrhaphies	751	2.53
Garcell *et al.* 2025 [11]	Qatar	Cohort	Caesarean	1,913	2.56
Alharbi *et al.* 2023 [21]	Saudi Arabia	Cohort	Vascular surgeries	93	9.1
Alkhamis *et al.* 2024 [22]	Saudi Arabia	Cohort	Oral and maxillofacial surgeries	493	10.3
Aleid *et al.* 2024 [2]	Saudi Arabia	Cohort	General surgery	1,219	7.4
Al-Rashdi *et al.* 2020 [23]	Oman	Cohort	Orthopedic surgery	922	8.57
Zaky *et al.* 2020 [24]	Saudi Arabia	Cohort	General surgery	300	3.67
Gadeer *et al.* 2020 [25]	Saudi Arabia	Cohort	Caesarean	340	3.4
Alsiddiky *et al.* 2013 [26]	Saudi Arabia	Cross sectional	Spinal fusion	48	4.16
Alqarni *et al.*2023 [27]	Saudi Arabia	Cohort	Stoma	123	11.4
Dhar *et al.* 2014 [10]	Oman	Cohort	Caesarean	211	2.66
Chowdhury *et al.* 2019 [28]	Saudi Arabia	Cohort	Caesarean	70	12.9
Alfouzan *et al.* 2019 [9]	Kuwait	Cohort	Laparotomy	7,235	2.1
Aldriwesh *et al.* 2023 [29]	Saudi Arabia	Cohort	Colorectal Cancer	92	27.2
Abuzaid *et al.* 2015 [30]	Bahrain	Case control	CABG	80	42
Garcell *et al.* 2017 [31]	Qatar	Cohort	Appendectomies	603	3.6
Almajed *et al.* 2024 [32]	Bahrain	Cohort	Caesarean	8,301	2.1
M. Al Majid *et al.* 2020 [33]	Saudi Arabia	Cohort	Cardiac surgery	1,241	3.2
Al-Mulhim *et al.* 2014 [34]	Saudi Arabia	Cohort	Orthopedic surgery	3,096	2.55
Ghnnam *et al.* 2010 [12]	Saudi Arabia	Cohort	Cholecystectomy	340	0.9
Albaharnah *et al.* 2024 [35]	Saudi Arabia	Cohort	Caesarean	1,584	4.7

Table 2. Critical appraisal using Newcastle-Ottawa Scale (NOS)

Author, year (ref.)	Study design	Selection	Comparability	Outcome	Total score	Remark
AlRiyami *et al.* 2022 [18]	Cohort	★★★	★	★★★	7	Good quality
Alotaibi *et al.*2020 [19]	Cohort	★★	★	★★	5	Fair quality
Alwehibi *et al.* 2024 [20]	Cohort	★★	★	★★★	6	Fair quality
Garcell *et al.* 2025 [11]	Cohort	★★	★	★★★	6	Fair quality
Alharbi *et al.*2023 [21]	Cohort	★★	★	★★★	6	Fair quality
Alkhamis *et al.* 2024 [22]	Cohort	★★	★	★★★	6	Fair quality
Aleid *et al.* 2024 [2]	Cohort	★★	★	★★★	6	Fair quality
Al-Rashdi *et al.* 2020 [23]	Cohort	★★	★	★★★	6	Fair quality
Zaky *et al.* 2020 [24]	Cohort	★★★	★	★★★	7	Good quality
Gadeer *et al.* 2020 [25]	Cohort	★★★	★	★★★	7	Good quality
Alsiddiky *et al.* 2013 [26]	Cross sectional	★★	★	★★	5	Fair quality

Al-Gunaid et al. Narra X 2026; 4 (1): e243 - http://doi.org/10.52225/narrax.v4i1.243

Author, year (ref.)	Study design	Selection	Comparability	Outcome	Total score	Remark
Alqarni *et al*. 2023 [27]	Cohort	★★	★	★★★	6	Fair quality
Dhar *et al*. 2014 [10]	Cohort	★★★	★	★★★	7	Good quality
Chowdhury *et al*. 2019 [28]	Cohort	★★	★	★★★	6	Fair quality
Alfouzan *et al*. 2019 [9]	Cohort	★★★	★	★★★	7	Good quality
Aldriwesh *et al*. 2023 [29]	Cohort	★★	★	★★	5	Fair quality
Abuzaid *et al*. 2015 [30]	Case control	★★	★	★★	5	Fair quality
Garcell *et al*. 2017 [31]	Cohort	★★	★	★★★	6	Fair quality
Almajed *et al*. 2024 [32]	Cohort	★★★	★	★★★	7	Good quality
M. Al Majid *et al*. 2020 [33]	Cohort	★★★	★	★★★	7	Good quality
Al-Mulhim *et al*. 2014 [34]	Cohort	★★	★	★★	5	Fair quality
Ghnnam *et al*. 2010 [12]	Cohort	★★	★	★★	5	Fair quality
Albaharnah *et al*. 2024 [35]	Cohort	★★	★	★★★	6	Fair quality

Al-Gunaid et al. Narra X 2026; 4 (1): e243 - http://doi.org/10.52225/narrax.v4i1.243

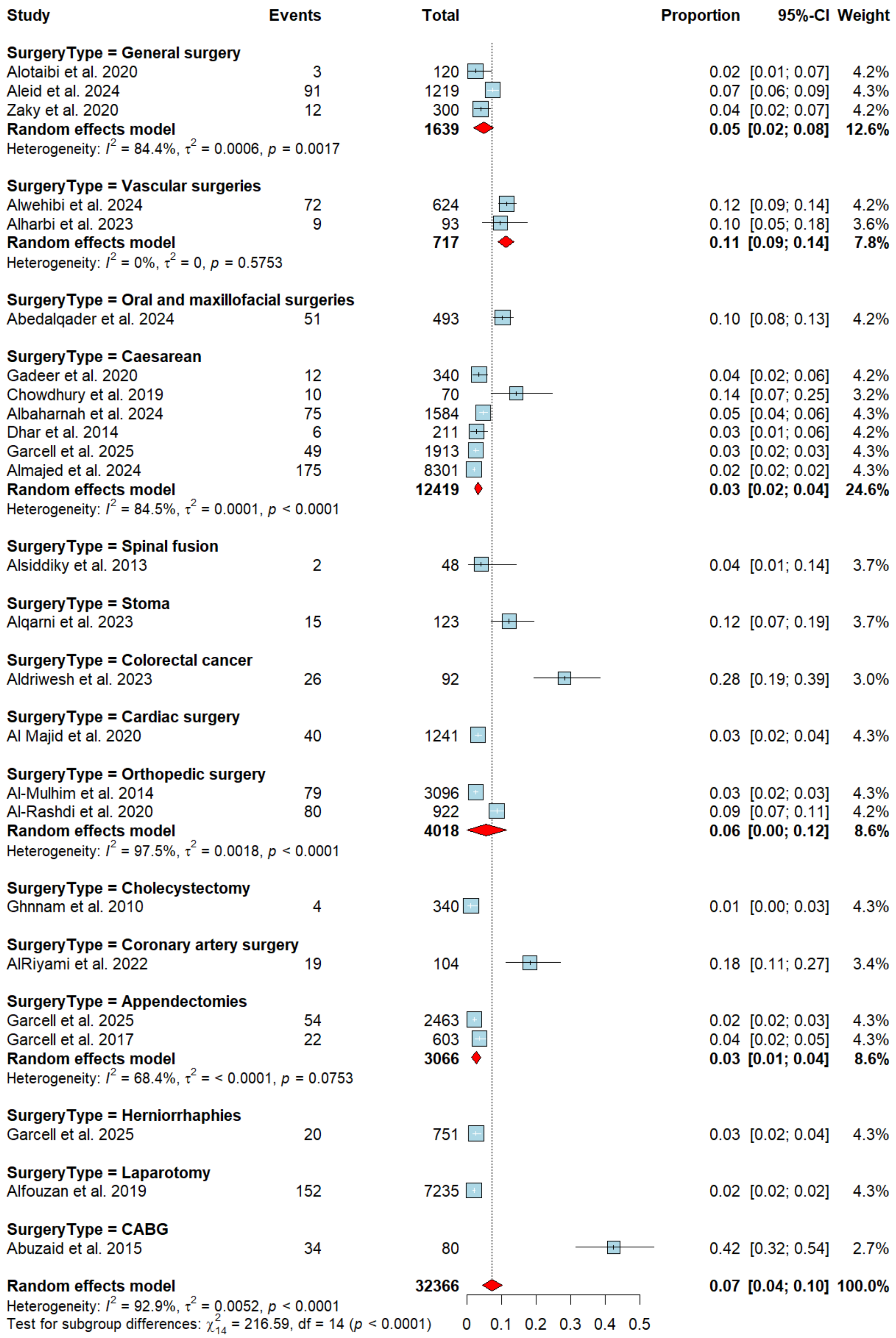

Figure 2. Forest plot of surgical site infection prevalence across included studies, with random effects pooled estimates overall and by surgical procedure.

Subgroup analysis by surgery type

Subgroup analysis revealed statistically significant differences in SSI prevalence according to surgical procedure (χ^2=216.59; *df*=16; *p*<0.001). The highest SSI prevalence was observed in coronary artery surgery (18%; 95%CI: 0.11–0.27), colorectal surgery (28%; 95%CI: 0.19–0.39), and CABG (42%; 95%CI: 0.32–0.54). In contrast, cholecystectomy and laparotomy had the lowest reported SSI rates, with pooled estimates of 0% and 5%, respectively. Caesarean sections, which constituted the most commonly studied surgical type (n=12,419), showed a pooled SSI prevalence of 3% (95%CI: 0.02–0.04), although heterogeneity within this subgroup remained high (I^2=84.5%, *p*<0.0001).

Several subgroups, such as vascular surgeries and appendectomies, showed more consistent estimates with minimal heterogeneity (I^2=0% and 68.4%, respectively). However, substantial heterogeneity was noted in other subgroups, including orthopedic surgeries (I^2=97.5%). The mixed-effects meta-regression showed no evidence that the examined moderator significantly influenced effect sizes ($Q_m(1)$=0.08; *p*=0.78). Residual heterogeneity was negligible (τ^2=0; I^2=0%), indicating that effect size variability was fully attributable to sampling error. The moderator explained none of the between-study variance (R^2=0%).

Publication bias

Publication bias was assessed using visual inspection of the funnel plot and Egger's regression test. The funnel plot demonstrated noticeable asymmetry, with smaller studies tending to report higher SSI prevalence, while studies with lower SSI estimates appeared underrepresented. This pattern suggests the presence of small study effects and raises the possibility of publication or selective reporting bias (**Figure 3**).

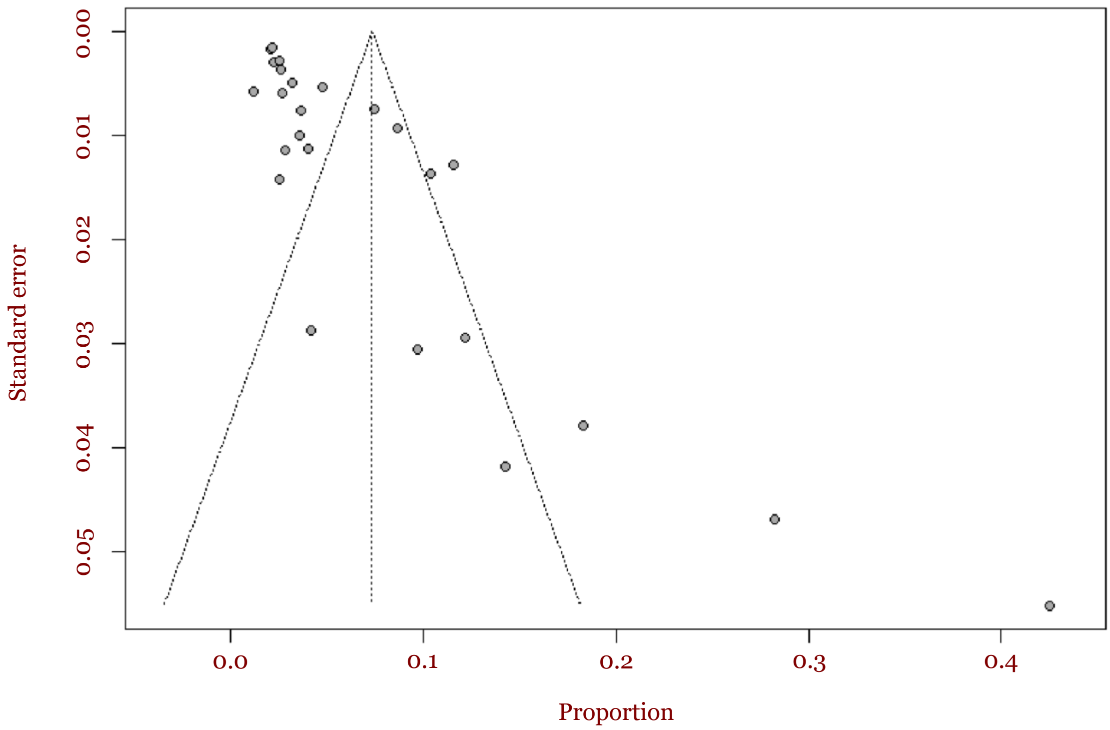

Figure 3. Funnel plot for the meta-analysis of surgical site infection (SSI) prevalence, assessing small study effects.

However, given the substantial between-study heterogeneity across the included studies, funnel plot asymmetry should be interpreted with caution, as heterogeneity itself can contribute to plot distortion (**Figure 4**). Egger's regression test indicated significant funnel plot asymmetry (t=5.84; df=23; *p*<0.0001), suggesting the presence of small study effects consistent with publication bias. Therefore, although publication bias cannot be excluded, the observed asymmetry is more likely to reflect a combination of methodological variability, differences in surgical procedures, and study size rather than publication bias alone.

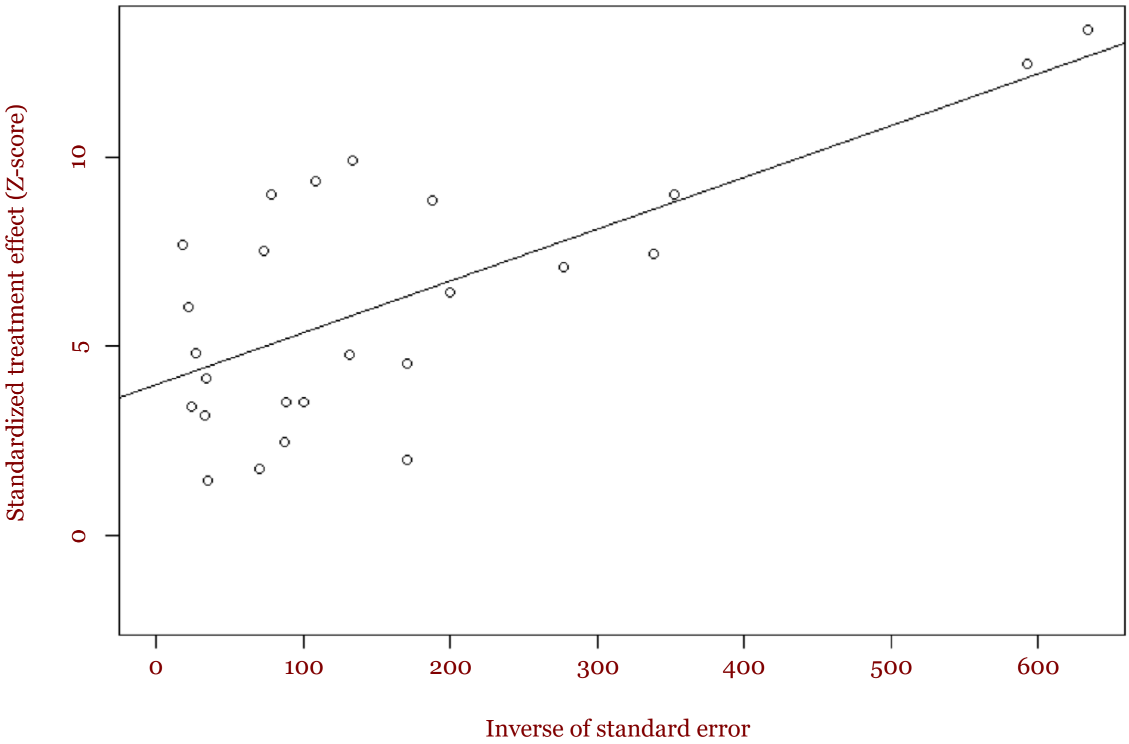

Figure 4. Funnel plot for meta-analysis of surgical site infection prevalence, with Egger's regression line, assessing small study effects.

Discussion

This study synthesizes data from 23 studies that assess the occurrence of SSIs in various surgical procedures. The overall prevalence of SSIs was calculated to be 7% using a random-effects model, which accounts for the differences among studies. The significant level of heterogeneity between studies indicates substantial variation in SSI rates, likely resulting from factors such as differences in healthcare infrastructure, patient populations, surgical techniques, and infection prevention strategies.

Several studies have highlighted factors that contribute to the risk of SSIs and may explain the variability observed across investigations. Factors related to the patient, including low body mass index, diabetes, obesity, smoking, and prior chemotherapy or radiotherapy, have been repeatedly linked to a higher prevalence of SSIs. For instance, individuals undergoing surgeries for spinal fusion and hysterectomy showed significantly increased infection risks when these comorbid conditions were present in previously conducted studies [36,37]. These results underscore the necessity of optimizing patient health before surgery to minimize postoperative complications.

Factors related to surgical procedures are also important contributors to the risk of SSIs. The implementation of wound protectors has been demonstrated to significantly lower infection rates in gastrointestinal surgeries [38,39]. On the other hand, minimally invasive techniques like laparoscopic surgery tend to result in reduced infection rates when compared to traditional open surgeries. Various preventive measures, such as following evidence-based guidelines for antibiotic prophylaxis, maintaining strict control of blood sugar levels, and using effective skin antisepsis methods (for example, choosing chlorhexidine-alcohol over iodine-based alternatives), have further proven to lead to notable declines in SSI prevalence [40-43]. Additionally, there is notable variability based on the specific procedure; studies on caesarean sections, for example, showed that SSI rates fell from 27% to 14%, primarily due to variations in postoperative care practices and the criteria used to define SSIs [44]. These differences highlight the necessity for standardized perioperative protocols and surveillance definitions to achieve more uniform and comparable outcomes across various healthcare settings.

Al-Gunaid et al. Narra X 2026; 4 (1): e243 - http://doi.org/10.52225/narrax.v4i1.243

The analysis of subgroups in the meta-analysis reveals marked differences in the occurrence of SSIs among various surgical procedures. Specifically, the highest rates of SSIs were found in coronary artery bypass grafting (42%), followed by colorectal surgery (28%) and general coronary artery surgery (18%). These operations are often complicated and drawn-out, typically involving older or critically ill individuals, who naturally possess a greater susceptibility to SSIs. This is consistent with earlier studies indicating that factors such as extended surgical durations and patient underlying conditions, including older age and critical health issues, elevate the risk of SSIs [45-48].

On the other hand, procedures like cholecystectomy and laparotomy demonstrated lower rates of SSIs. This variation is likely a reflection of differences in the complexity of surgeries, infection control measures, and the methodologies employed in the studies. Additionally, these procedures may be performed on patients who tend to be healthier or younger, which further decreases the risk [40,49].

Caesarean sections, constituting the largest group in this analysis (n=12,419), exhibited a relatively low prevalence of surgical site infections (3%). However, the considerable heterogeneity (I^2=84.5%) within this subgroup suggests significant variability in methodology or context, which could be related to differing antibiotic protocols [50]. For example, a study revealed that the prophylactic use of cefepime notably decreased instances of both superficial and deep SSI incidences compared to ampicillin/sulbactam following caesarean delivery [44].

Moreover, variations in skin preparation protocols can influence infection rates, as underscored by guidelines for administering pre-incision antibiotic prophylaxis and properly preparing the vagina with iodine-povidone solution [51]. These perioperative approaches are essential for reducing infection risks and improving surgical results.

Factors related to patients, including obesity and diabetes, also play a major role in the variability of SSIs. The prevalence of these conditions varies across populations, thereby influencing the overall risk profile for infections. For instance, studies from Ethiopia have shown that prolonged labor, anemia, and chorioamnionitis are associated with increased SSI rates, highlighting the impact of patient health on surgical results [52,53].

Orthopedic surgeries show a high degree of variability (I^2=97.5%). This significant heterogeneity can be linked to variations in implant usage, wound categorization, and the distinctions between superficial and deep SSIs. For example, orthopedic procedures frequently involve implants, which heighten infection risks by serving as a breeding ground for microbial growth [54]. Additionally, the intricate nature of operations like bone tumor surgeries, which entail lengthy surgical durations and the implementation of implants, further escalates the considerable variability observed in SSIs associated with orthopedic surgeries [55,56]. Overall, this research emphasizes the persistent challenge posed by SSIs, despite progress in surgical methods and infection prevention strategies. The present study results reinforce prevailing theories that intricate surgical procedures, critical patient conditions, and variable perioperative practices heighten the risk of SSIs [16,17]. Furthermore, these findings underscore the necessity for uniform SSI definitions, consistent monitoring protocols, and thorough postoperative care.

The results of this study highlight the need to consider both patient-related factors and procedure-specific characteristics when developing strategies to prevent SSIs. Targeted interventions, such as optimizing patient health prior to surgery, utilizing minimally invasive surgical methods, standardizing perioperative procedures, and implementing evidence-based infection control bundles, can lessen the incidence of SSIs and enhance patient outcomes. Additionally, standardizing definitions and monitoring practices for SSIs across different institutions is crucial for enabling meaningful comparisons and for improving global standards.

Despite advances in surgical methods and infection prevention, SSIs continue to pose a major challenge, especially in intricate and high-risk operations. Future studies should concentrate on overlooked surgical groups and environments in low- and middle-income countries, where significant data deficiencies exist. Moreover, implementing quality enhancement strategies aimed at high-risk surgeries and using standardized preventive bundles is essential for achieving lasting decreases in SSI occurrences and enhancing patient safety.

Conclusion

In conclusion, SSIs remain a significant concern across all GCC countries, with prevalence varying greatly based on the type of surgical procedure. High-risk operations, particularly colorectal surgery and CABG, demonstrate substantially higher SSI rates compared with other procedures. These findings underscore the need for targeted, procedure-specific infection prevention strategies and strengthened regional surveillance systems.

Ethics approval

Not required.

Acknowledgments

None to declare.

Competing interests

All the authors declare that there are no conflicts of interest.

Funding

This study received no external funding.

Underlying data

Derived data supporting the findings of this study are available from the corresponding author on request.

Declaration of artificial intelligence use

The authors declare the use of ChatGPT (GPT-5.0; OpenAI, San Francisco, CA, USA) during manuscript preparation solely to assist with English language editing, grammar, clarity, and text formatting. All AI-assisted content was critically reviewed by the authors to ensure the integrity and reliability of the results. The final decisions and interpretations presented in this article were made solely by the authors.

How to cite

Al-Gunaid ST, Rampengan DDCH, Khadra JB, *et al*. Prevalence of surgical site infections in Gulf Cooperation Council countries: A systematic review and meta-analysis. Narra X 2026; 4 (1): e243- http://doi.org/10.52225/narrax.v4i1.243.

References

1. Allegranzi B, Zayed B, Bischoff P, *et al.* New WHO recommendations on intraoperative and postoperative measures for surgical site infection prevention: an evidence-based global perspective. Lancet Infect Dis 2016;16(12):e288-e303.
2. Aleid AF, Althobaiti HS, Alzahrani MN, *et al.* Surgical site infections and post-operative health: A cross-sectional study amongst surgical patients in Saudi Arabia. J Adv Trends Med Res 2024;1(1):53-58.
3. Woelber E, Schrick EJ, Gessner BD, *et al.* Proportion of surgical site infections occurring after hospital discharge: A systematic review. Surg Infect 2016;17(5):510-519.
4. Ban KA, Minei JP, Laronga C, *et al.* American College of Surgeons and Surgical Infection Society: Surgical site infection guidelines, 2016 update. J Am Coll Surg 2017;224(1):59-74.
5. Islam N, Thalib L, Mahmood S, *et al.* Regional variations in incidence of surgical site infection and associated risk factors in women undergoing cesarean section: A systematic review and meta-analysis. Intensive Crit Care Nurs 2025;89.
6. Anderson DJ, Podgorny K, Berríos-Torres SI, *et al.* Strategies to prevent surgical site infections in acute care hospitals: 2014 update. Infect Control Hosp Epidemiol 2014;35(6):605-627.
7. Khoja T, Rawaf S, Qidwai W, *et al.* Health care in Gulf Cooperation Council countries: A review of challenges and opportunities. Cureus 2017;9(8):e1586.
8. Katoue MG, Cerda AA, García LY, Jakovljevic M. Healthcare system development in the Middle East and North Africa region: Challenges, endeavors and prospective opportunities. Front Public Health 2022;10:1045739.

9. Alfouzan W, Al Fadhli M, Abdo N, *et al*. Surgical site infection following cesarean section in a general hospital in Kuwait: Trends and risk factors. Epidemiol Infect 2019;147:e287.
10. Dhar H, Al-Busaidi I, Rathi B, *et al*. A study of post-caesarean section wound infections in a regional referral hospital, Oman. Sultan Qaboos Univ Med J 2014;14(2):e211-e217.
11. Garcell HG, Al-Ajmi J, Arias AV, *et al*. Incidence of surgical site infection among appendectomy, herniorrhaphy and caesarean section patients in Qatar. East Mediterr Health J 2025;31(1):37-44.
12. Ghnnam W, Malek J, Shebl E, *et al*. Rate of conversion and complications of laparoscopic cholecystectomy in a tertiary care center in Saudi Arabia. Ann Saudi Med 2010;30(2):145-148.
13. Haseeb A, Faidah HS, Al-Gethamy M, *et al*. A point prevalence survey of antimicrobial usage for surgical site infections: A pilot perspective from Holy Makkah, Saudi Arabia. J Pharm Res Int 2020:39-44.
14. El-Saed A, Othman F, AlMohrij S, *et al*. Coverage and methods of surveillance of healthcare-associated infections in Middle Eastern and North African countries. Am J Infect Control 2023;51(10):1151-1156.
15. Al Ismaili S. Adherence to international and national recommendations for the prevention of surgical site infections in elective surgery at two tertiary hospitals in Oman. Wales: Cardiff University; 2017.
16. Birhanu Y, Endalamaw A. Surgical site infection and pathogens in Ethiopia: A systematic review and meta-analysis. Patient Saf Surg 2020;14(1).
17. Ansari S, Hassan M, Barry HD, *et al*. Risk factors associated with surgical site infections: A retrospective report from a developing country. Cureus 2019;11(6):e4801.
18. AlRiyami FM, AL-Rawajfah OM, Al Sabei S, *et al*. Incidence and risk factors of surgical site infections after coronary artery bypass grafting surgery in Oman. J Infect Prev 2022;23(6):285-292.
19. Alotaibi A, Alghamdi E, Alkhashlan N, *et al*. The epidemiology and factors associated with surgical site infection among patients in Riyadh, Saudi Arabia. Int J Med Dev Ctries 2020:1390-1396.
20. Alwehibi N, Alharbi A, Alfurayji R, *et al*. Incidence of surgical site infection after all vascular surgeries from 2020 to 2023: A retrospective study in a tertiary hospital in the Qassim region, Saudi Arabia. Int J Med Dev Ctries 2024:2729-2734.
21. Alharbi IH, Sandogji HI, Shabaan AM, *et al*. Incidence and outcomes of surgical site infections after adult cardiac surgery: A single-center experience. World J Cardiovasc Dis 2023;13(11):764-779.
22. Alkhamis M, Ouban A, Ali N, *et al*. Surgical site infections in oral and maxillofacial surgeries: Prevalence and associated risk factors. World J Surg Surgical Res 2024;7:1565.
23. Al-Rashdi A. Surgical site infections after orthopedic procedures in a tertiary hospital in Oman: Incidence, characteristics and risk factors. Gaz Med Sci 2020;1(2).
24. Zaky MK, Albokhari MA, Albouq TK, *et al*. Prevalence of postoperative surgical-site infection in Al-Madinah. Med Sci 2020;24(102):639-646.
25. Gadeer R, Baatiah NY, Alageel N, *et al*. Incidence and risk factors of wound infection in women who underwent cesarean section in 2014 at King Abdulaziz Medical City, Jeddah. Cureus 2020;12(12):e12164.
26. Alsiddiky A, Nisar KA, Alhuzaimi F, *et al*. Wound healing without drains in posterior spinal fusion in idiopathic scoliosis. J Coll Physicians Surg Pak 2013;23(8):558-561.
27. Alqarni A, Almutairi MB, Alshehri SA, *et al*. Incidence and risk factors associated with surgical site infection among patients that underwent stoma reversal at a Saudi tertiary hospital. Med Sci 2023;27(132):1-6.
28. Chowdhury S, Bahatheq S, Alkaraawi A, *et al*. Surgical site infections after trauma laparotomy: An observational study from a major trauma center in Saudi Arabia. Saudi Med J 2019;40(3):266-270.
29. Aldriwesh M, Alnodley A, Almutairi N, *et al*. Prevalence, microbiological profile, and risk factors of surgical site infections in Saudi patients with colorectal cancer. Saudi J Med Med Sci 2023;11(3):208-218.
30. Abuzaid A, Zaki M, Al Tarief H. Potential risk factors for surgical site infection after isolated coronary artery bypass grafting in a Bahrain Cardiac Centre: A retrospective, case-controlled study. Heart Views 2015;16(3):79.
31. Garcell HG, Arias AV, Pancorbo Sandoval CA, *et al*. Incidence and etiology of surgical site infections in appendectomies: A 3-year prospective study. Oman Med J 2017;32(1):31-35.
32. Almajed H, Jalili Y, Noor A, *et al*. Evaluation of risk factors of surgical site infections after a lower segment cesarean section in Bahrain: A retrospective analytical study. J Bahrain Med Soc 2024;36(4):13-20.
33. Al Majid FM, Buba F, Barry M, *et al*. Incidence, types and outcomes of sternal wound infections after cardiac surgery in Saudi Arabia: A retrospective medical chart review. Saudi Med J 2020;41(2):177-182.
34. Al-Mulhim FA, Baragbah MA, Sadat-Ali M, *et al*. Prevalence of surgical site infection in orthopedic surgery: A 5-year analysis. Int Surg 2014;99(3):264-268.

35. Albaharnah SF, Rashed SA, Almuhaimeed RS, *et al*. Incidence of surgical site infection following cesarean section and its associated factors in a hospital of the Eastern Region, Saudi Arabia: A retrospective cohort study. Healthcare 2024;12(15).
36. Pesenti S, Pannu T, Andres-Bergos J, *et al*. What are the risk factors for surgical site infection after spinal fusion? A meta-analysis. Eur Spine J 2018;27(10):2469-2480.
37. Yang R, Wang L, Shui CY. A meta-analysis of the risk factors of surgical site infection after hysterectomy for endometrial cancer. Int Wound J 2024;21(2).
38. Zhang L, Elsolh B, Patel SV. Wound protectors in reducing surgical site infections in lower gastrointestinal surgery: An updated meta-analysis. Surg Endosc 2018;32(3):1111-1122.
39. Edwards JP, Ho AL, Tee MC, *et al*. Wound protectors reduce surgical site infection: A meta-analysis of randomized controlled trials. Ann Surg 2012;256(1):53-59.
40. Caroff DA, Chan C, Kleinman K, *et al*. Association of open approach vs laparoscopic approach with risk of surgical site infection after colon surgery. JAMA Netw Open 2019;2(10):e1913570.
41. Dior UP, Kathurusinghe S, Cheng C, *et al*. Effect of surgical skin antisepsis on surgical site infections in patients undergoing gynecological laparoscopic surgery: A double-blind randomized clinical trial. JAMA Surg 2020;155(9):807-815.
42. Mueller K, Zhao D, Johnson O, *et al*. The difference in surgical site infection rates between open and minimally invasive spine surgery for degenerative lumbar pathology: A retrospective single-center experience of 1442 cases. Oper Neurosurg 2019;16(6):750-755.
43. Gandaglia G, Ghani KR, Sood A, *et al*. Effect of minimally invasive surgery on the risk for surgical site infections: Results from the national surgical quality improvement program (NSQIP) database. JAMA Surg 2014;149(10):1039-1044.
44. Abdelrahman MA, Zaki A, Salem SAM, *et al*. The impact of cefepime and ampicillin/sulbactam on preventing post-cesarean surgical site infections: Randomized controlled trial. Antibiotics 2023;12(12).
45. Zukowska A, Zukowski M. Surgical site infection in cardiac surgery. J Clin Med 2022;11(23).
46. Harrington G, Russo P, Spelman D, *et al*. Surgical-site infection rates and risk factor analysis in coronary artery bypass graft surgery. Infect Control Hosp Epidemiol 2004;25(6):472-476.
47. Silvestri M, Dobrinja C, Scomersi S, *et al*. Modifiable and non-modifiable risk factors for surgical site infection after colorectal surgery: A single-center experience. Surg Today 2018;48(3):338-345.
48. Itani KMF, Jensen EH, Finn TS, *et al*. Effect of body mass index and ertapenem versus cefotetan prophylaxis on surgical site infection in elective colorectal surgery. Surg Infect 2008;9(2):131-137.
49. Richards C, Edwards J, Culver D, *et al*. Does using a laparoscopic approach to cholecystectomy decrease the risk of surgical site infection? Ann Surg 2003;237(3):358-362.
50. Martin EK, Beckmann MM, Barnsbee LN, *et al*. Best practice perioperative strategies and surgical techniques for preventing caesarean section surgical site infections: A systematic review of reviews and meta-analyses. BJOG 2018;125(8):956-964.
51. Mastrocola M, Matziolis G, Böhle S, *et al*. Meta-analysis of the efficacy of preoperative skin preparation with alcoholic chlorhexidine compared to povidone iodine in orthopedic surgery. Sci Rep 2021;11(1).
52. Adane F, Mulu A, Seyoum G, *et al*. Prevalence and root causes of surgical site infection among women undergoing caesarean section in Ethiopia: A systematic review and meta-analysis. Patient Saf Surg 2019;13(1).
53. Misha G, Chelkeba L, Melaku T. Bacterial profile and antimicrobial susceptibility patterns of isolates among patients diagnosed with surgical site infection at a tertiary teaching hospital in Ethiopia: A prospective cohort study. Ann Clin Microbiol Antimicrob 2021;20(1).
54. Ercole FF, Franco LM, Macieira TG, *et al*. Risk of surgical site infection in patients undergoing orthopedic surgery. Rev Lat Am Enfermagem 2011;19(6):1362-1368.
55. Li X, Nylander W, Smith T, *et al*. Risk factors and predictive model development of thirty-day post-operative surgical site infection in the veterans administration surgical population. Surg Infect 2018;19(3):278-285.
56. Kalmeijer MD, Nieuwland-Bollen E van, Bogaers-Hofman D, *et al*. Nasal carriage of Staphylococcus aureus is a major risk factor for surgical-site infections in orthopedic surgery. Infect Control Hosp Epidemiol 2000;21(5):319-323.