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Factors Associated with Post-Sternotomy Wound Infection: A Meta-Analysis

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ABSTRACT

Background: Sternal wound infection is a serious complication following cardiac surgery, contributing to increased morbidity, mortality, and length of hospital stay. Obesity, diabetes mellitus, smoking habits, and re-operation are suspected to contribute to the incidence of post-sternotomy wound infections. This study aimed to estimate the magnitude of the influence of obesity, diabetes, smoking, and re-operation as risk factors for post-sternotomy wound infections.
Subject and Method: This study is a systematic review and meta-analysis. Articles were obtained from databases including PubMed, Google Scholar and ScienceDirect, limited to publications from 2015 to 2025. The keywords and MeSH terms used were: "sternotomy, AND sternal wound infection OR deep sternal wound infection OR surgical site infection, AND "obesity OR body mass index, AND diabetes mellitus OR hyperglycemia AND smoking OR tobacco use AND re-operation AND cardiac surgery". Article selection was based on eligibility criteria defined using the PICO model: P = patients post-sternotomy; I = obesity, diabetes, smoking, re-operation; C = non-obese, non-diabetic, non-smokers, no re-operation; O = post-sternotomy wound infection. Only full-text articles with a cross-sectional study design were included. Data were analyzed using RevMan version 5.3.
Results: A total of 16 articles were included in this meta-analysis, originating from Finland, Denmark, Australia, Saudi Arabia, Colombia, Italy, France, China, Pakistan, Brazil, and United States. The meta-analysis showed that the risk of post-sternotomy wound infection was significantly increased in patients with obesity (aOR = 1.50; 95% CI: 1.31–1.72; p < 0.001), diabetes (aOR = 2.02; 95% CI: 1.26–3.25; p = 0.004), smoking (aOR = 2.44; 95% CI: 1.36–2.27; p = 0.05), obstructive sleep apnea (aOR = 1.76; 95% CI: 1.36–2.27; p < 0.001), and re-operation (aOR = 2.90; 95% CI: 1.49–5.64; p = 0.002). All findings were statistically significant.
Conclusion: Risk of sternal wound infection post-sternotomy significantly increases with obesity, diabetes, smoking, and re-operation.

Keywords: Obesity, diabetes, smoking, re-operation, sternal wound infection, sternotomy.

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BACKGROUND

Sternotomy remains the primary surgical approach for various cardiac procedures, including coronary artery bypass grafting (CABG), valve replacement, and aortic surgery. Although this technique provides optimal access to thoracic structures, it carries inherent postoperative risks, one of the most concerning being surgical site infections. Infections occurring after sternotomy, whether superficial or involving deep tissues, can result in significant clinical consequences (Ma et al. 2024).

Post-sternotomy wound infections are associated with prolonged hospital stays, increased healthcare costs, and poorer clinical outcomes. Patients who develop such infections are also at greater risk for re-operation, impaired wound healing, and even death. This complication not only burdens the healthcare system but also hampers recovery and negatively affects patients' quality of life (Rochayati et al., 2023).

Numerous studies have examined various factors suspected to contribute to sternal wound infections. Among the most frequently highlighted are obesity, diabetes mellitus, smoking habits, and re-operation. These factors are believed to impair immune response and tissue regeneration, thereby increasing the likelihood of infection (Majid et al. 2020).

Obesity is known to cause impaired tissue perfusion and increased pressure on the wound, while diabetes mellitus can delay healing due to metabolic disturbances and immune dysfunction (Lemaignen et al. 2015). Smoking has long been associated with vasoconstriction and tissue hypoxia, and re-operation increases infection risk due to repeated tissue trauma. Given the high prevalence of these conditions among cardiac surgery patients, a systematic review is needed to provide stronger, more reliable conclusions to guide clinical management. A meta-analysis is essential to quantitatively evaluate the relationship between these risk factors, particularly in older populations, and to support the development of targeted multidisciplinary interventions.

This study aimed to estimate the magnitude of the association between identified risk factors and the incidence of post-sternotomy wound infections. Despite extensive research on post-sternotomy wound infection, existing studies show substantial variability in reported risk factors and effect sizes. Many primary studies focus on single risk factors, use different operational definitions, or apply heterogeneous analytical methods, leading to inconsistent and sometimes conflicting conclusions. In addition, several studies are limited by small sample sizes or regional data, which restricts the generalizability of findings. Previous reviews often combine different study designs or do not exclusively use adjusted effect estimates, increasing the risk of confounding bias. As a result, the magnitude of association between key modifiable risk factors such as obesity, diabetes mellitus, smoking, and re-operation remains unclear. This lack of consolidated and comparable evidence highlights the need for a systematic review and meta-analysis based on adjusted odds ratios to provide more robust, precise, and clinically relevant estimates of risk.

SUBJECTS AND METHOD

1. Study Design

This meta-analysis study review and these articles were obtained from databases namely PubMed, Google Scholar, and Science Direct. The keywords used in searching for articles in the database are "sternotomy, AND sternal wound infection OR deep sternal wound infection OR surgical site infection, AND "obesity OR body mass index, AND diabetes mellitus OR hyperglycemia AND smoking OR tobacco use AND re-

operation AND cardiac surgery" adjusted Odds Ratio".

2. Step of Meta-Analysis

This study employed the following steps of meta-analysis:

1) Formulate research questions in the PICO, including: P= patients post-sternotomy; I= obesity, diabetes, smoking, re-operation; C= non-obese, non-diabetic, non-smokers, no re-operation; O= post-sternotomy wound infection.
2) Search for primary study articles from various electronic and non-electronic databases.
3) Conduct screening and critical assess-ment of primary research articles.
4) Perform data extraction and synthesize effect estimates into RevMan 5.3.
5) Interpret and conclude the results.

3. Inclusion Criteria

The inclusion criteria used in this study were full-text articles with a cross-sectional study design. Articles were published in English and Indonesian from 2015-2025. The final results were reported using the adjusted Odds Ratio (aOR).

4. Exclusion Criteria

Exclusion criteria in this study were different operational definitions, anonymous re-search, articles that did not use univariate and bivariate analysis, and articles that used quasi experiment, protocol study, pilot study, cohort, case control, and RCT study designs.

5. Operational Definition of Variables

Obesitas is an overweight status measured by Body Mass Index (BMI) ≥ 30 kg/m², according to the WHO classification.

Diabetes mellitus is a patients diagnosed with type 1 or type 2 diabetes mellitus, identified by a documented history of insulin use, oral hypoglycemic agents, or a fasting blood glucose level ≥126 mg/dL.

Smoking is an atients with a history of active smoking or those who had quit smoking within ≤6 months prior to surgery, as documented in medical records or based on patient self-report.

Re-operation defined as a repeat surgical intervention involving the sternotomy site during the same hospitalization period, performed due to bleeding, infection, or other postoperative complications.

Sternal wound infection is an infection at the site of the sternotomy incision, either superficial or deep , diagnosed clinically by the surgeon based on local signs and/or laboratory and culture findings.

6. Instruments

The instrument in this study was the PRISMA Flow Diagram using primary study quality assessment for a cross-sectional meta-analysis research design.

7. Data Analysis

Articles were collected and data processing was carried out using the Review Manager application (RevMan 5.3) to determine the influence between knowledge, self-efficacy and social support and the use of HIV testing among homosexuals. Data process-ing was presented in the form of forest plots and funnel plots.

RESULTS

The article search process across online publication databases resulted in 16 selected articles originating from Asia, Europe, the Americas, and Oceania.

Figure 1 is PRISMA flow diagram illustrating the selection of studies related to factors associated with post-sternotomy wound infection. This systematic review initially identified 1,025 articles through database searches. After screening and removing duplicates, 439 full-text articles were assessed for eligibility, with 423 excluded due to not meeting the inclusion criteria. This rigorous selection process ensured that only the most relevant studies were included for further analysis.

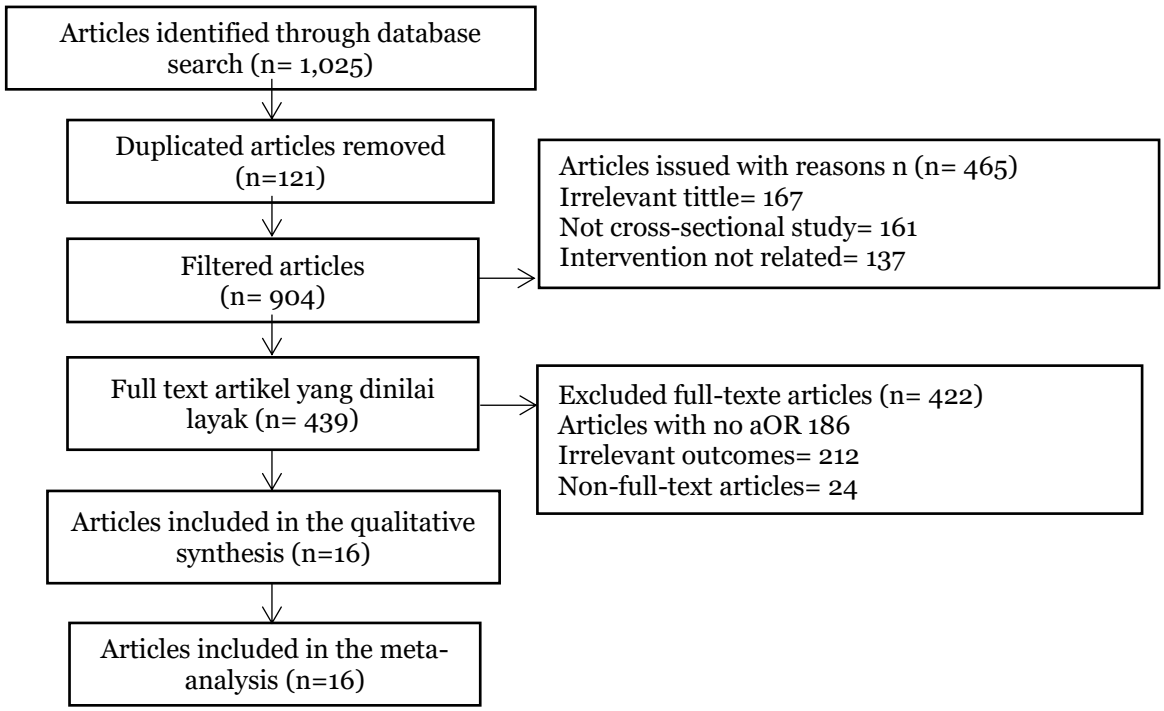

Figure 1. Results of PRISMA Flow diagrams on factors associated with post-sternotomy wound infection

Figure 2. Research distribution map on factors associated with post-sternotomy wound infection

Figure 2 illustrates the geographic distribution of studies included in the meta-analysis on factors associated with post-sternotomy wound infection. The studies were conducted across four continents: Asia, Europe, the Americas, and Oceania.

Table 1. The quality assessment result on factors associated with post-sternotomy wound infection

Primary Study	Criteria													Total
	1				2		3		4	5	6		7	
	a	b	c	d	a	b	a	b			a	b		
Lemaignen et al. (2015)	2	2	2	2	2	2	2	2	2	2	2	2	2	26
Fu et al (2016)	2	2	2	2	2	2	2	2	2	2	2	2	2	26
Gatti et al. (2016)	2	0	1	2	2	2	2	2	2	2	2	2	2	24
Pan et al. (2017)	2	2	2	2	2	2	2	2	2	2	2	2	2	26
Sá et al. (2017)	2	2	2	2	2	2	2	2	2	2	2	2	2	26
Ohira et al. (2019)	2	2	2	2	2	2	2	2	2	2	2	2	2	26
Theodore et al. (2019)	2	2	2	2	2	2	2	2	2	2	2	2	2	26
Ali et al. (2020)	2	2	2	2	2	2	2	2	2	2	2	2	2	26
Biancari et al. (2020)	2	0	1	2	2	2	2	2	2	2	2	2	2	24
Brunet et al. (2020)	2	0	1	2	2	2	2	2	2	2	2	2	2	24
Majid et al. (2020)	2	2	2	2	2	2	2	2	2	2	2	2	2	26
Yang et al. (2022)	2	2	2	2	2	2	2	2	2	2	2	2	2	26
Gundestrup et al. (2023)	2	1	1	2	2	2	2	2	2	2	2	2	2	25
Isaac 2023	2	2	2	2	2	2	2	2	2	2	2	2	2	26
Ma et al. (2024)	2	2	2	2	2	2	2	2	2	2	2	2	2	26
Chen et al. (2024)	2	2	2	2	2	2	2	2	2	2	2	2	2	26

Description of the question criteria:

1. Formulation of research questions in PICO acronym:
   a. What is the population in the study primary is the same as the population in PICO meta-analysis?
   b. What is the operational definition of intervention (intervention), namely the status of exposure (exposed) in primary studies is the same as that definition intended in meta-analysis?
   c. Is the comparison in primary studies has similar definition in meta-analysis?
   d. What is the outcome variable being studied? in primary studies is the same as that definition intended in meta-analysis?
2. Method for selecting research subjects:
   a. Descriptive cross-sectional study (prevalence): Is the sample randomly selected?
   b. Analytical cross-sectional study: Are samples randomly or purposively selected??
3. Methods for measuring comparisons (intervention) and outcome variables:
   a. Are both exposure or intervention and outcome variables measured with the same instruments in all primary studies?
   b. If variables are measured on a categorical scale, are the cut-offs used the same across primary studies?
4. Bias of the design:
   a. How much is the response rate?
   b. Is non-response related to outcomes?
5. Methods to control confounding:
   a. Is there any confusion in the results or conclusions of the primary study?
   b. Have primary study researchers used appropriate methods to control the effects of confusion?
6. Method of statistical analysis:
   a. Is there any confusion in the results or conclusions of the primary study?

b. Have primary study researchers used appropriate methods to control the effects of confusion?

7. Is there any confusion in the results or conclusions of the primary study?

Description of scoring:
0= No
1= Hesitate
2= Yes.

Table 2. Description of the primary study on factors associated with post-sternotomy wound infection

Author (Year)	Country	Sampel	P	I	C	O
Lemaignen et al. (2015)	France	176	Post-sternotomy patients treated at University Hospital of Tours, France.	Obesity and diabetes	Non-obese and non diabetic	Sternal woun infection
Fu et al (2016)	Columbia	40	18-year-old patients undergoing sternotomy	Obesity	Non obese	Sternal woun infection
Gatti et al. (2016)	Italy	1,526	Post-sternotomy patients from 2007 to 2014 at San Gerardo Hospital, Italy.	Obesity	Non obese	Sternal woun infection
Pan et al. (2017)	China	7,944	Post-sternotomy patients from 2002 to 2016 at Nanjing Drum Tower Hospital, China.	Obesity and re-operation	Non-obese and no re-operation	Sternal woun infection
Sá et al. (2017)	Brazil	1,500	Post-sternotomy patients treated at a hospital in Brazil.	Obesity, diabetes, and smoker	Non-obese, non diabetic, and non smoker	Sternal woun infection
Ohira et al. (2019)	Amerika Serikat	2,174	Post-sternotomy patients between 2002 and 2016	Obesity and re-operation	Non-obese and no re-operation	Sternal woun infection
Theodore et al. (2019)	Amerika Serikat	1,610	Post-sternotomy patients from 2011 to 2015	Obesity	Non obese	Sternal woun infection
Ali et al. (2020)	Australia	1,902	Post-sternotomy patients from 2015 to 2019 at Fiona Stanley Hospital, Australia	Obesity	Non obese	Sternal woun infection
Biancari et al. (2020)	Finlandia	2,423	Post-sternotomy patients from five hospitals in Finland between 2004 and 2016	Obesity	Non obese	Sternal woun infection
Brunet et al. (2020)	Prancis	182	Post-sternotomy patients at Reims University Hospital, France, between 2015 and 2016	Obesity	Non obese	Sternal wound infection
Majid et al. (2020)	Pakistan	417	Post-sternotomy patients at Bahria International Hospital, Pakistan, between 2017 and 2018	Obesity, diabetes, and smoker	Non-obese, non diabetic, and non smoker	Sternal wound infection
Yang et al. (2022)	China	465	Post-sternotomy patients aged >18 years at Chinese PLA	Obesity and diabetes	Non-obese and non diabetic	Sternal wound infection

Author (Year)	Country	Sampel	P	I	C	O
			General Hospital, China, from 2011 to 2021			
Gundestrup et al. (2023)	Denmark	189	Post-sternotomy patients aged >18 years at Odense University Hospital, Denmark, from 2000 to 2020.	Obesity, smoker, and re-operation	Non-obese, non-smoker, and no re-operation	Sternal wound infection
Isaac 2023	Saudi Arabia	204	Post-sternotomy patients at Saud Al-Babtain Cardiac Centre, Dammam, Saudi Arabia	Obesity and diabetes	Non-obese and non diabetic	Sternal wound infection
Ma et al. (2024)	China	427	Post-sternotomy patients at Chinese PLA General Hospital, China, from 2011 to 2021	Obesity and diabetes	Non-obese and non diabetic	Sternal wound infection
Chen et al. (2024)	China	6,715	Post-sternotomy patients at Xijing Hospital, China.	Smoker and re-operation	Non-smoker and no re-operation	Sternal wound infection

Table 3 presents the adjusted odds ratios (aOR) from studies analyzing the effect of obesity on post-sternotomy wound infection, with the highest aOR reported by Brunet et al. (2020) and the lowest by Ma et al. (2024).

The forest plot in Figure 3 indicates that obesity increases the risk of post-sternotomy wound infection. The results show that individuals with obesity have a 1.50-fold higher risk of developing surgical site infections compared to non-obese individuals (aOR= 1.50; 95% CI: 1.31 to 1.72; $p < 0.001$), and the association is statistically significant. The heterogeneity of the study data showed I^2= 84% so that data distribution was declared non heterogeneous.

Figure 4 shows the funnel plot assessing publication bias regarding the effect of obesity on post-sternotomy wound infection. The distribution of effect estimates is asymmetrical around the vertical line representing the pooled effect size, indicating potential publication bias. Since the bias appears predominantly on the right side of the mean estimate line, which aligns with the direction of the diamond in the forest plot, it suggests that the effect of obesity on wound infection may be overestimated.

Table 3. aOR and 95% CI data the effect of obesity on post-sternotomy wound infection

Author (Year)	aOR	95% CI	
		Lower Limit	Upper Limit
Lemaignen et al. (2015)	2.30	1.60	3.40
Fu et al (2016)	2.17	1.16	4.05
Pan et al. (2017)	1.08	1.01	1.16
Sá et al. (2017)	2.58	1.11	6.68
Ohira et al. (2019)	2.13	1.59	2.85
Theodore et al. (2019)	1.8	1.1	3.0

Author (Year)	aOR	95% CI	
		Lower Limit	Upper Limit
Ali et al. (2020)	1.72	1.16	2.56
Biancari et al. (2020)	1.72	1.16	2.56
Brunet et al. (2020)	14.61	2.64	80.75
Majid et al. (2020)	1.24	0.33	4.70
Yang et al. (2022)	2.29	1.38	3.70
Gundestrup et al. (2023)	2.35	1.50	3.71
Isaac 2023	1.25	1.04	1.50
Ma et al. (2023)	1.08	1.01	1.11

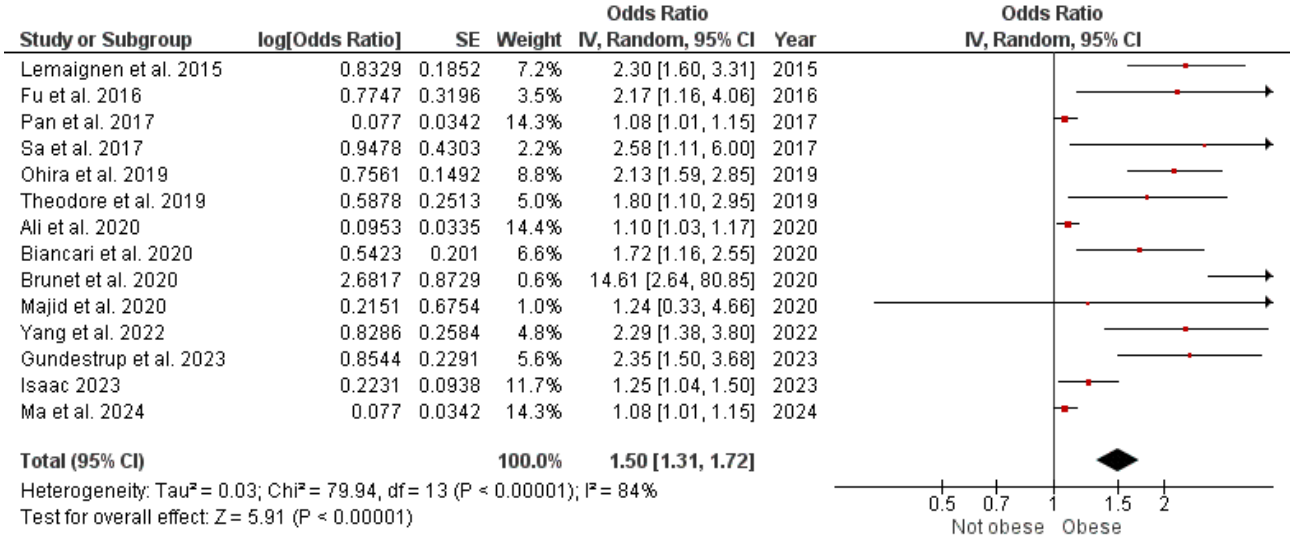

Figure 3. Forest plot of the effect of obesity on post-sternotomy wound infection

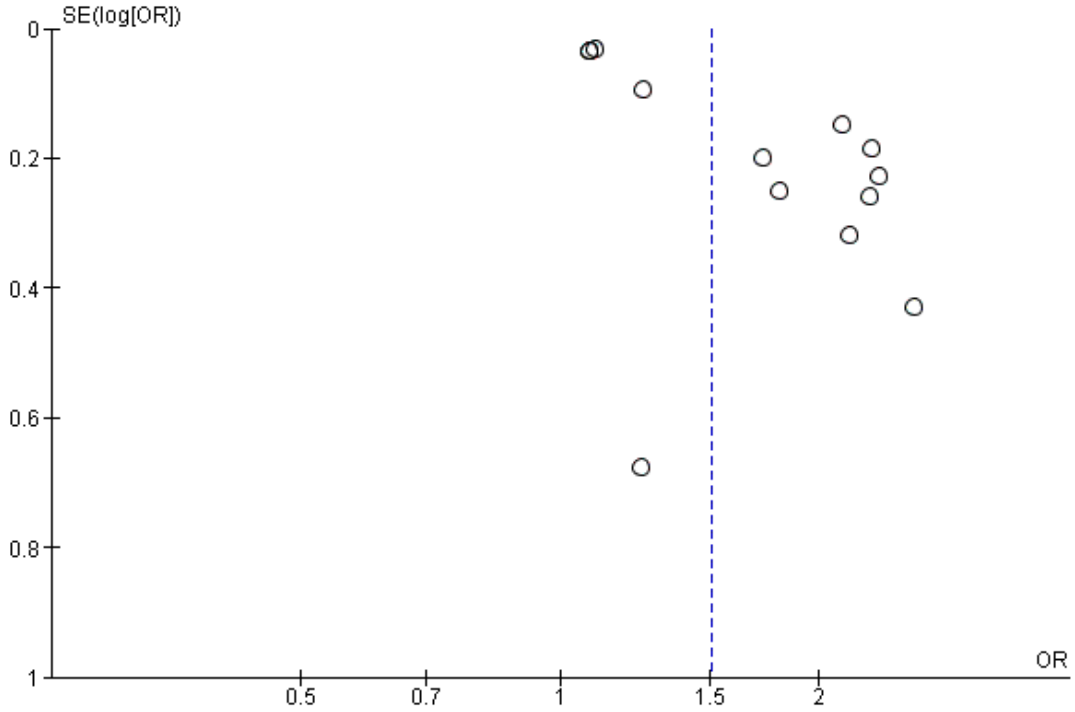

Figure 4. Funnel plot of the effect of obesity on post-sternotomy wound infection

Table 4 presents the adjusted odds ratios (aOR) from studies examining the effect of diabetes on post-sternotomy wound infection, with the highest aOR reported by Gatti et al. (2016) and the lowest by Lemaignen et al. (2015).

Table 4. aOR and 95% CI data the effect of diabetes on post-sternotomy wound infection

(Author, Year)	aOR	95% CI	
		Lower Limit	Upper Limit
Lemaignen et al. (2015)	1.0	0.7	1.6
Gatti et al. (2016)	5.01	2.47	10.15
Sa et al. (2017)	2.61	1.12	6.63
Majid et al. (2020)	2.18	0.58	8.20
Yang et al. (2022)	3.44	1.84	6.78
Isaac 2023	1.09	0.84	1.41
Ma et al. (2024)	2.04	1.09	3.80

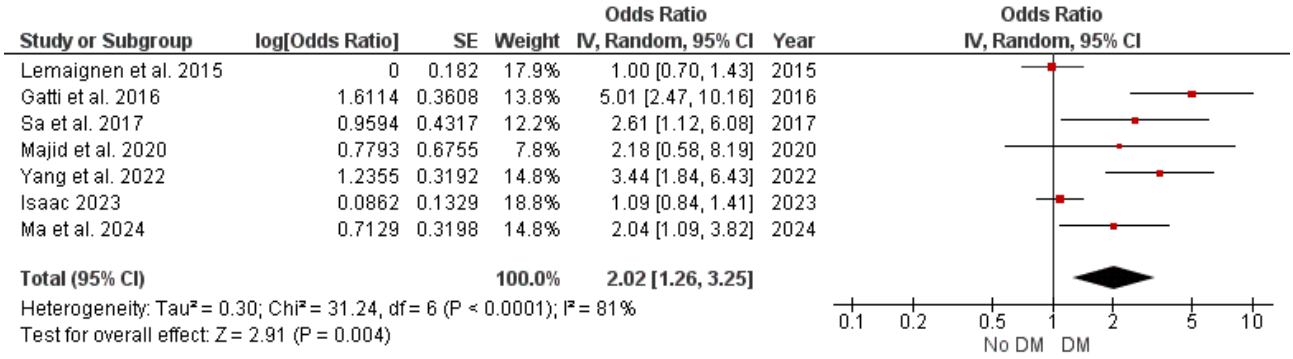

Figure 5. Forest plot of the effect of diabetes on post-sternotomy wound infection

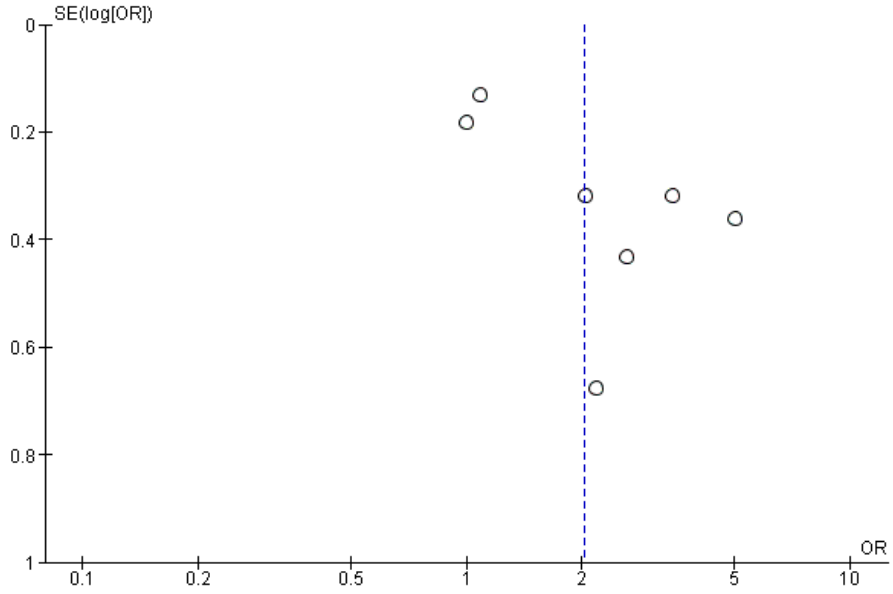

Figure 6. Funnel plot of the effect of diabetes on post-sternotomy wound infection

The forest plot in Figure 5 demonstrates that diabetes increases the risk of post-sternotomy wound infection. The results indicate that individuals with diabetes have a 2.02 times higher risk of developing wound infections following sternotomy compared to non-diabetic individuals (aOR= 2.02; 95% CI: 1.26 to 3.25; p= 0.004), and this result is statis-tically significant. The heterogeneity of the study data showed I^2= 81% so that data distribution was declared non heterogeneous.

Figure 6 shows the funnel plot assessing publication bias regarding the effect of diabetes on post-sternotomy wound infection. The distribution of effect estimates is symmetrical around the vertical line representing the average effect size, indicating no evidence of publication bias.

Table 5 presents the adjusted odds ratios (aOR) from studies examining the effect of smoking on post-sternotomy wound infection, with the highest aOR reported by Chen et al. (2024) and the lowest by Majid et al. (2020).

Table 5. Studies of effect of smoking on post-sternotomy wound infection

(Author, Year)	aOR	95% CI	
		Lower Limit	Upper Limit
Sa et al. (2017)	2.10	1.12	4.67
Majid et al. (2020)	1.04	0.29	3.39
Gundestrup et al. (2023)	1.69	1.20	2.35
Chen et al. (2024)	7.05	5.03	9.89

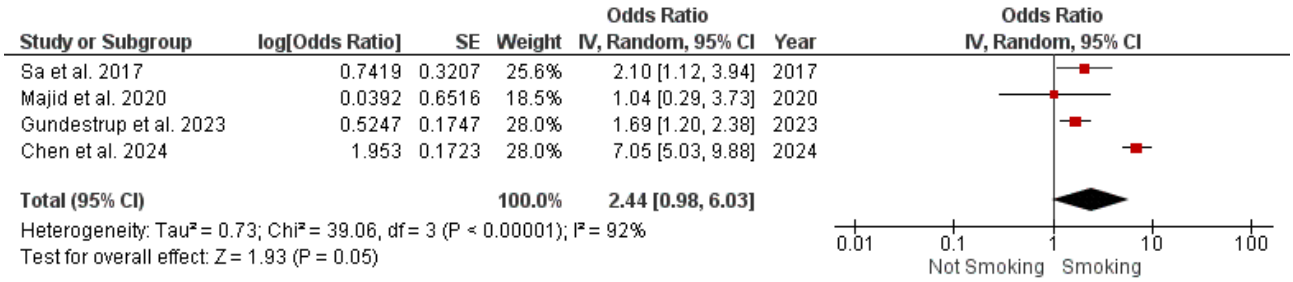

Figure 7. Forest plot of the effect of smoking on post-sternotomy wound infection

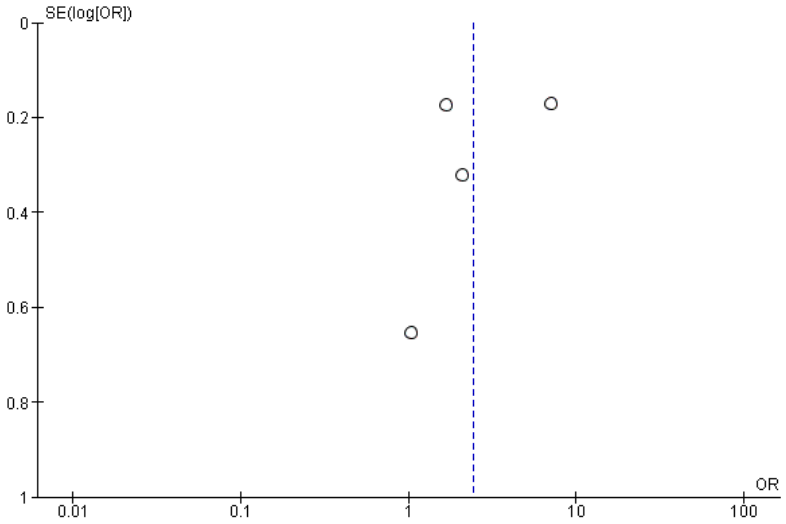

Figure 8. Funnel plot of the effect of smoking on post-sternotomy wound infection

The forest plot in Figure 7 demonstrates that smoking increases the risk of post-sternotomy wound infection. The results show that individuals with a history of smoking have a 2.44 times higher risk of developing wound infections after sternotomy compared to non-smokers (aOR= 2.44; 95% CI: 1.36 to 2.27; p = 0.05), and the result is statistically significant. The heterogeneity of the study data showed I^2= 92% so that data distribution was declared non heterogeneous.

Figure 8 displays the funnel plot assessing potential publication bias in studies investigating the effect of smoking on post-sternotomy wound infection. The distribution of effect estimates is symmetrical on both sides of the vertical line representing the average effect size, indicating no evidence of publication bias.

Table 6. aOR of studies examining the effect of re-operation on wound infection

(Author, Year)	aOR	95% CI	
		Lower Limit	Upper Limit
Pan et al. (2017)	5.93	2.88	12.25
Ohira et al. (2019)	2.64	1.04	6.67
Gundestrup et al. (2023)	1.63	1.06	2.45
Chen et al. (2024)	3.23	1.08	9.62

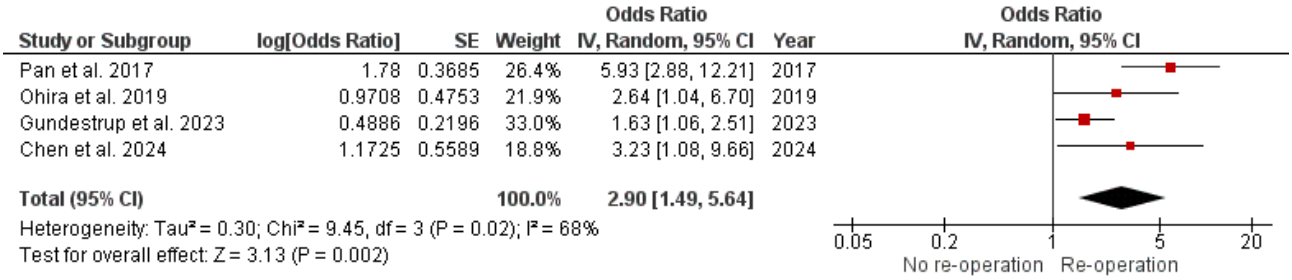

Figure 9. Forest plot of the effect of re-operation on post-sternotomy wound infection

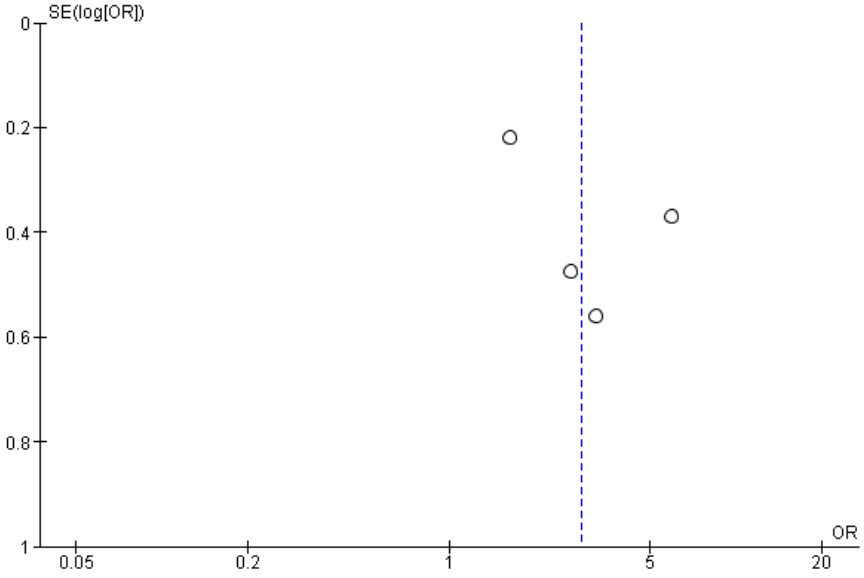

Figure 10. Funnel plot of the effect of re-operation on post-sternotomy wound infection

Table 6 presents the adjusted odds ratios (aOR) from studies investigating the effect of re-operation on post-sternotomy wound infection, with the highest aOR reported by Pan et al. (2017) and the lowest by Gundestrup et al. (2023).

The forest plot in Figure 9 shows that re-operation increases the risk of post-sternotomy wound infection. The results indicate that individuals who underwent re-operation had a 2.90 times higher risk of developing wound infections after sternotomy compared to those who did not (aOR = 2.90; 95% CI: 1.49 to 5.64; p = 0.002), and the result is statistically significant. The heterogeneity of the study data showed I^2 = 68% so that data distribution was declared non heterogeneous.

Figure 10 displays the funnel plot assessing the potential for publication bias regarding the effect of re-operation on post-sternotomy wound infection. The distribution of effect estimates appears symmetrical on both sides of the vertical line representing the mean estimate, suggesting no evidence of publication bias.

DISCUSSION

Obesity and Post-Sternotomy Wound Infection

Obesity contributes to impaired tissue perfusion and local hypoxia at the wound site. In obese patients, thick subcutaneous fat compresses small blood vessels, reducing blood flow to the skin and sternum. This condition hampers the delivery of oxygen and nutrients essential for wound healing and limits the distribution of systemic antibiotics to the surgical site. Additionally, poorly vascularized adipose tissue is more prone to necrosis and infection due to the accumulation of toxic metabolites. As a result, sternal wounds in obese individuals tend to heal more slowly and are at higher risk of dehiscence or infection (Isaac, 2023).

Chronic low-grade inflammation often impairs the immune system in obese patients. Excess adipose tissue promotes the release of pro-inflammatory cytokines such as TNF-α and IL-6, which disrupt the function of neutrophils and macrophages—key immune cells responsible for fighting bacterial infections. Obesity also weakens the body's ability to defend against pathogens like Staphylococcus aureus, a common cause of sternal wound infections, by reducing phagocytic activity and antibody production. Furthermore, hyperglycemia, frequently associated with obesity, exacerbates micro-injuries and fosters bacterial growth (Brunet et al., 2020).

In obese patients, technical factors during surgery and wound closure are more complex. One independent risk factor for infection is the thick subcutaneous fat layer, which obstructs surgical visibility. The risk of sternal fixation failure or wire loosening increases due to the mechanical strain from the heavy adipose tissue on the sutures. Moreover, excessive use of electrocautery for hemostasis in fatty tissue can result in thermal injury and local necrosis, both of which predispose the wound to secondary infection.ini dapat menyebabkan infeksi sekunder (Theodore et al., 2019).

Diabetes and Post-Sternotomy Wound Infection

Chronic hyperglycemia in diabetic patients creates a favorable environment for bacterial proliferation and delays wound healing. Elevated blood glucose levels impair neutrophil and macrophage function—critical immune cells in preventing infection. Hyperglycemia also increases the production of advanced glycation end products (AGEs), which damage collagen and elastin, thereby

slowing tissue repair. Additionally, high glucose levels serve as a nutrient source for bacteria, increasing the risk of colonization and infection in the sternotomy wound, particularly by organisms such as Staphylococcus aureus and Pseudomonas aeruginosa (Lemaignen et al., 2020).

Diabetes impairs microcirculation and causes peripheral neuropathy, both of which reduce blood supply and sensation at the wound site. Microangiopathy, or small vessel disease, limits oxygen and nutrient delivery to the sternal tissues. Patients with peripheral neuropathy may also fail to notice early signs of infection, such as redness or pain, leading to delayed diagnosis and treatment. These factors collectively heighten the risk of infection and severe complications such as mediastinitis (Yang et al., 2022).

Perioperative management in diabetic patients is often complex and increases infection risk. Blood glucose fluctuations during and after surgery are difficult to control, particularly in the setting of postoperative physiological stress. Perioperative hyperglycemia can also impair the effectiveness of prophylactic antibiotics by reducing drug concentrations at the target tissues. Furthermore, diabetic patients frequently present with comorbidities such as obesity or peripheral vascular disease, further compounding their susceptibility to infection. Therefore, strict glycemic control before, during, and after surgery is critical to minimizing the risk of sternal wound complications in this population (Ma et al., 2024).

Smoking and Post-Sternotomy Wound Infection

Nicotine in cigarettes acts as a vasoconstrictor, reducing blood flow to tissues, including the sternal area after surgery. This limits the supply of oxygen and essential nutrients necessary for wound healing. In addition, carbon monoxide from cigarette smoke binds to hemoglobin with high affinity, reducing the blood's oxygen-carrying capacity by up to 15–20%. The combination of vasoconstriction and hypoxia creates an ischemic environment that is conducive to the growth of anaerobic bacteria while simultaneously weakening the local immune response to infection (Gundestrup et al., 2023).

Smoking also impairs immune function and increases susceptibility to bacterial invasion. Cigarette smoke disrupts the activity of neutrophils and macrophages—two primary immune cells responsible for clearing bacteria from wounds. Moreover, smokers demonstrate reduced antibody production and T-cell activity, diminishing their overall defense against infection. Studies have shown that smokers are approximately 2.5 times more likely to develop sternal wound infections compared to non-smokers (Chen et al., 2024).

Tindakan re-operation dan infeksi luka pasca sternotomi

Re-operation significantly increases the risk of infection due to repeated tissue trauma and prolonged exposure to environmental pathogens. Each subsequent surgical intervention damages the tissue further, interferes with wound healing, and increases the duration of bacterial contamination. Manipulation of an already compromised sternum also creates anatomical spaces that facilitate bacterial colonization (Pan et al., 2017).

Patients requiring re-operation are often in a more critical condition, which inherently raises their infection risk. They may be experiencing hemorrhage, shock, or multi-organ failure—all of which impair immune competence. The immune system is further suppressed by repeated blood transfusions often needed during their care.

As a result, the risk of sternal wound infection following re-operation may be four to five times higher than after the initial surgery (Ohira et al., 2019).

AUTHOR CONTRIBUTION

Aris Widiyanto, as the main researcher, designed, determined the research topic, and participated in the search for articles.

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CONFLICT OF INTEREST

The authors declare that theres no conflict of interest in this study.

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