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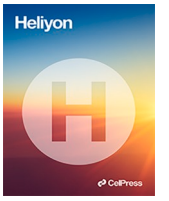

Research article

Risk factors for acute respiratory distress syndrome in sepsis patients: A meta-analysis

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ABSTRACT

Background: Acute Respiratory Distress Syndrome (ARDS) is a critical complication of sepsis, associated with high morbidity and mortality. Identifying risk factors for ARDS among sepsis patients is essential for early intervention and improving outcomes.
Methods: We conducted a comprehensive meta-analysis, reviewing studies that examined the association between various risk factors and ARDS development in sepsis patients. Databases such as PubMed, EMBASE, Cochrane Library, Medline, CINAHL, and Web of Science were searched up to January 2024, without language restrictions. Eligible studies included observational cohorts and case-control studies. Pooled odds ratios (ORs) and standardized mean differences (SMDs) were calculated using a random-effects model. Heterogeneity was assessed through I^2 statistics, and publication bias was evaluated via the Luis Furuya-Kanamori (LFK) index.
Results: 15 studies with more than 40,000 participants were analyzed. Significant risk factors for ARDS included pulmonary infection (OR: 2.696, 95 % CI: 1.655 to 4.390), septic shock (OR: 2.627, 95 % CI: 1.850 to 3.731), and pancreatitis (OR: 3.734, 95 % CI: 2.958 to 4.712). No significant associations were found between the development of ARDS in septic patients and the following risk factors: sex (OR: 1.106, 95%CI: 0.957–1.279), smoking status (OR: 1.214, 95%CI: 0.835–1.765), or steroid use (OR: 0.901, 95%CI: 0.617–1.314). APACHE-II and SOFA scores were predictive of ARDS development, emphasizing their utility in clinical assessments.
Conclusion: Pulmonary infection, septic shock, and pancreatitis significantly increase ARDS risk in sepsis patients. Our findings advocate for targeted management of these risk factors to mitigate ARDS development, emphasizing the importance of personalized care in sepsis management.

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1. Introduction

Acute Respiratory Distress Syndrome (ARDS) represents a severe, life-threatening condition characterized by rapid onset of widespread inflammation in the lungs [1,2]. It is a key complication among patients with sepsis, a systemic response to infection that can lead to significant morbidity and mortality [3].

ARDS occurs when an injury to the lungs leads to an inflammatory response, resulting in increased vascular permeability and accumulation of protein-rich fluid in the alveolar spaces [4,5]. This process leads to impaired gas exchange, decreased lung compliance, and severe hypoxemia. ARDS can be triggered by various direct and indirect pulmonary insults, including sepsis, which is the most common cause. The complex interplay between the systemic inflammatory response and the pulmonary system in sepsis makes understanding ARDS within this context particularly challenging [6].

The incidence of ARDS in septic patients varies, but it is recognized as a significant predictor of poor outcomes, including extended hospital stays, increased healthcare costs, and high mortality rates [7,8]. Despite advancements in supportive care strategies, the ARDS-related mortality remains high, underscoring the need for early identification and intervention in patients at risk [8].

Sex has been explored as a potential risk factor for the development of ARDS in sepsis, with studies suggesting differences in susceptibility and outcomes between men and women [9–13]. Elevated lactate levels in septic patients are indicative of tissue hypoperfusion and have been associated with increased risk of developing ARDS [12,14]. The use of steroids in sepsis has been a topic of debate, with potential benefits in modulating the inflammatory response but also risks that may include predisposing patients to ARDS [10,15].

Scoring systems such as the Acute Physiology and Chronic Health Evaluation (APACHE) II and the Sequential Organ Failure Assessment (SOFA) are valuable tools for assessing the severity of illness and predicting outcomes in critically ill patients, including those with sepsis [9–14]. Pulmonary infections can directly contribute to lung injury and inflammation, increasing the risk of ARDS [10–13]. Smoking history is another factor that may influence the risk of ARDS in sepsis [9–11]. Patients with septic shock are at an elevated risk for ARDS due to the intense systemic inflammatory response and the potential for direct lung injury [9,10,16].

ARDS in septic patients is a multifaceted issue with numerous contributing factors. Understanding the interplay between these risk factors is essential for developing strategies for early detection, prevention, and management of ARDS in this vulnerable population. Despite the growing body of research on ARDS, there remains a significant gap in understanding the precise risk factors and their interplay in the context of sepsis [9–13]. Previous studies have often been limited by small sample sizes, inconsistent methodologies, and varying definitions of ARDS, leading to conflicting results [9–13]. Furthermore, the evolving nature of sepsis management and the emergence of new therapeutic strategies necessitate an updated and comprehensive analysis of ARDS risk factors. A meta-analysis that synthesizes data from diverse studies can provide robust evidence and clearer insights into the most significant predictors of ARDS in septic patients. This, in turn, can guide clinical decision-making, optimize patient outcomes, and inform future research directions. Hence, this review determines the sociodemographic, behavioural, biochemical, clinical therapy, severity of illness scores, and haemodynamic instability related risk factors for ARDS in septic patients.

2. Methods

2.1. Eligibility criteria

Population (P): Adults (18 years and older) diagnosed with sepsis.

Exposure (E): Risk factors including sex differences, elevated lactate levels, steroid treatment, scores from APACHE II and SOFA, pulmonary site of infection, history of smoking, and presence of septic shock.

Comparator (C): Septic patients without these specified risk factors.

Outcomes (O): Incidence of ARDS among septic patients.

Study Designs (S): Observational study designs, including prospective and retrospective cohorts, case-control, and cross-sectional studies.

2.2. Search strategy

A comprehensive search strategy was employed across multiple databases, including PubMed, EMBASE, Cochrane Library, Medline, CINAHL, and Web of Science. The search utilized a combination of key terms such as "Sepsis," "Acute Respiratory Distress Syndrome," alongside the specific risk factors of interest: "Gender," "Lactate Levels," "Steroid Use," "APACHE II," "SOFA," "Pulmonary Infection," "Smoking History," and "Septic Shock." The strategy aimed to capture all relevant studies from the inception of each database up to January 2024, without imposing any language restrictions. The full search strategy is provided in **Supplementary file 1**.

2.3. Study selection procedure

The process of selecting studies involved two independent reviewers conducting initial screenings based on titles, abstracts, and key terms, followed by in-depth evaluations of full-text articles. This meticulous approach aimed to identify studies that met the project criteria, with any disagreements resolved through consensus. The selection protocol adhered to PRISMA guidelines to ensure a structured and transparent methodology.

2.4. Data collection process

For data collection, the primary investigator extracted crucial information from each study, including specifics about the study population, context, methods, and key findings related to the risk factors under investigation. This encompassed data on participant numbers for each risk factor, observed outcomes, details of risk exposures, and the duration of follow-up. Accuracy of the extracted data was confirmed by a secondary reviewer, enhancing the review's reliability.

2.5. Risk of bias assessment

The integrity and validity of the studies included in this review were rigorously assessed for risk of bias using the Newcastle-Ottawa Scale (NOS), a tool esteemed for its efficacy in evaluating observational studies. Two independent researchers applied the NOS, ensuring an unbiased and thorough analysis by resolving any scoring discrepancies through mutual agreement [17].

The NOS evaluates studies across three principal dimensions: the selection of participants, the comparability of study groups, and the ascertainment of either exposure (in case-control studies) or outcomes (in cohort studies). Each dimension is rated using a star system, contributing to a composite score that reflects the study's methodological quality. High-quality studies are denoted by a score of seven to nine stars, indicating a lower risk of bias. Studies scoring four to six stars are considered to have a moderate risk of bias, while those with three or fewer stars are seen as having a high risk of bias.

2.6. Statistical analysis

The statistical analysis within our investigation was executed using STATA software, version 14.2, to ensure precision and robustness in evaluating the data. This choice of software facilitated an in-depth analysis, crucial for the integrity of our findings. Since the outcomes in our study were binary, we computed the aggregate odds ratio (OR) and a 95 % confidence interval (CI) to compare the

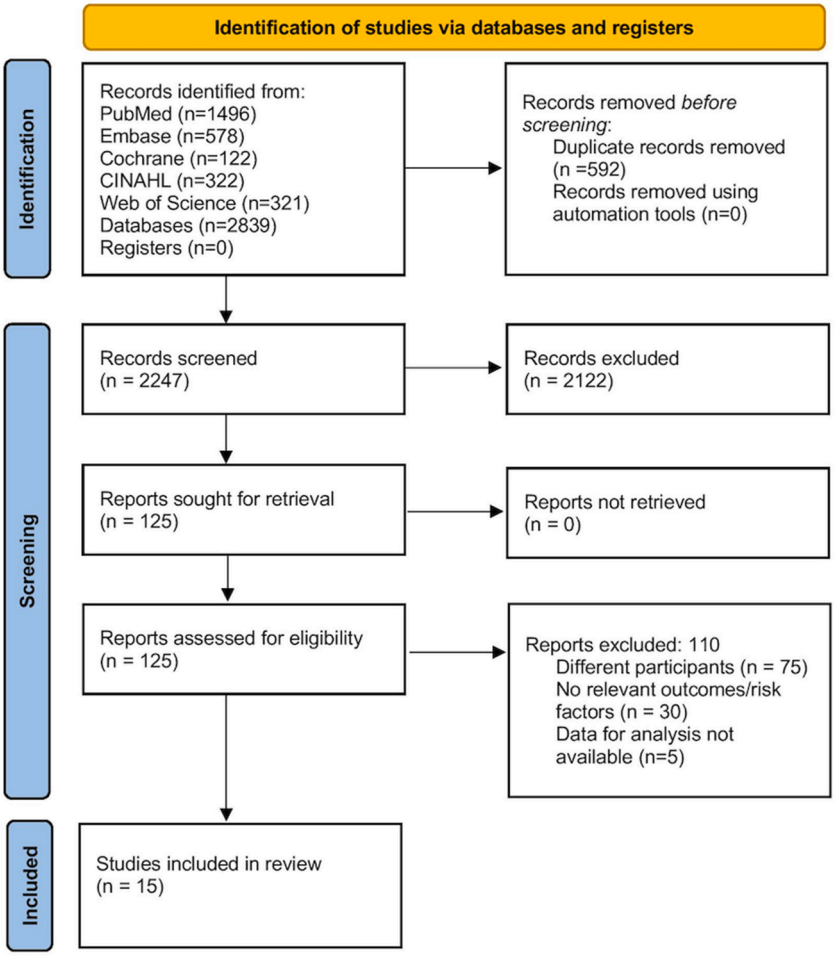

Fig. 1. PRISMA flowchart.

impact of risk factors on the development of ARDS among septic patients. This calculation was based on the frequency of events in both groups under study, enabling a comparative analysis of the risk factors' effects. Opting for a random-effects model, using the inverse variance method, was pivotal to accommodate the heterogeneity inherent in the collected data from various studies [18].

To evaluate heterogeneity, or the variance in outcomes across the studies, we applied a comprehensive approach. Chi-Square tests were employed to identify the presence of heterogeneity, while the I^2 Statistic quantified the proportion of total variation across studies due to heterogeneity rather than by chance. A sensitivity analysis was also conducted to gauge the impact of individual studies on the overall meta-analysis results, ensuring the findings' robustness and credibility.

Given the scarcity of studies for each risk factor (with fewer than the required minimum of 10 for traditional publication bias assessment methods), we could not use the Funnel plot or Egger's test. Instead, the Doi plot and the Luis Furuya Kanamori (LFK) index were utilized as alternative methods for detecting and quantifying potential publication bias. The LFK index categorizes the absence of

Table 1
Characteristics of the included studies (N = 15).

Author and Year	Study region and country	Design	Total ssample	Study Participants details	Criteria for ARDS diagnosis	Average age (in years)	Risk of bias assessment
Ahlstrom 2022	Europe (Sweden)	Cohort study	22354	Sepsis patients admitted to ICU	American European Consensus conference definition for ARDS	70 (overall)	Low
Auriemma 2020	America (United States)	Prospective cohort study	811	Sepsis patients admitted to ICU	Berlin definition of ARDS	66 (overall)	Low
Fein 1983	America (United States)	Prospective study	116	Sepsis patients admitted to Albert Einstein Medical Center	Clinical, roentgenographic and physiologic criteria	NA	High
Gong 2005	America (United States)	Observational prospective cohort study	688	Sepsis patients admitted to ICU	American European Consensus conference definition for ARDS	Median age of 65 in ARDS group and 67 in non-ARDS group	Low
Iriyama 2020	Asia (Japan)	Prospective study	594	Severe sepsis adult patients caused by non-pulmonary infection	Berlin definition of ARDS	Median age of 70 in ARDS group and 72 in non-ARDS group	Low
Li 2020	Asia (China)	Prospective study	150	Sepsis patients who attended Cangzhou Central Hospital	Berlin definition of ARDS	56.9 (overall)	Low
Mckown 2017	America (United States)	Retrospective observational study	1080	Critically ill sepsis patients in academic tertiary care hospital	Berlin definition of ARDS	57 (Overall)	High
Mikkelsen 2013	America (United States)	Retrospective study	778	Severe sepsis adults presenting to ED	Berlin definition of ARDS	Median age of 55 in ARDS group and 57 in non-ARDS group	Low
Moazed 2022	America (United States)	Prospective cohort study	592	Sepsis patients from 2009 to 2017	Berlin definition of ARDS	69 in non-smokers 66 in passive smokers 58 in active smokers	Moderate
Nam 2019	Asia (South Korea)	Retrospective study	125	Septic bacteremia patients presenting to ICU	Berlin definition of ARDS	73 (overall)	Moderate
Qiao 2015	Asia (China)	Retrospective study	312	Sepsis patients admitted to ED of China Medical University Affiliated First Hospital	Berlin definition of ARDS	NA	Moderate
Seethala 2017	America (United States)	Prospective study	2534	Septic adult patients presenting to the ED	Berlin definition of ARDS	58.5 (overall)	Low
Shi 2022	Asia (China)	Retrospective study	529	Sepsis patients admitted to ICU	Berlin definition of ARDS	Median age of 66 in ARDS group and 70 in non-ARDS group	Moderate
Wang 2020	Asia (China)	Prospective cohort study	156	Sepsis patients admitted to ICU	Berlin definition of ARDS	59.2 in Sepsis patients without ARDS and 62 in sepsis patients with ARDS	Low
Xu 2023	Asia (China)	Retrospective study	11566	Sepsis patients admitted to ICU	Berlin definition of ARDS	65.4 (overall)	Low

ARDS = Acute respiratory distress syndrome.
ICU = Intensive care unit.
ED = Emergency department.
NA = Not available.

publication bias as values within −1 to +1, suggesting symmetry. Values ranging from −1 to −2 or +1 to +2 indicate mild asymmetry, and extreme values beyond these thresholds (less than −2 or greater than +2) denote significant asymmetry, pointing to a probable presence of publication bias [19]. However, for this analysis also, minimum of four studies were required and it was not performed for risk factor having less than four studies.

3. Results

3.1. Search results

Our comprehensive search across various databases initially identified 2839 studies that appeared relevant to our research objectives. A preliminary assessment based on titles and abstracts refined this number down to 125 studies that potentially aligned with our inclusion criteria. Further detailed scrutiny of these full-text articles resulted in the selection of 15 studies that were deemed appropriate and met all the necessary criteria for inclusion in our analysis (Fig. 1) [9–16,20–26].

3.2. Characteristics of the studies included

The meta-analysis incorporated 15 studies, covering more than 40,000 septic patients admitted to Intensive Care Units (ICUs) or emergency departments, across various regions including Europe, America, and Asia. The majority of studies were conducted in the United States (7 studies) and China (5 studies), with single studies from Sweden, Japan, and South Korea. The designs of these studies varied, encompassing both prospective and retrospective. The diagnosis of ARDS was primarily based on the Berlin definition, with two studies using the American European Consensus Conference definition. Risk of bias assessments revealed most studies (10 out of 15) were classified as having a low risk of bias, while 3 were considered to have a moderate risk, and 2 were assessed as having a high risk of bias (Table 1).

3.3. Sex

Our meta-analysis, which included 12 studies with a total of 40,360 participants, examined the impact of sex on the development of ARDS among septic patients using a random-effects inverse-variance model. The pooled OR for the overall effect was 1.106 (95 % CI: 0.957 to 1.279), suggesting no significant association between sex and ARDS development in septic patients (p = 0.172) (Fig. 2). The analysis revealed substantial heterogeneity (I^2 = 65.0 %, p = 0.001). Sensitivity analysis revealed that the pooled estimate was robust to the single study effects. LFK index was −0.64, with doi plot showing no asymmetry, indicating no publication bias (Supplementary Fig. 1).

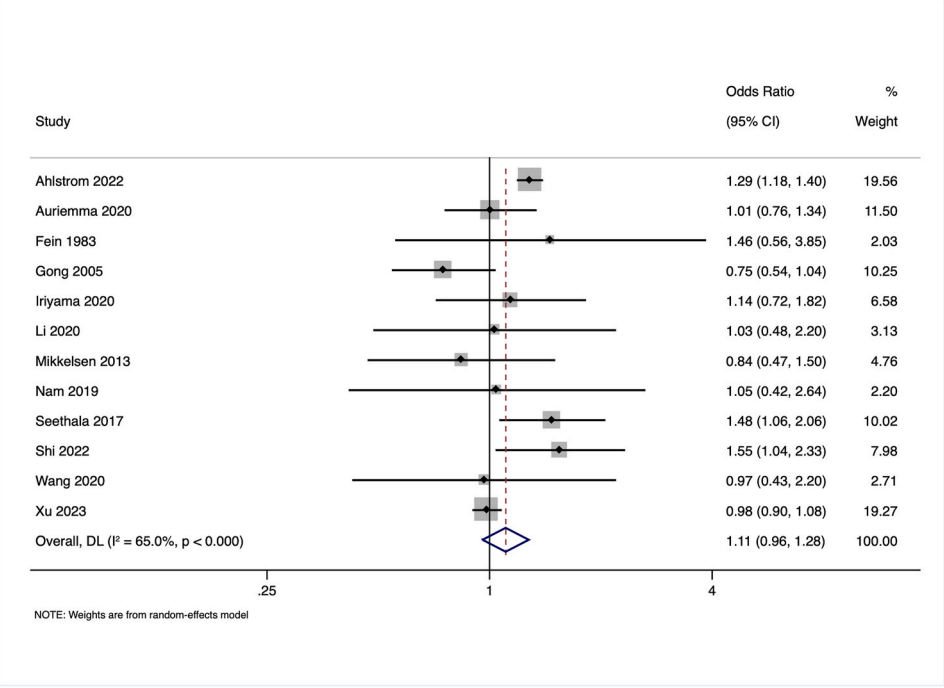

Fig. 2. Forest plot showing the association between sex and acute respiratory distress syndrome amongst septic patients.

3.4. Smoking

In our meta-analysis, which encompassed 6 studies with a total of 3869 participants, we explored the relationship between smoking status and the development of ARDS in septic patients. The analysis yielded a pooled OR of 1.214 (95 % CI: 0.835 to 1.765), indicating no statistically significant impact of smoking status on the likelihood of developing ARDS in the context of sepsis ($p = 0.310$) (Fig. 3). The studies demonstrated considerable heterogeneity ($I^2 = 70.9$ %, $p = 0.004$)

. Sensitivity analysis revealed that the pooled estimate was robust to the single study effects. LFK index was 0.67, with doi plot showing no asymmetry, indicating no publication bias (Supplementary Fig. 2).

3.5. Pulmonary site of infection

Our meta-analysis assessed the influence of pulmonary infection on the development of ARDS in septic patients, including data from 6 studies with 2750 participants. The pooled analysis revealed a significant association with an OR of 2.696 (95 % CI: 1.655 to 4.390), indicating that septic patients with a pulmonary infection have a markedly higher risk of developing ARDS compared to those without ($p < 0.001$) (Fig. 4). The analysis also showed high heterogeneity among the included studies ($I^2 = 80.5$ %, $p < 0.001$). Sensitivity analysis revealed that the pooled estimate was robust to the single study effects. LFK index was −0.90, with doi plot showing no asymmetry, indicating no publication bias (Supplementary Fig. 3).

3.6. Septic shock

Our meta-analysis assessed the influence of pulmonary infection on the development of ARDS in septic patients, including data from 6 studies with 2750 participants. The pooled analysis revealed a significant association with an OR of 2.696 (95 % CI: 1.655 to 4.390), indicating that septic patients with a pulmonary infection have a markedly higher risk of developing ARDS compared to those without ($p < 0.001$) (Fig. 5). The analysis also showed high heterogeneity among the included studies ($I^2 = 80.5$ %, $p < 0.001$). Sensitivity analysis revealed that the pooled estimate was robust to the single study effects. LFK index was 1.99, with doi plot showing minor asymmetry, indicating the possibility of minor publication bias (Supplementary Fig. 4).

3.7. Pancreatitis

Our meta-analysis, which included 3 studies with a total of 14,629 participants, assessed the association between pancreatitis and the development of ARDS. The pooled OR was 3.734 (95 % CI: 2.958 to 4.712), indicating a significantly increased risk of ARDS in patients with pancreatitis ($p < 0.001$) (Fig. 6). The heterogeneity among the included studies was remarkably low ($I^2 = 0.0$ %, $p = 0.981$). Sensitivity analysis revealed that the pooled estimate was robust to the single study effects.

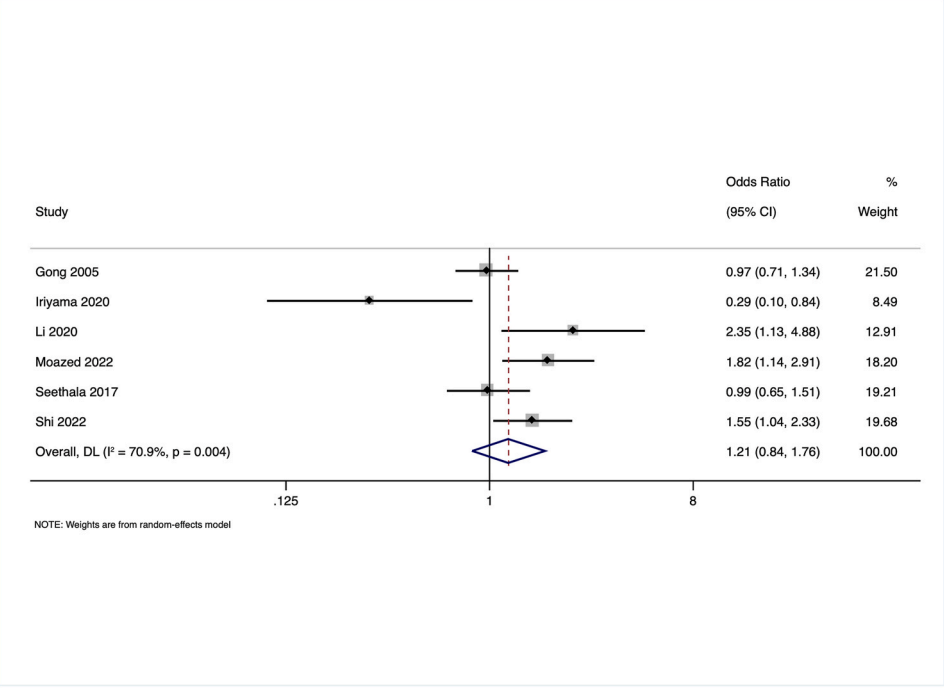

Fig. 3. Forest plot showing the association between smoking and acute respiratory distress syndrome amongst septic patients.

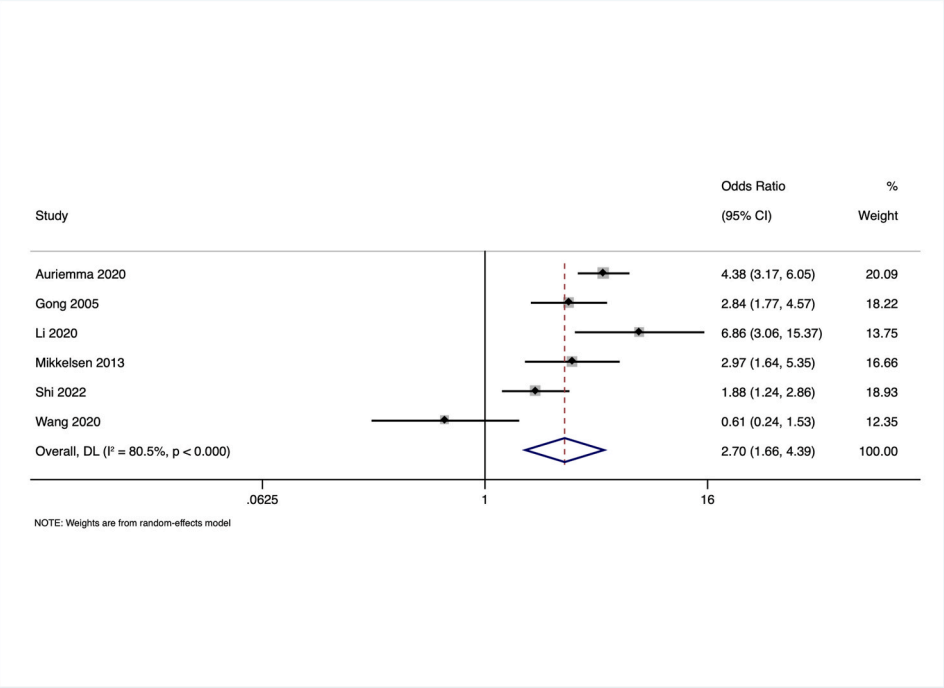

Fig. 4. Forest plot showing the association between pulmonary site of infection and acute respiratory distress syndrome amongst septic patients.

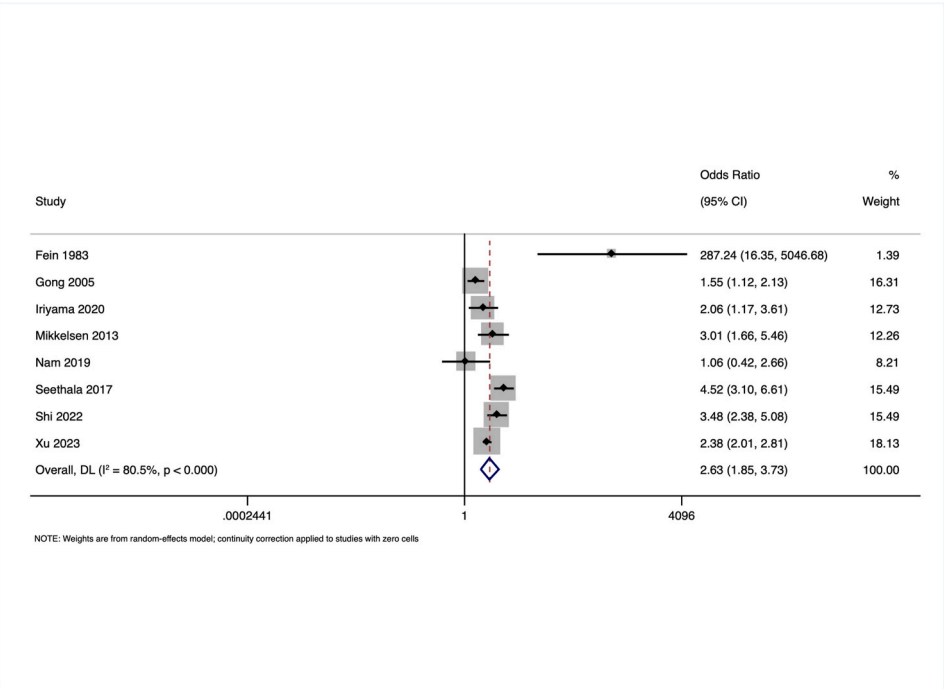

Fig. 5. Forest plot showing the association between septic shock and acute respiratory distress syndrome amongst septic patients.

3.8. Steroid use

In this meta-analysis, which included 3 studies with a total of 2362 participants, we evaluated the effect of steroid use on the development of ARDS. The analysis resulted in a pooled OR of 0.901 (95 % CI: 0.617 to 1.314), indicating no significant association

between steroid use and the development of ARDS in patients (p = 0.587) (Supplementary Fig. 5). The heterogeneity among the included studies was moderate (I^2 = 39.1 %, p = 0.194). Sensitivity analysis revealed that the pooled estimate was robust to the single study effects.

3.9. Apache-II score

In our meta-analysis, encompassing 8 studies with 5862 participants, we investigated the difference in APACHE II scores between septic patients who developed ARDS and those who did not. The pooled analysis yielded a SMD of 0.640 (95 % CI: 0.390 to 0.891), indicating a significant difference in APACHE II scores, with a higher score observed in those who developed ARDS (p < 0.001) (Supplementary Fig. 6). This suggests that patients with higher APACHE II scores are more likely to develop ARDS in the context of sepsis. The heterogeneity among the included studies was high (I^2 = 90.1 %, p < 0.001). Sensitivity analysis revealed that the pooled estimate was robust to the single study effects. LFK index was 1.35, with doi plot showing minor asymmetry, indicating the possibility of minor publication bias (Supplementary Fig. 7).

3.10. SOFA score

In this meta-analysis, which included 5 studies with a total of 12,964 participants, we assessed the difference in SOFA scores between septic patients who developed ARDS and those who did not. The analysis revealed a pooled SMD of 0.904 (95 % CI: 0.140 to 1.667), indicating a significant difference in SOFA scores, with higher scores observed in patients who developed ARDS (p = 0.020) (Supplementary Fig. 8). This suggests that elevated SOFA scores are associated with an increased likelihood of developing ARDS in the context of sepsis. The heterogeneity among the included studies was extremely high (I^2 = 98.7 %, p < 0.001). Sensitivity analysis revealed that the pooled estimate was robust to the single study effects. LFK index was −7.49, with doi plot showing major asymmetry, indicating the possibility of publication bias (Supplementary Fig. 9).

3.11. Lactate levels

In our meta-analysis focusing on the association between lactate levels and the development of ARDS in septic patients, only 2 studies were included. The pooled analysis revealed a significant effect, with an overall estimate of 11.676 (95 % CI: 0.216 to 23.135) (Supplementary Fig. 10), indicating no association between elevated lactate levels and the likelihood of developing ARDS (p = 0.046).

4. Discussion

Our comprehensive meta-analysis investigated the impact of various factors, including sex, smoking status, pulmonary site of

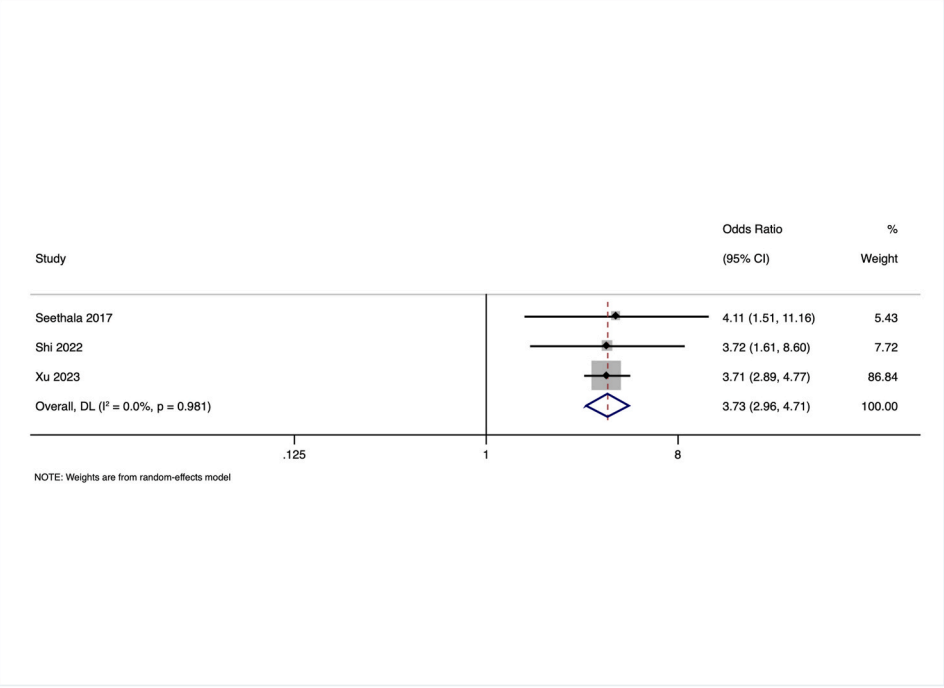

Fig. 6. Forest plot showing the association between pancreatitis and acute respiratory distress syndrome amongst septic patients.

infection, septic shock, pancreatitis, steroid use, APACHE-II, SOFA scores, and lactate levels, on the development of ARDS among septic patients.

Previous literature has been divided on the role of sex and smoking status in ARDS development [27]. Our findings align with some recent studies suggesting that these factors may not have a straightforward relationship with ARDS risk in septic patients [9–14]. The significant association between pulmonary infections, septic shock, and ARDS development corroborates earlier findings, emphasizing the severe implications of these conditions on lung health [27].

The role of pancreatitis as a significant risk factor for ARDS development is particularly noteworthy, as it highlights a systemic link between abdominal pathologies and lung injury, a connection that has been speculated but not robustly demonstrated in prior studies [27]. The lack of association between steroid use and ARDS development also adds to the ongoing debate regarding the immunomodulatory strategies in sepsis management [28,29].

Our findings regarding the predictive value of APACHE-II and SOFA scores are consistent with the existing literature, reinforcing the reliability of these scores in identifying patients at high risk for ARDS. The association between elevated lactate levels and ARDS development, although based on limited data, aligns with the known pathophysiological mechanisms linking metabolic distress to lung injury [12,14].

The absence of a significant association between sex or smoking status and ARDS development may reflect the multifactorial nature of ARDS, where the impact of individual risk factors can be modulated by a complex interplay of genetic, environmental, and clinical variables. The significant association observed with pulmonary infections and septic shock can be attributed to the direct and indirect lung injury mechanisms activated by these conditions, leading to the heightened inflammatory response characteristic of ARDS.

The strong link between pancreatitis and ARDS development suggests a systemic inflammatory response that transcends organ-specific boundaries, potentially mediated by inflammatory cytokines and other mediators that contribute to lung injury [30,31]. The neutral impact of steroid use on ARDS development may indicate that the potential benefits of modulating inflammation with steroids are counterbalanced by the risks of immunosuppression and other side effects in the context of sepsis [28,29].

The predictive value of APACHE-II and SOFA scores is likely due to their comprehensive assessment of organ dysfunction, which reflects the severity of sepsis and the systemic stress response, both of which are critical determinants of ARDS risk [12,14]. The association between lactate levels and ARDS development underscores the role of tissue hypoxia and metabolic dysfunction in the pathogenesis of lung injury.

One of the key strengths of our study is the large sample size and the inclusion of a diverse range of studies, which enhances the generalizability of our findings. Additionally, the use of a rigorous meta-analytical methodology, including sensitivity analyses and publication bias assessment, adds to the reliability of the results. However, the study is not without limitations. The high heterogeneity observed in some analyses suggests variability in study populations, methodologies, and definitions of ARDS, which could affect the interpretation of the pooled estimates. The limited number of studies available for certain risk factors, such as lactate levels, also constrains the conclusions that can be drawn for these variables.

The findings of our study have several important clinical and research implications. Firstly, the identification of significant risk factors such as pulmonary infection, septic shock, and pancreatitis for ARDS development in septic patients underscores the need for early recognition and aggressive management of these conditions to mitigate the risk of ARDS. The lack of association between steroid use and ARDS development calls for a cautious approach to steroid therapy in sepsis, emphasizing the importance of individualized treatment plans based on a patient's specific clinical scenario.

The demonstrated predictive value of APACHE-II and SOFA scores for ARDS risk highlights the utility of these scoring systems in clinical practice, not only for assessing the severity of illness but also for identifying patients at high risk for ARDS who may benefit from targeted preventive strategies. Furthermore, the association between elevated lactate levels and ARDS development points to the potential role of metabolic monitoring and management in sepsis care to prevent ARDS.

Our study points to several areas for future research. There is a need for further studies to explore the underlying mechanisms linking significant risk factors like pancreatitis to ARDS development, which could reveal novel therapeutic targets. Additionally, research aimed at elucidating the reasons behind the lack of association between factors like sex, smoking status, and steroid use with ARDS development could provide valuable insights into the complex pathophysiology of ARDS.

Future studies should also focus on developing and validating predictive models that incorporate the identified risk factors, including APACHE-II and SOFA scores and lactate levels, to enhance the early identification of septic patients at high risk for ARDS. Moreover, there is a need for randomized controlled trials to evaluate the efficacy of targeted interventions in preventing ARDS in high-risk patient populations identified through such predictive models.

5. Conclusion

Our meta-analysis identified pulmonary infection, septic shock, and pancreatitis as significant risk factors for ARDS development in septic patients, while finding no association with sex, smoking status, or steroid use. The predictive value of APACHE-II and SOFA scores, along with elevated lactate levels, highlights important areas for clinical focus in preventing ARDS. These findings underscore the need for targeted management strategies in sepsis care to mitigate ARDS risk. Future research should build on these findings to further our understanding of ARDS pathophysiology and to develop effective strategies for prevention and management in septic patients.

Data availability statement

Data will be made available upon reasonable request from researchers.

CRediT authorship contribution statement

Rui Yin: Writing – review & editing, Writing – original draft, Software, Methodology, Investigation, Formal analysis, Data curation. **Xiaoshan Yang:** Software, Resources, Methodology, Investigation. **Yanfen Yao:** Writing – review & editing, Project administration, Funding acquisition, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.heliyon.2024.e37336.

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