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REVIEW ARTICLE

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Prevalence of surgical wound infection and related factors in patients after long bone surgery: A systematic review and meta-analysis

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Abstract

The goal of this systematic review and meta-analysis is to provide an overview of the prevalence of surgical wound infection and related factors in patients after long bone surgery. A comprehensive, systematic search was conducted in different international electronic databases, such as Scopus, PubMed, Web of Science and Persian electronic databases such as Iranmedex and Scientific Information Database using keywords extracted from Medical Subject Headings such as "Prevalence", "Surgical wound infection", "Surgical site infection" and "Orthopedics" from the earliest to the May 1, 2023. The appraisal tool for cross-sectional studies (AXIS tool) evaluates the quality of the included studies. A total of 71 854 patients undergoing long bone surgery participated in 12 studies. The pooled prevalence of surgical wound infection in patients who underwent long bone surgery reported in the 12 studies was 3.3% (95% CI: 1.5%–7.2%; $I^2 = 99.39\%$; $p < 0.001$). The pooled prevalence of surgical wound infection in male and female patients who underwent long bone surgery was 4.6% (95% CI: 1.7%–11.7%; $p < 0.001$; $I^2 = 99.34\%$) and 2.6% (95% CI: 1.0%–6.3%; $I^2 = 98.84\%$; $p < 0.001$), respectively.

The pooled prevalence of surgical wound infection in patients with femur surgery sites reported in nine studies was 3.7% (95% CI: 2.1–6.4%; $I^2 = 93.43\%$; $p < 0.001$). The pooled prevalence of surgical wound infection in open and close fractures was 16.4% (95% CI: 8.2%–30.2%; $I^2 = 95.83\%$; $p < 0.001$) and 2.9% (95% CI: 1.5%–5.5%; $I^2 = 96.40\%$; $p < 0.001$), respectively. The pooled prevalence of surgical wound infection in patients with diabetes mellitus (DM), hypertension (HTN) and cardiovascular disease (CVD) was 4.6% (95% CI: 2.3%–8.9%; $I^2 = 81.50\%$; $p < 0.001$), 2.7% (95% CI: 1.2%–6.0%; $I^2 = 83.82\%$; $p < 0.001$) and 3.0% (95% CI: 1.4%–6.4%; $I^2 = 69.12\%$; $p = 0.006$), respectively. In general, the different prevalence of surgical wound infection in patients undergoing surgical treatment after long bone fracture may be caused by underlying factors (gender and co-morbidity) and fracture-related factors (surgery site and type of fracture).

KEYWORDS

meta-analysis, orthopaedics, prevalence, surgical site infection, surgical wound infection

Key Messages

- The pooled prevalence of surgical wound infection in patients who underwent long bone surgery reported in 12 studies was 3.3% (95% CI: 1.5% to 7.2%; $I^2 = 99.39\%$; $p < 0.001$).
- The pooled prevalence of surgical wound infection in male and female patients who underwent long bone surgery was 4.6% (95% CI: 1.7%–11.7%; $p < 0.001$; $I^2 = 99.34\%$) and 2.6% (95% CI: 1.0%–6.3%; $I^2 = 98.84\%$; $p < 0.001$), respectively.
- The pooled prevalence of surgical wound infection in patients with femur surgery sites reported in nine studies was 3.7% (95% CI: 2.1%–6.4%; $I^2 = 93.43\%$; $p < 0.001$). The pooled prevalence of surgical wound infection in open and close fractures was 16.4% (95% CI: 8.2%–30.2%; $I^2 = 95.83\%$; $p < 0.001$) and 2.9% (95% CI: 1.5%–5.5%; $I^2 = 96.40\%$; $p < 0.001$), respectively.
- The pooled prevalence of surgical wound infection in patients with DM, HTN and CVD was 4.6% (95% CI: 2.3%–8.9%; $I^2 = 81.50\%$; $p < 0.001$), 2.7% (95% CI: 1.2%–6.0%; $I^2 = 83.82\%$; $p < 0.001$) and 3.0% (95% CI: 1.4%–6.4%; $I^2 = 69.12\%$; $p = 0.006$), respectively.
- In general, the different prevalence of surgical wound infection in patients undergoing surgical treatment after long bone fracture may be caused by underlying factors (gender and co-morbidity) and fracture-related factors (surgery site and type of fracture).

1 | INTRODUCTION

The development and expansion of the use of vehicles have caused an increase in fractures of the extremities and any loss of long bones integrity, due to road injuries.[1,2] In addition to imposing direct and indirect costs of treatment, the fracture of long bones also affects society due to the loss of productivity. Management and treatment of this type of fracture include high costs for surgery and rehabilitation. Furthermore, the occurrence of complications after surgery and the need for re-hospitalisation can significantly increase the burden on the healthcare system.[3]

One of the common consequences of surgery is surgical site infection. Post-operative infection in the surgical site, the most common nosocomial infection, accounts for 31% of all hospital-acquired illnesses.[4] Surgical wound infections are divided into two categories: superficial and deep. Superficial surgical wound infection is an infection that occurs within 30 days after surgery in the skin or subcutaneous tissues, while deep surgical wound infection occurs within one year after surgery in deep soft tissue and is defined by at least one of the following criteria: (a) persistent wound discharge or dehiscence from the deep incision; (b) visible abscess or gangrenous requiring surgical debridement and implants removal or exchange; and (c) culture-positive excretions from the deep incision site.[5]

The development of aseptic surgical techniques and advances in infection control have not been successful in controlling the global prevalence of orthopaedic surgical wound infection,[6] and estimates show that it ranges from 1.4% to 41.9%.[7] The prevalence of surgical wound infection in long bone fractures varies by bone type. The prevalence of surgical wound infection in femur fracture was between 2% and 14%.[8,9] The prevalence rate of radius and leg (tibia and fibula) fractures was 9% and 14%, respectively.[9,10] The occurrence of this complication after orthopaedic surgeries is much more challenging because it is difficult to eliminate the bone and joint infection and the lifetime risk of recurrence is 10%–20%.[11]

Orthopaedic surgical wound infection affects the economic and social conditions of the patient,[12] in addition to causing severe consequences such as an increased probability of readmission up to 34.3%,[13] prolonged hospitalisation, revision surgery and increased mortality.[14] However, if there is adequate knowledge of the risk factors and susceptibility patterns of common pathogens, the consequences of surgical wound infection are largely preventable.[15]

2 | RESEARCH QUESTIONS

- What is the prevalence of surgical wound infection in patients after long bone surgery?
- What is the prevalence of surgical wound infection in patients after long bone surgery based on gender?
- What is the prevalence of surgical wound infection in patients with the femur surgery site?
- What is the prevalence of surgical wound infection in patients with open and close fracture?
- What is the prevalence of surgical wound infection in patients with diabetes mellitus (DM) after long bone surgery based on gender?
- What is the prevalence of surgical wound infection in patients with hypertension (HTN) after long bone surgery based on gender?
- What is the prevalence of surgical wound infection in patients with cardiovascular disease (CVD) after long bone surgery based on gender?

2.1 | Aim

Considering the importance of the prevention of surgical wound infection and its consequences, as well as the differences in reported infection rates, this study aims to determine the prevalence of surgical wound infection in long bone fractures and its related factors.

3 | METHODS

The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines were used to conduct this systematic review and meta-analysis.[16] The current review was also not included in the International Prospective Register of Systematic Reviews (PROSPERO) database.

3.1 | Search strategy

A comprehensive, systematic search was conducted in different international electronic databases, such as Scopus, PubMed, Web of Science and Persian electronic databases such as Iranmedex and Scientific Information Database (SID) using keywords extracted from Medical Subject Headings such as "Prevalence", "Surgical wound infection", "Surgical site infection" and "Orthopedics" from the earliest to the May 1, 2023. For example, the search strategy was in PubMed/MEDLINE database including (("Prevalence") OR ("Outbreak")) AND (("Surgical wound infection") OR ("Surgical site infection") OR ("Postoperative wound infections")) AND (("Orthopedics") OR ("Orthopedic wards") OR ("Orthopedic patients")) AND (("Long bone") OR ("Femur") OR ("Tibia") OR ("Fibula") OR ("Ulnar") OR ("Radius") OR ("Humerus")). To combine phrases, the Boolean operators "OR" and "AND" were used. Persian keyword equivalents of Iranian electronic databases were also searched. Two researchers independently searched extensively. The grey literature, which includes expert opinions, conference presentations, theses, research and committee reports and current research, is not included in this systematic review and meta-analysis. Grey literature, whether published in print or electronically, is literature that has not received the publisher's approval for commercial publication.[17]

3.2 | Inclusion and exclusion criteria

This systematic review investigated Persian and English written and published cross-sectional studies on the occurrence of surgical wound infections in patients following long bone surgery. The following were excluded: reviews, case studies, conference materials, letters to the editor, legal processes and qualitative research.

3.3 | Study selection

Data were managed for this systematic review using EndNote 20. Based on the inclusion and exclusion criteria, two researchers independently assessed the published complete texts, study titles and abstracts, as well as the electronic and manual removal of duplicate studies. While choosing the studies, the third researcher settled any differences between the first two researchers. To avoid data loss, references were lastly thoroughly reviewed.

3.4 | Data extraction and quality assessment

The information extracted in this review by the researchers includes the name of the first author, year of publication, location, sample size, age, gender, Body mass index (BMI), duration of surgery, surgical wound infection, surgery site, fracture type, reduction type, no. of comorbidities, DM, HTN, CVD, smoking and alcohol use. The appraisal tool for cross-sectional studies (AXIS tool) evaluates the quality of the included studies via 20 items with a two-point Likert scale, including yes (score of 1) and no (score of 0). This tool assesses report quality (7 items), study design quality (7 items) and the possible introduction of biases (6 items). Finally, AXIS rates the quality of studies at three levels: high (70%–100%), fair (60%–69.9%) and low (0%–59.9%).[18]

3.5 | Statistical analysis

Version 3 of the CMA program was used for the analysis. The sample size and prevalence of surgical wound infections in each trial were collected and used to compute the overall effect size. The I^2 statistics were used to evaluate heterogeneity. I^2 values of 25%, 50% and 75% are regarded as mild, moderate and high heterogeneity, respectively. The use of the random effects model was made necessary by the significant degree of outcome heterogeneity.

3.6 | Sensitivity analysis

A sensitivity analysis was conducted to assess how each study's absence would affect the prevalence of surgical wound infections as a whole.

3.7 | Publication of bias

With the help of a funnel plot and the results of the Egger test, the publication of bias was evaluated.

4 | RESULTS

4.1 | Study selection

As shown in Figure 1, 2785 studies from the systematic review and meta-analysis were found through database searches. Two thousand one hundred ninety-three papers were left after duplicate studies were eliminated. Following a thorough examination of the study's title and abstract, 2002 studies were eliminated because they did

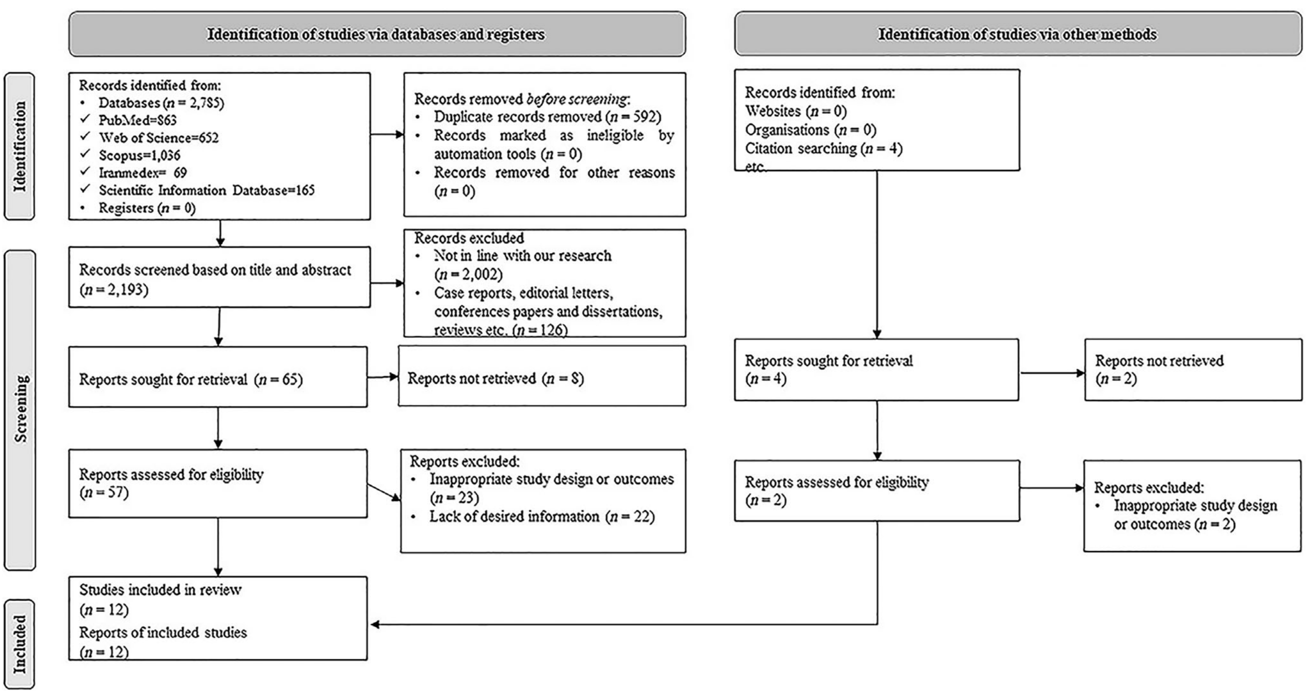

FIGURE 1 Flow diagram of the study selection process.

TABLE 1 Basic characteristics of the included studies in this systematic review and meta-analysis.

First Author/year	Location	Sample size	Age (mean ± SD)	M/F ratio (%)	BMI (mean ± SD)	Surgery duration (mean ± SD)	Key results
Kaabachi et al., 2005[8]	Tunisia	49	N/A	N/A	N/A	N/A	-
Amaradeep et al., 2017[20]	India	117	N/A	N/A	N/A	N/A	-
Bai et al., 2019[21]	China	665	49.40 (SD = 15.70)	35.87/64.13	N/A	N/A	There was a significant relationship between obesity, DM, chronic steroid use, smoking, fracture type, wound class and temporary external fixation use with the rate of surgical wound infection ($p < 0.05$).
Lu et al., 2019[23]	China	724	47.53 (SD = 18.40)	56.07/43.93	N/A	2.05 (SD = 1.03)	There was a significant relationship between obesity, DM, smoking, fracture type, wound class and prophylactic antibiotic use with the rate of surgical wound infection ($p < 0.05$).
Rundgren et al., 2020[10]	Sweden	31 807	N/A	N/A	N/A	N/A	There was a significant relationship between age, gender, fracture type and prophylactic antibiotics with the rate of surgical wound infection ($p < 0.001$).
Zhao et al., 2020[26]	China	1941	72.92 (SD = 14.45)	42.56/57.44	N/A	N/A	There was a significant relationship between gender, number of comorbidities, reduction type, surgery duration, implant type, ALB and HGB with the rate of surgical wound infection ($p < 0.05$).
Zhu et al., 2021[27]	China	364	N/A	53.02/46.98	25.60 (SD = 4.10)	N/A	There was a significant relationship between place of residence, smoking, alcohol use, fracture type, injury mechanism, concurrent fracture, wound class, drain use, length of hospitalisation, A/G level and ALB with the rate of surgical wound infection ($p < 0.05$).
Albright et al., 2022[19]	USA	32 368	N/A	61.44/38.56	N/A	N/A	There was a significant relationship between age groups and gender with the rate of surgical wound infection ($p < 0.01$).
Brodke et al., 2022[22]	USA	1107	57.00 (SD = 18.00)	40.65/59.35	30.00 (SD = 8.00)	3.30 (SD = 1.70)	There was a significant relationship between age, alcohol use, intra-articular injection, vascular injury, medical communication, fracture type and surgery duration with the rate of surgical wound infection ($p < 0.05$).
Soomro et al., 2022[24]	Pakistan	364	53.70 (SD = 17.00)	53.02/46.98	25.60 (SD = 4.10)	N/A	• There was a significant relationship between smoking, injury mechanism, fracture type, concurrent fracture, length of hospitalisation,

(Continues)

TABLE 1 (Continued)

First Author/year	Location	Sample size	Age (mean ± SD)	M/F ratio (%)	BMI (mean ± SD)	Surgery duration (mean ± SD)	Key results
							A/G level and ALB with the surgical wound infection rate ($p < 0.05$). • There was a significant positive relationship between wound class and drain use with the surgical wound infection rate ($p < 0.05$).
Zhang et al., 2022[25]	China	2218	66.80 (SD = 15.50)	38.45/61.55	N/A	N/A	There was a significant relationship between gender, concurrent fracture, injury mechanism, preoperative waiting time, ALB, DBIL and CHE with the rate of surgical wound infection ($p < 0.05$).
Zhao et al., 2022[9]	China	130	N/A	76.92/23.08	N/A	N/A	There was a significant relationship between the type of open fracture, duration of external fixation, WBC, ALB, CRP and ESR with the rate of surgical wound infection ($p < 0.05$).

Abbreviations: A/G, albumin/globulin; ALB, albumin; BMI, body mass index; CHE, cholinesterase; CRP, C-reactive protein; DBIL, direct bilirubin; DM, diabetes mellitus; ESR, erythrocyte sedimentation rate; HGB, haemoglobin;SD, standard deviation; WBC, white blood cell count.

not further the goal of the study, and 126 studies were eliminated because they contained case reports, editorial letters, conference papers, dissertations, reviews and other types of non-research-related material. Twenty-three studies were removed owing to improper research design or outcomes, and 22 studies were discarded due to a lack of necessary data after carefully examining the full text of 55 studies. Finally, this systematic review and meta-analysis included 12 studies.[8–10,19–27]

4.2 | Study characteristics

As shown in Table 1, a total of 71 854 patients undergoing long bone surgery participated in 12 studies.[8–10,19–27] Their mean age was 57.89 (SD = 16.51), and 57.79% of them were women.

4.3 | Methodological quality assessment of eligible studies

As shown in Figure 2, all studies[8–10,19–27] were of high quality. However, limitations in two studies[8,24] and findings and conflicts of interest were not reported in two studies.[8,20]

4.4 | Prevalence of surgical wound infection

As shown in Figure 3, the pooled prevalence of surgical wound infection in patients who underwent long bone surgery reported in 12 studies was 3.3% (95% CI: 1.5%–7.2%; $I^2 = 99.39\%$; $p < 0.001$).

4.5 | Prevalence of surgical wound infection based on gender

As shown in Figure 4, the pooled prevalence of surgical wound infection in male patients who underwent long bone surgery reported in nine studies was 4.6% (95% CI: 1.7%–11.7%; $p < 0.001$; $I^2 = 99.34\%$). As shown in Figure 5, the pooled prevalence of surgical wound infection in female patients who underwent long bone surgery reported in nine studies was 2.6% (95% CI: 1.0%–6.3%; $I^2 = 98.84\%$; $p < 0.001$).

4.6 | Prevalence of surgical wound infection in patients with the femur surgery site

As shown in Figure 6, the pooled prevalence of surgical wound infection in patients with femur surgery sites

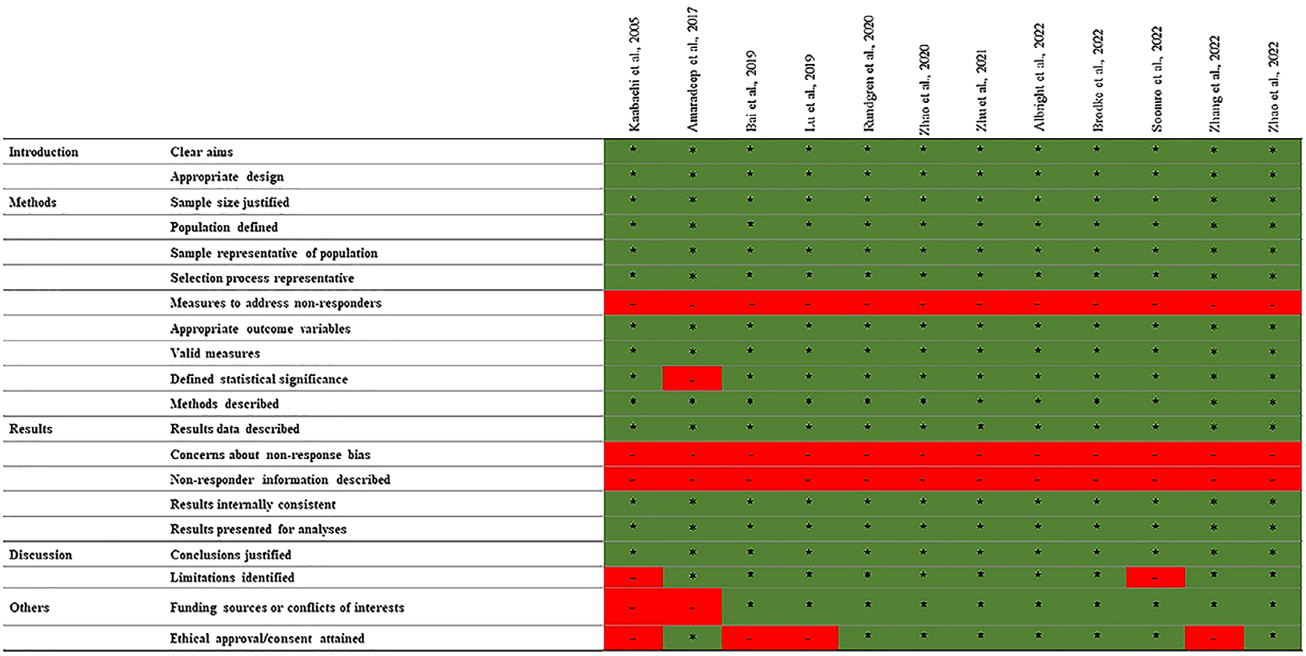

FIGURE 2 Methodological quality assessment of included studies.

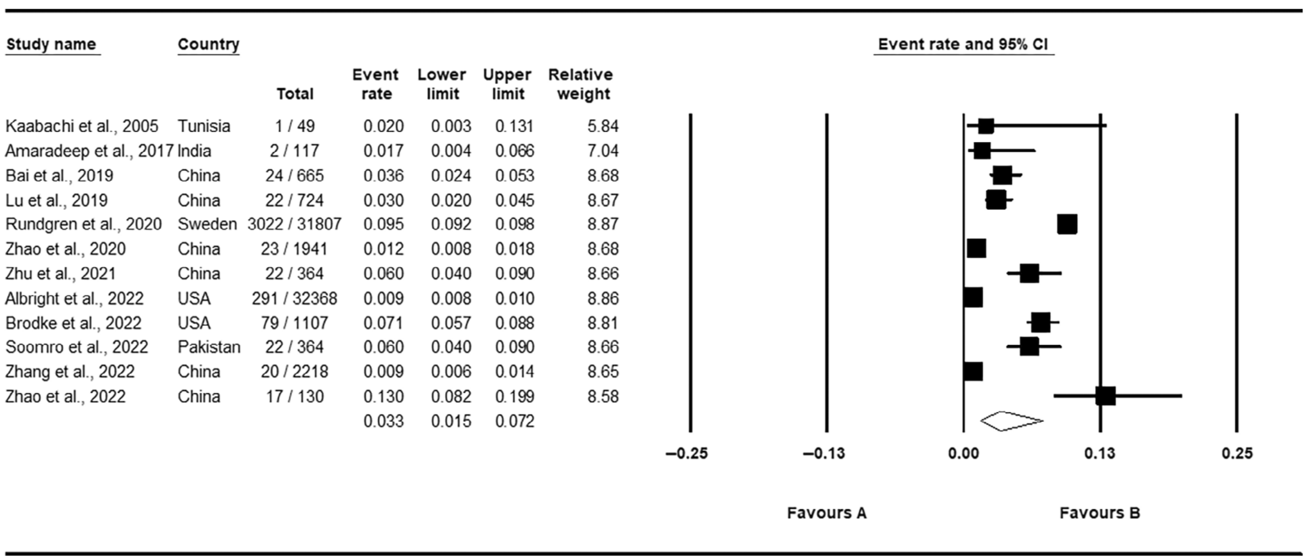

FIGURE 3 Forest plot prevalence of surgical wound infection.

reported in nine studies was 3.7% (95% CI: 2.1%–6.4%; $I^2 = 93.43\%$; $p < 0.001$).

4.7 | Prevalence of surgical wound infection in patients with open and close fracture

As shown in Figure 7, the pooled prevalence of surgical wound infection in open fractures reported in seven studies was 16.4% (95% CI: 8.2%–30.2%; $I^2 = 95.83\%$; $p < 0.001$). As shown in Figure 8, the pooled prevalence of surgical wound infection in close fractures reported in eight studies was 2.9% (95% CI: 1.5% to 5.5%; $I^2 = 96.40\%$; $p < 0.001$).

4.8 | Prevalence of surgical wound infection in patients with DM

As shown in Figure 9, the pooled prevalence of surgical wound infection in patients with DM reported in seven studies was 4.6% (95% CI: 2.3%–8.9%; $I^2 = 81.50\%$; $p < 0.001$).

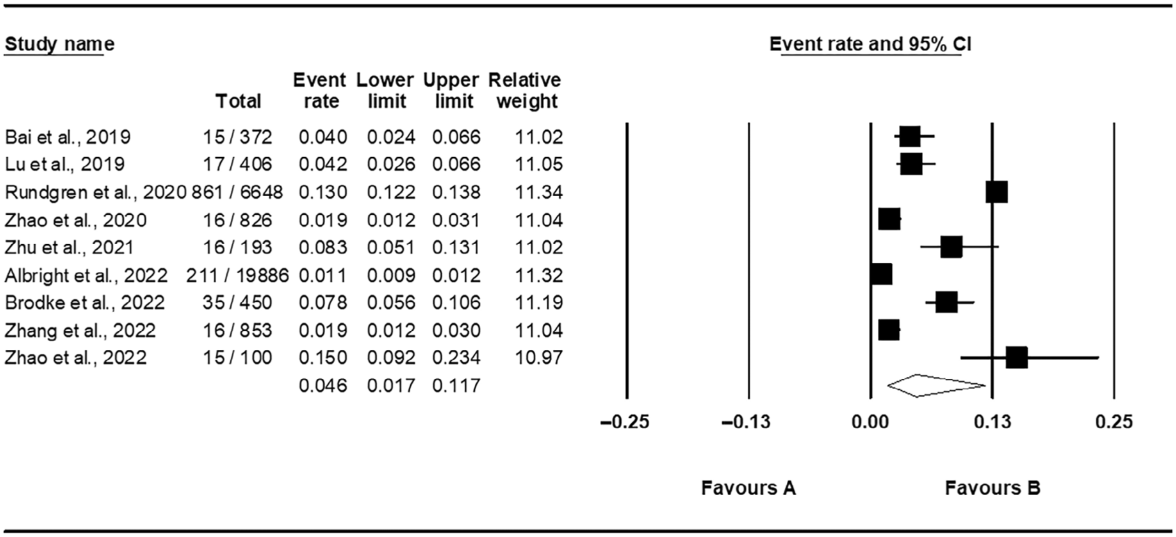

FIGURE 4 Forest plot prevalence of surgical wound infection in males.

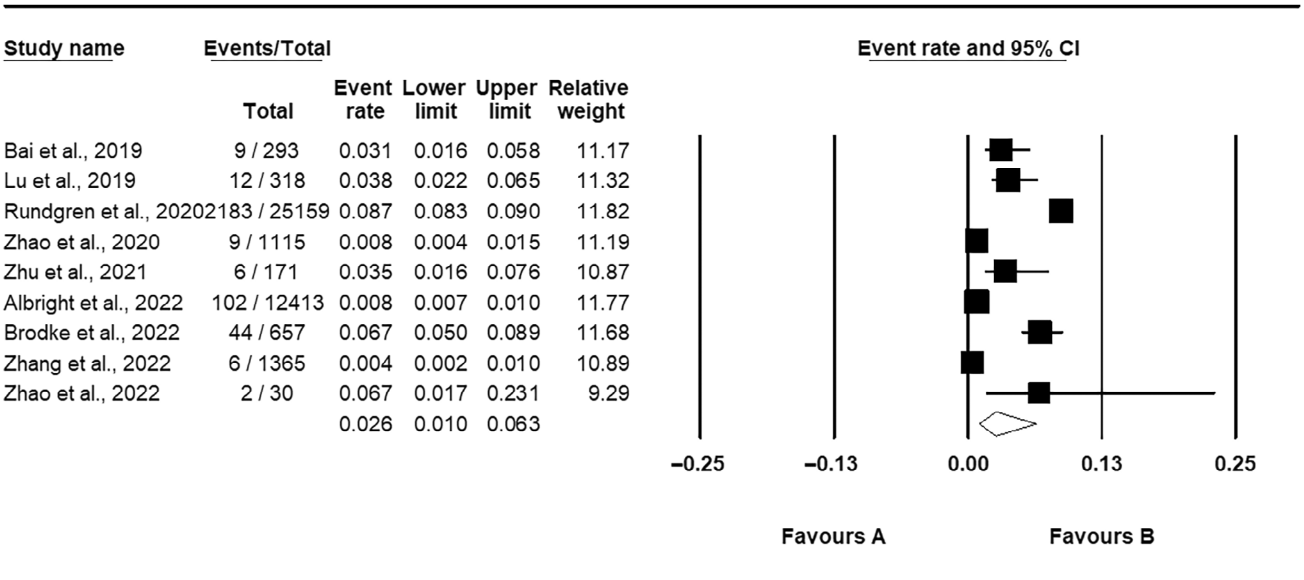

FIGURE 5 Forest plot prevalence of surgical wound infection in females.

4.9 | Prevalence of surgical wound infection in patients with HTN

As shown in Figure 10, the pooled prevalence of surgical wound infection in patients with HTN reported in six studies was 2.7% (95% CI: 1.2%–6.0%; $I^2 = 83.82\%$; $p < 0.001$).

4.10 | Prevalence of surgical wound infection in patients with CVD

As shown in Figure 11, the pooled prevalence of surgical wound infection in patients with CVD reported in six studies was 3.0% (95% CI: 1.4%–6.4%; $I^2 = 69.12\%$; $p = 0.006$).

4.11 | Sensitivity analysis

As shown in Figure 12, sensitivity analyses were carried out by removing one study at a time to determine how each one affected the summary results and between-study heterogeneity.

4.12 | Publication bias

The symmetric funnel plot for the prevalence of surgical wound infection, which rejected any evidence of publication bias, was supported by the results of Egger's regression analysis ($t = 1.52$, $p = 0.15$). The symmetric funnel plot for the

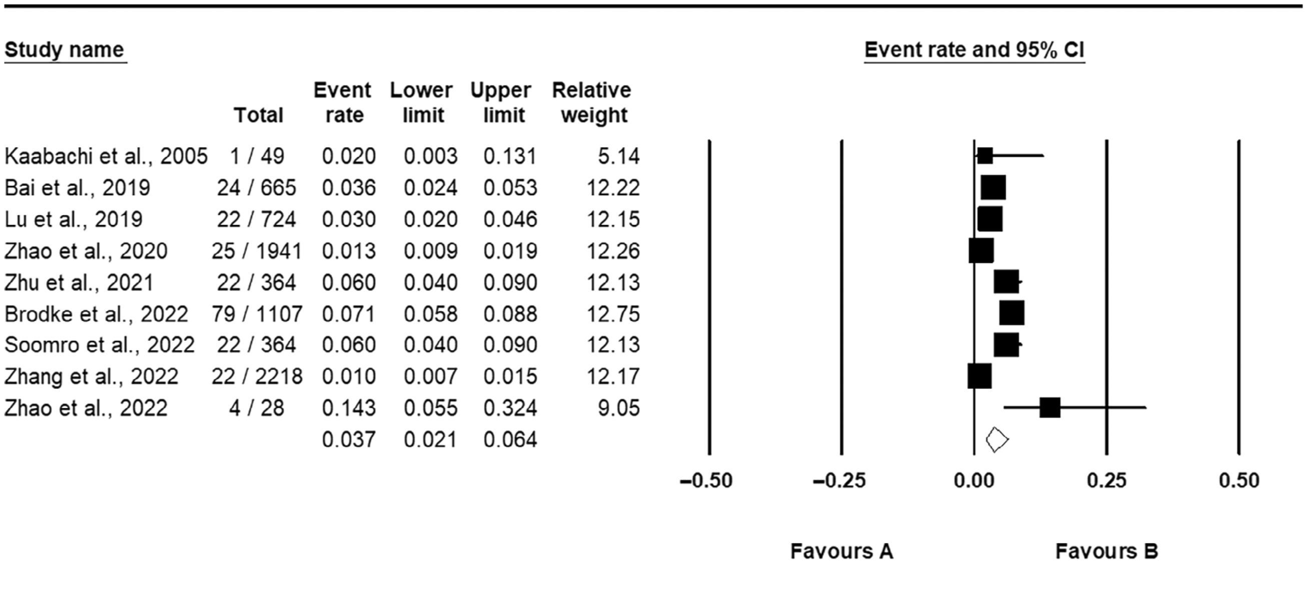

FIGURE 6 Forest plot prevalence of surgical wound infection in the femur surgery site.

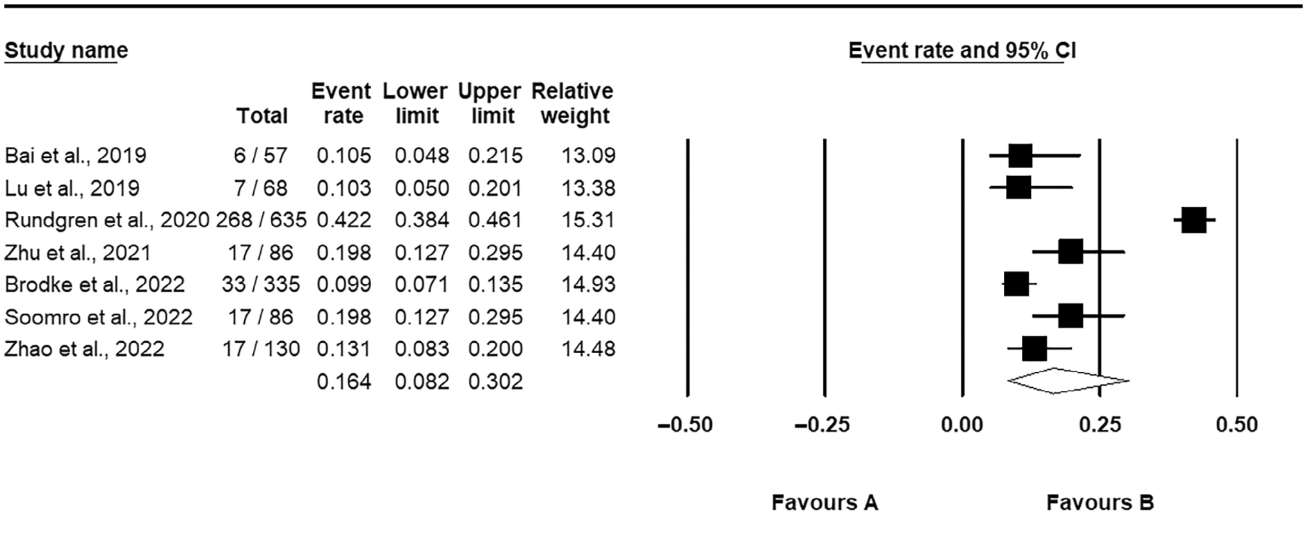

FIGURE 7 Forest plot prevalence of surgical wound infection in an open fracture.

prevalence of surgical wound infection in male patients, which rejected any evidence of publication bias, was supported by the results of Egger's regression analysis ($t = 0.93$, $p = 0.38$). The symmetric funnel plot for the prevalence of surgical wound infection in female patients, which rejected any evidence of publication bias, was supported by the results of Egger's regression analysis ($t = 1.91$, $p = 0.09$). The symmetric funnel plot for the prevalence of surgical wound infection in femur surgery sites, which rejected any evidence of publication bias, was supported by the results of Egger's regression analysis ($t = 0.58$, $p = 0.57$). The symmetric funnel plot for the prevalence of surgical wound infection in open fracture showed a publication bias, which was confirmed by the Egger regression test ($t = 3.35$, $p = 0.02$). The symmetric funnel plot for the prevalence of surgical wound infection in close fracture showed a publication bias, which was confirmed by the Egger regression test ($t = 4.30$, $p = 0.005$). The symmetric funnel plot for the prevalence of surgical wound infection in patients with DM, which rejected any evidence of publication bias, was supported by the results of Egger's regression analysis ($t = 2.10$, $p = 0.08$). The symmetric funnel plot for the prevalence of surgical wound infection in patients with HTN, which rejected any evidence of publication bias, was supported by

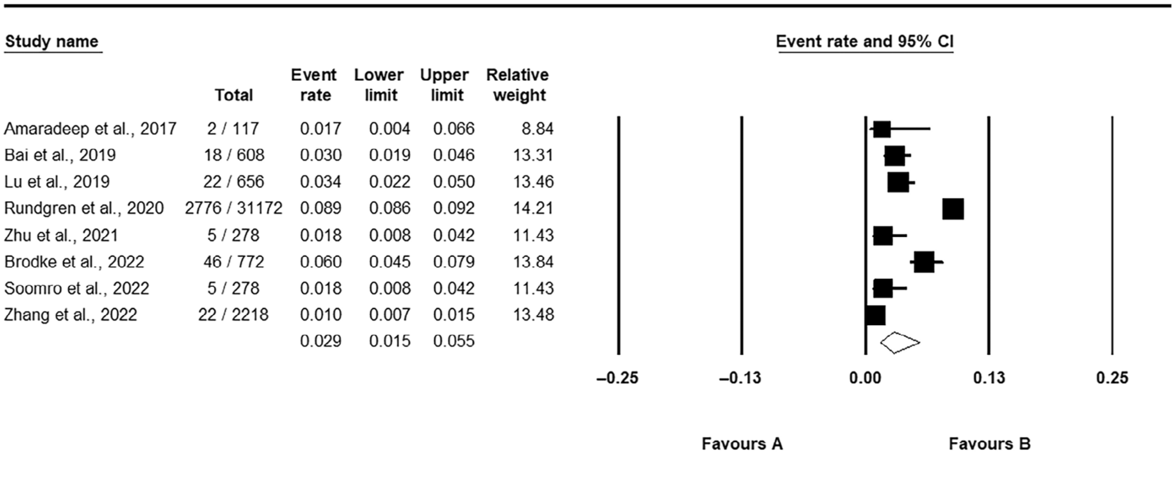

FIGURE 8 Forest plot prevalence of surgical wound infection in close fracture.

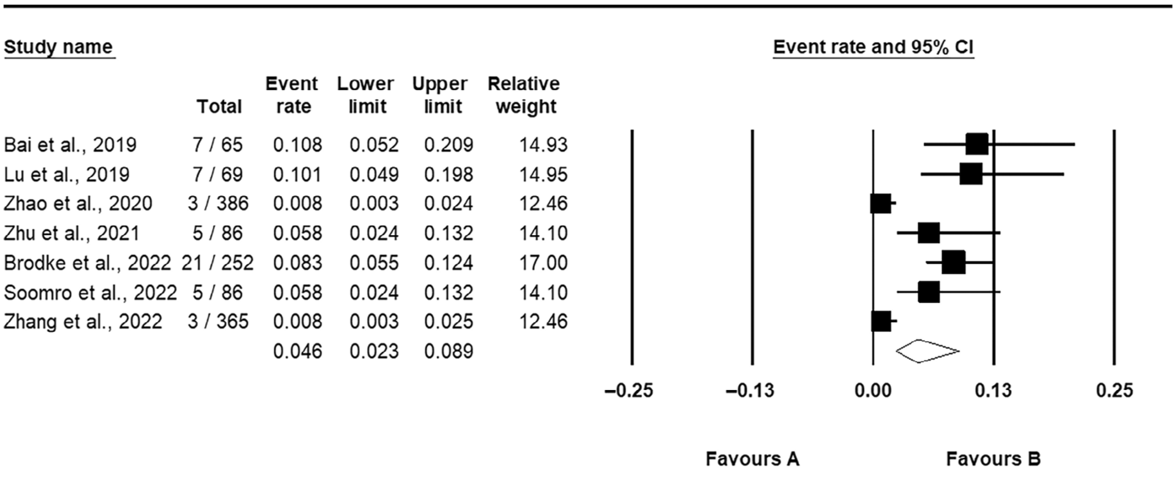

FIGURE 9 Forest plot prevalence of surgical wound infection in patients with DM.

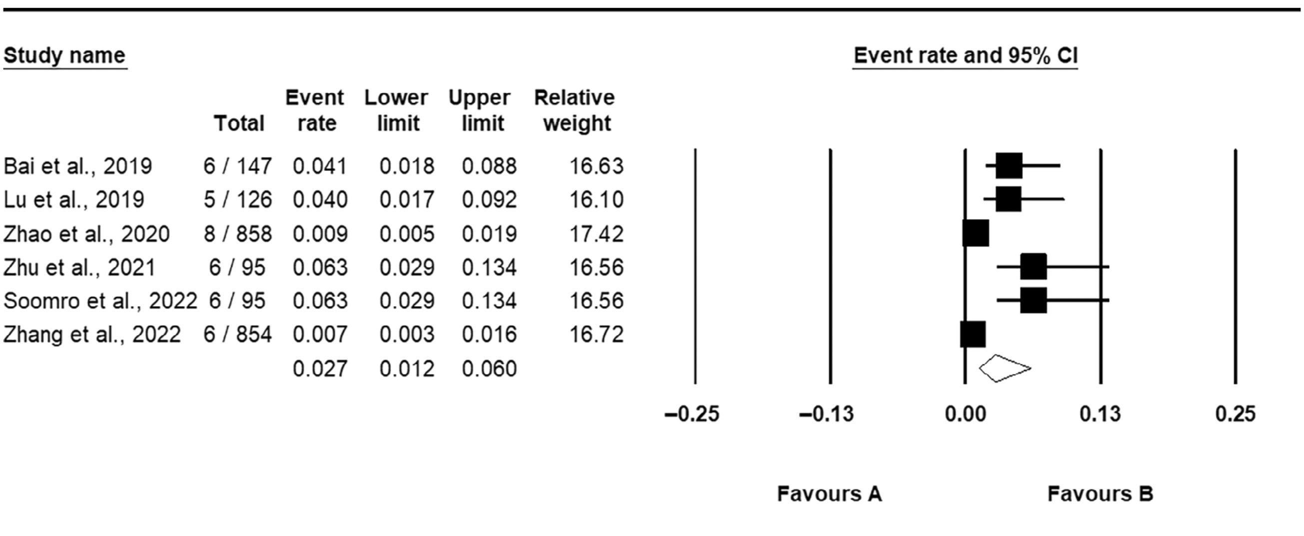

FIGURE 10 Forest plot prevalence of surgical wound infection in patients with HTN.

Study name	Total	Event rate	Lower limit	Upper limit	Relative weight
Bai et al., 2019	3 / 40	0.075	0.024	0.208	16.04
Lu et al., 2019	3 / 35	0.086	0.028	0.234	15.98
Zhao et al., 2020	7 / 633	0.011	0.005	0.023	20.45
Zhu et al., 2021	2 / 54	0.037	0.009	0.136	13.85
Soomro et al., 2022	2 / 54	0.037	0.009	0.136	13.85
Zhang et al., 2022	6 / 459	0.013	0.006	0.029	19.84
		0.030	0.014	0.064	

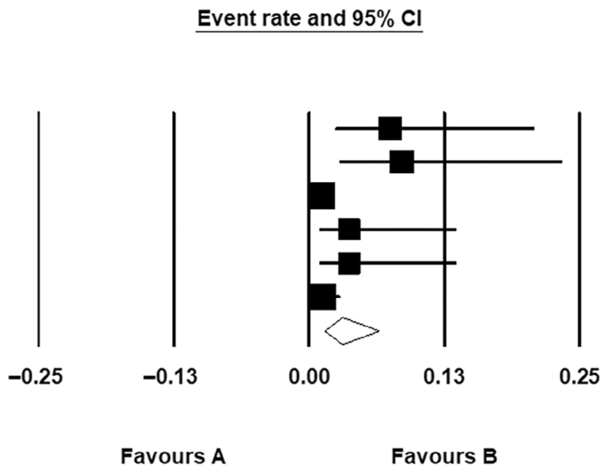

FIGURE 11 Forest plot prevalence of surgical wound infection in patients with CVD.

Study name	Statistics with study removed			
	Point	Lower limit	Upper limit	*p*-Value
Kaabachi et al., 2005	0.034	0.015	0.076	0.000
Amaradeep et al., 2017	0.035	0.015	0.078	0.000
Bai et al., 2019	0.033	0.014	0.075	0.000
Lu et al., 2019	0.034	0.014	0.076	0.000
Rundgren et al., 2020	0.030	0.015	0.060	0.000
Zhao et al., 2020	0.037	0.016	0.082	0.000
Zhu et al., 2021	0.031	0.013	0.072	0.000
Albright et al., 2022	0.039	0.023	0.064	0.000
Brodke et al., 2022	0.031	0.013	0.074	0.000
Soomro et al., 2022	0.031	0.013	0.072	0.000
Zhang et al., 2022	0.038	0.016	0.084	0.000
Zhao et al., 2022	0.029	0.012	0.066	0.000
	0.033	0.015	0.072	0.000

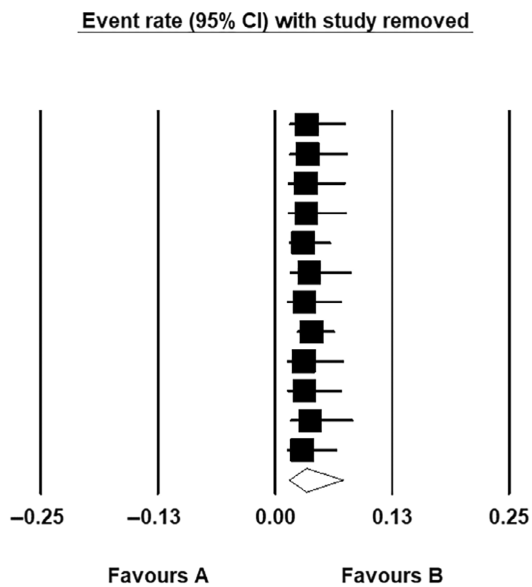

FIGURE 12 The sensitivity analysis results were performed by removing one study at a time.

the results of Egger's regression analysis ($t = 1.74$, $p = 0.15$). The symmetric funnel plot for the prevalence of surgical wound infection in patients with CVD showed a publication bias, which was confirmed by the Egger regression test ($t = 2.91$, $p = 0.04$).

5 | DISCUSSION

Since the majority of orthopaedic diseases require surgical treatment, surgical wound infection, the most common complication after surgeries, becomes more important.[28–31] Orthopaedic surgeries mainly consist of spine surgery, joint surgery and post-trauma surgery.[32] The findings of the previous systematic review and meta-analysis show that the prevalence of surgical wound infection in all types of orthopaedic surgery was 2.7%.[33] The results of the current study were corroborative and revealed that the prevalence of surgical wound infection is 3.3% among patients undergoing surgery after long bone fractures. Also, this study by collecting data from cross-sectional studies determined that the prevalence of surgical wound infection in

TABLE 2 Surgical wound infection prevalence and related factors.

		Gender		Surgery site						Fracture type	
		Surgical wound infection n/Total n		Surgical wound infection n/total n						Surgical wound infection n/total n	
First Author/year	Surgical wound infection (%)	Male	Female	Humerus	Radius	Ulna	Femur	Tibia	Fibula	Open	Close
Kaabachi et al., 2005[8]	2.04	-	-	0	0	0	1/49	0	0	-	-
Amaradeep et al., 2017[20]	1.70	-	-	-	-	-	-	-	-	0	2/117
Bai et al., 2019[21]	3.60	15/372	9/293	0	0	0	24/665	0	0	6/57	18/608
Lu et al., 2019[23]	3.03	17/406	12/318	0	0	0	22/724	0	0	7/68	22/656
Rundgren et al., 2020[10]	9.57	861/6648	2183/ 25 159	0	3044/ 31 807	0	0	0	0	268/635	2776/ 31 172
Zhao et al., 2020[26]	1.28	16/826	9/1115	0	0	0	25/1941	0	0	-	-
Zhu et al., 2021[27]	6.04	16/193	6/171	0	0	0	22/364	0	0	17/86	5/278
Albright et al., 2022[19]	0.96	211/19886	102/12413	0	313/32368	0	0	0	0	-	-
Brodke et al., 2022[22]	7.13	35/450	44/657	0	0	0	79/1107	0	0	33/335	46/772
Soomro et al., 2022[24]	6.04	-	-	0	0	0	22/364	0	0	17/86	5/278
Zhang et al., 2022[25]	0.99	16/853	6/1365	0	0	0	22/2218	0	0	0	22/2218
Zhao et al., 2022[9]	13.07	15/100	2/30	0/5	1/16		4/28	12/81		17/130	0

	Reduction type		No. of Comorbidities			DM	HTN	CVD	Smoking	Alcohol use
	Surgical wound infection n/total n		Surgical wound infection n/total n			Surgical wound infection n/total n	Surgical wound infection n/total n	Surgical wound infection n/total n	Surgical wound infection n/total n	Surgical wound infection n/total n
First Author/year	Open	Close	0	1	>1					
Kaabachi et al., 2005[8]	-	-	-	-	-	-	-	-	-	-
Amaradeep et al., 2017[20]	-	-	-	-	-	-	-	-	-	-
Bai et al., 2019[21]	24/665	0	-	-	-	7/65	6/147	3/40	10/148	11/263
Lu et al., 2019[23]	22/724	0	-	-	-	7/69	5/126	3/35	11/135	12/288
Rundgren et al., 2020[10]	1110/ 21 348	1934/ 10 459	-	-	-	-	-	-	-	-
Zhao et al., 2020[26]	7/296	18/1645	0/380	12/465	8/1096	3/386	8/858	7/633	-	-
Zhu et al., 2021[27]	22/364	0	-	-	-	5/86	6/95	2/54	8/50	9/58
Albright et al., 2022[19]	-	-	-	-	-	-	-	-	-	-
Brodke et al., 2022[22]	-	-	-	-	-	21/252	-	-	26/303	13/96
Soomro et al., 2022[24]	-	-	-	-	-	5/86	6/95	2/54	8/50	-

TABLE 2 (Continued)

First Author/year	Reduction type		No. of Comorbidities			DM	HTN	CVD	Smoking	Alcohol use
	Surgical wound infection n/total n		Surgical wound infection n/total n			Surgical wound infection n/total n	Surgical wound infection n/total n	Surgical wound infection n/total n	Surgical wound infection n/total n	Surgical wound infection n/total n
	Open	Close	0	1	>1					
Zhang et al., 2022[25]	2/44	20/2174	-	-	-	3/365	6/854	6/459	-	-
Zhao et al., 2022[9]	-	-	-	-	-	-	-	-	-	-

Abbreviations: CVD, cardiovascular disease; DM, diabetes mellitus; HTN, hypertension.

long bone fracture surgery ranges from 0.96% to 13.07%. The different prevalence of surgical wound infection is caused by various factors such as gender, surgical site, type of fracture and comorbidities (see Table 2).

The present study determined that the prevalence of surgical wound infection after surgery in patients with femur fractures is higher than the prevalence of surgical wound infection in the surgical treatment of all types of long bone fractures. Fracture of the femur often occurs as a result of high-energy trauma, which may damage several organs. In such conditions, the incidence of complications increases during hospitalisation.[34] Also, this study confirmed the previous evidence and showed that the prevalence of infection after open fractures is much higher than that after closed fractures. The risk of infection in open fractures of long bones is much higher due to soft tissue damage, exposure to contamination and the need for multiple interdisciplinary treatments.[35] Although surgical wound infection can be caused by several factors, including immunodeficiency, malnutrition and opportunistic infections,[36] surgeons and care providers can play an important role in infection control by keeping the surgical site sterile.[37] Furthermore, healthcare policymakers and medical centre managers should take the necessary decisions with this evidence to provide the necessary facilities to provide higher quality care for these patients.

In the present systematic review and meta-analysis, it was found that the prevalence of surgical wound infection is higher in males than that in females. Consistent with the present finding, previous studies also showed a higher rate of surgical wound infection in men undergoing orthopaedic surgery.[38] However, several studies that determined the prevalence of surgical wound infection in surgeries other than long bone fractures showed that there was no association between surgical wound infection and gender.[39–41] The existing discrepancy may be because long bone fractures are usually caused by vehicle accidents, and most of the victims are male. In addition, the presence of comorbidities also plays a role in surgical wound infection. The findings of this study showed that the prevalence of surgical wound infection in the DM population is higher than that in the general population. Previous findings indicated that diabetic subjects undergoing orthopaedic surgery were twice as likely to have surgical wound infection.[41] Access to evidence showing the underlying factors affecting the prevalence of surgical wound infection can help healthcare policymakers to be more successful in planning for its prevention.

6 | LIMITATIONS

This systematic review had several limitations. Although this systematic review was conducted based on the

PRISMA checklist, it was not registered in the International Prospective Register of Systematic Reviews (PROSPERO) database, and a public protocol does not exist. One of the limitations can be attributed to the significant degree of heterogeneity among the included studies. High heterogeneity is typically a significant problem in prevalence meta-analyses, though. Additionally, more research is required to establish the prevalence of surgical wound infections in patients receiving long bone surgery based on the findings of publication bias.

6.1 | Recommendations for future research

It is recommended that future studies, with current evidence, conduct studies to prevent surgical wound infection after long bone fracture surgery.

7 | CONCLUSION

In general, the different prevalence of surgical wound infection in patients undergoing surgical treatment after long bone fracture may be caused by underlying factors (gender and co-morbidity) and fracture-related factors (surgery site and type of fracture).

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CONFLICT OF INTEREST STATEMENT

We do not have potential conflicts of interest concerning the research, authorship and publication of this article.

DATA AVAILABILITY STATEMENT

The datasets used during the current study are available from the corresponding author upon request.

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