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## Research Article

# Prevalence And Mortality of Acute Respiratory Distress Severity in The Pediatric Intensive Care Units' Emergencies: A Systematic Review and Meta-Analysis

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### Abstract

**Objective:** To review the prevalence of risk factors associated with mortality rate of acute respiratory distress (ARDs) severity in the pediatric intensive care units (ICU) emergencies.

**Data Sources:** A systematic search of MEDLINE (PubMed, Medscape, Science Direct. EMF-Portal) and Internet was conducted on all articles published from 1980 to 2025.

**Study Selection:** English-language reports of about the prevalence, risk factors associated with mortality rate of ARDs in the pediatric. The initial search presented 95 articles where 50 had inclusion criteria.

**Data Extraction:** Articles not reporting on the prevalence, risk factors, mortality of ARDs in the pediatric in the title or abstract were not included. 10 independent investigators extracted data on methods.

**Data Synthesis:** Comparisons were made by structured review with the results tabulated. 20 studies about Prevalence of ARDs in the pediatric, 14 emphasized Risk Factors of ARDs in pediatrics and another 16 studies about mortality of ARDs in pediatrics.

**Findings:** Mortality rate of ARDs from 1998 till 2025, there were 8 studies conducted in 1998-2009 that reported that the mortality rate among pediatric ARDs in ICU ranged from 22-70%. However, other 7 studies were carried out in 2012-2022 years resulted that the mortality rate among pediatric ARDs in ICU ranged from 21.2% to 57.3%, while Pai et al. in 2025 reported the lower percentage from 16.4%-38.3%.

**Conclusions:** The prevalence of acute respiratory distress severity in the pediatric in intensive care units widely differed from 0.2% to 21.3% during the years studied from 1998 till 2025. Studies conducted and published later were associated with better survival. The prevalence Overall mortality rate among ARDS in pediatric intensive care units is high, with previous estimates varying widely between 21.2%-70%. Earlier years of publication was an independent factor adversely affecting mortality in pediatric ARDS regardless of study design.

**Keywords:** Complex febrile seizures, Serum zinc, Selenium, Children, Oxidative stress

## Introduction

Acute Respiratory Distress Syndrome (ARDS) is an acute, diffuse, inflammatory form of lung injury that represents a life-threatening condition in critically ill patients. It is characterized by impaired oxygenation, the presence of pulmonary infiltrates, and an acute onset of respiratory failure. On a histopathological level, ARDS is associated with widespread capillary endothelial injury and diffuse alveolar damage, leading to increased vascular permeability and severe impairment of gas exchange [1].

Respiratory distress can present in a variety of ways, ranging from increased respiratory rate, cough and wheezing to intercostal recessions and cyanosis [2]. According to the Berlin Definition, ARDS is diagnosed based on acute onset, bilateral opacities on chest imaging (chest radiography or CT), a non-cardiac origin of pulmonary edema, and a  $\text{PaO}_2/\text{FiO}_2$  ratio less than 300 mmHg with a positive end-expiratory pressure (PEEP) or continuous positive airway pressure (CPAP) of  $\geq 5$  cm  $\text{H}_2\text{O}$ . The Berlin Definition refined the earlier American European Consensus Conference (AECC) criteria by eliminating the term acute lung injury (ALI), removing the requirement of a pulmonary capillary wedge pressure  $<18$  mmHg, and emphasizing standardized ventilatory support parameters [3].

Early identification of respiratory distress in children is critical to prevent progression to respiratory failure and reduce morbidity and mortality. Delayed recognition can lead to hypoxemia, multi-organ dysfunction, and the need for invasive mechanical ventilation, which is associated with higher risks of complications and prolonged hospital stays. Therefore, having a reliable, simple, and rapid bedside assessment tool is essential, particularly in resource-limited settings, to guide timely intervention and optimize patient outcomes [4]. This review aims to review the prevalence; risk factors associated with mortality rate of acute respiratory distress (ARDs) severity in the pediatric intensive care units (ICU) emergencies.

## Materials and Methods

**Data Sources:** A systematic search on the studies on a study of the prevalence, risk factors associated with mortality rate of ARDs in the pediatric using MEDLINE (PubMed, Medscape, Science Direct, EMF-Portal) and Internet was conducted on all articles published from 1980 to 2025. During research focused on ARDs in the pediatric/prevalence of ARDs/ risk factors, mortality of ARDs, ARDs and ICU/ pediatrics mortality, PICIU as searching terms. Additional records were identified by reference lists in retrieved articles. The search was established in electronic databases from 1980 to 2025.

**Study Selection:** Eligible articles were published in peer-reviewed journals and written in English. Articles not reporting on prevalence, risk factors associated with mortality rate of ARDs in the pediatric in the title or abstract were not included.

Full-text articles were screened, and the final inclusion decisions were made according to the following criteria: original studies, systematic reviews, or meta-analyses; primary or first-line treatment and, if necessary, secondary treatment described, and treatment success, complications and side-effects described.

**Data Extraction:** Articles not reporting about the prevalence, risk factors, mortality rate of ARDs in the pediatric in the title or abstract were not included. 10 independent investigators extracted data on methods, health outcomes, and traditional protocols. Surveys about symptoms and health without exposure assessment, report without peer-review, not within national research programme, letters/comments/editorials/news and studies not focused on the ARDs in the pediatric.

The analyzed publications were evaluated according to evidence-based medicine (EBM) criteria using the classification of the U.S. Preventive Services Task Force & UK National Health Service protocol for EBM in addition to the Evidence Pyramid according to [5]

U.S. Preventive Services Task Force [5].

- Level I: Evidence obtained from at least one properly designed randomized controlled trial.
- Level II-1: Evidence obtained from well-designed controlled trials without randomization.
- Level II-2: Evidence obtained from well-designed cohort or case-control analytic studies, preferably from more than one center or research group.
- Level II-3: Evidence obtained from multiple time series with or without intervention. Dramatic results in uncontrolled trials might also be regarded as this type of evidence.
- Level III: Opinions of respected authorities, based on clinical experience, descriptive studies, or reports of expert committees.

**Study Quality Assessment:** quality of all the studies was assessed. Important factors included, study design, ethical approval, calculation of evidence power, specified eligibility criteria, appropriate controls, adequate information, and specified assessment measures. It was expected that confounding factors would be reported and controlled for, and appropriate data analysis were made in addition to an explanation of missing data.

**Data Synthesis:** A structured systematic review was done with the results tabulated. 20 studies about prevalence of ARDs in pediatrics, 14 emphasized Risk Factors of ARDs in pediatrics and another 16 studies about mortality of ARDs in pediatrics.

**Outcome of the study:** The primary outcome was the proportion of death among patients with ARDS. For primary outcome, we also planned subgroup analysis a priori: year of

publication and study design.

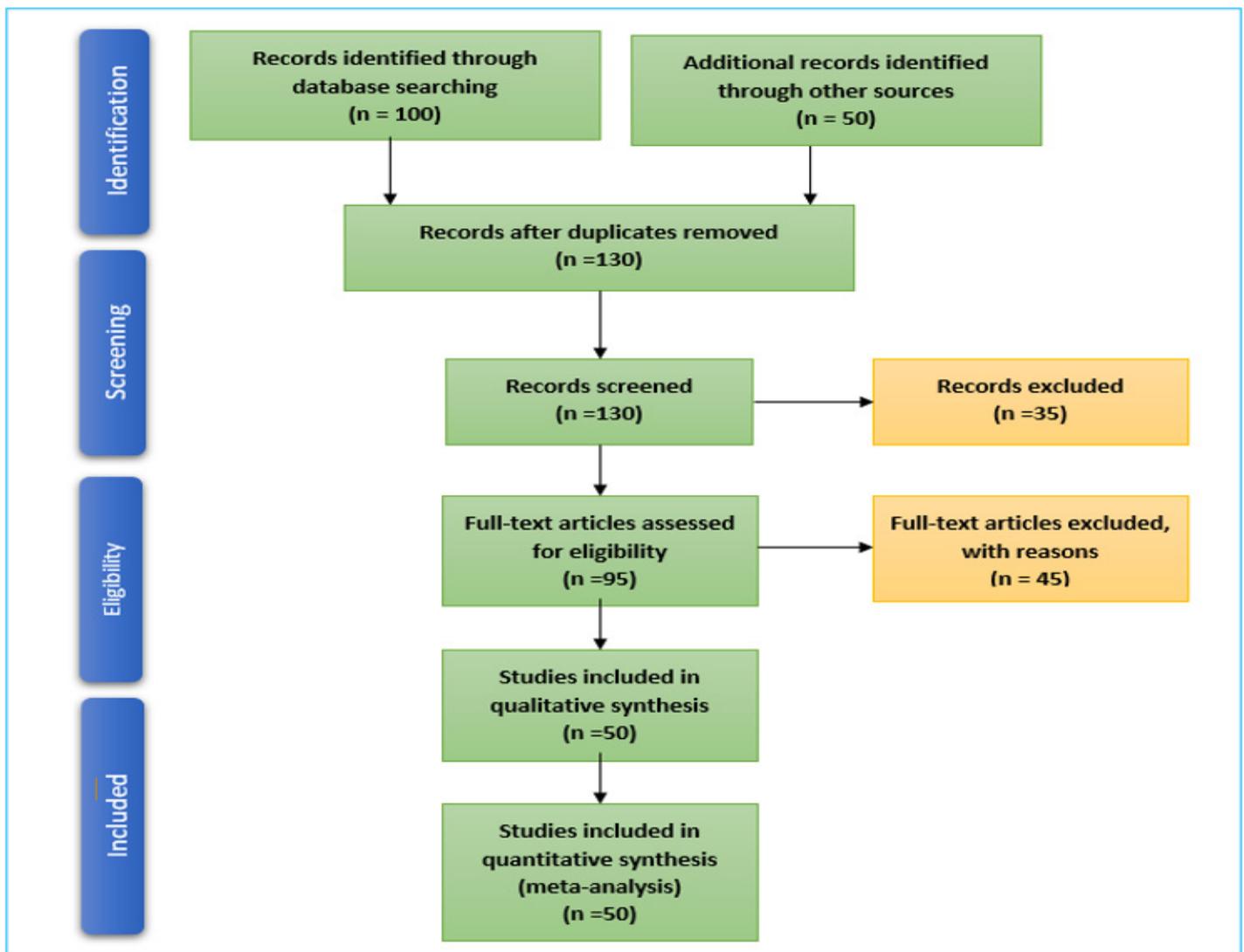
## Results

### Study Selection and Characteristics

A systematic search on the studies on a study of the prevalence, risk factors associated with mortality rate of ARDs in the pediatric using MEDLINE (PubMed, Medscape, Science Direct, EMF-Portal) and Internet was conducted on all articles published from 1980 to 2025. Articles not reporting on prevalence, risk factors, mortality rate of ARDs in the pediatric in the title or abstract were not included. 10 independent investigators extracted data on methods, health outcomes, and traditional protocols. Potentially relevant publications were identified; 45 articles were excluded as they are away from our inclusion criteria. 20 studies about Prevalence of

ARDs in the pediatric, 14 emphasized Risk Factors of ARDs in pediatrics and another 16 studies about mortality of ARDs in pediatrics. PRISMA flowchart was downloaded from the PRISMA website (Figure 1)

Regarding four studies there were 11 retrospective studies [37,21,6,7,38,28, 30,8,14,36,19] that came to level II-2 or (level B) and found that the prevalence of acute respiratory distress severity in the pediatric in intensive care units were widely differed from 0.85% to 19%. Also, 6 prospective or cohort studies [18,3,17,25,32,34] Comes to level II-2 or (level B) reported the prevalence of acute respiratory distress severity in the pediatric in intensive care units were in range 0.2% to 21.3%, additionally, 3 Cross-Sectional studies [39,31,5] Come to level I or (level A) and they estimated that the prevalence of ARDs in the PICU were 0.2% to 2.7%, (Table 1).



**Figure 1.** Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) flowchart of the number of studies in each stage of search.

No.	Author	Year	Study design	Level of EBM	Prevalence (%)
1.	Holbrook et al.	1980	A retrospective trial	II-2 or (level B)	8.5-27 cases per 1,000
2.	Lyrene and Truog,	1981	A retrospective trial	II-2 or (level B)	8.5-27 cases per 1,000
3.	Effmann et al.	1985	A retrospective study	II-2 or (level B)	
4.	Davis et al.	1993	Retrospective descriptive	II-2 or (level B)	8.5-27 cases per 1,000
5.	Chan and Goh,	1999	Retrospective review	II-2 or (level B)	8%
6.	Lodha et al.	2001	Case controlled study	Level I or (Level A)	20.1 per 1,000
7.	Farias et al.	2004	Prospective cohort study	level II-2 or (level B)	1-4%
8.	Rubinfeld et al.	2005	Narrative literature review	level II-2 or (level B)	2-12.8 cases per 100,000 people/year
9.	Erickson et al.	2007	Multicenter prospective study	level II-2 or (level B)	
10.	Zimmerman et al.	2009	Prospective cohort study	level II-2 or (level B)	
11.	Chetan et al.	2009	Retrospective study	II-2 or (level B)	22.7 per 1,000
12.	López-Fernández et al.	2012	Cross-sectional observational study	Level I or (Level A)	1.4%
13.	Smith et al.	2013	Cohort study	level II-2 or (level B)	2-12.8 cases per 100,000 people/year
14.	Wong et al.	2014	Retrospective chart review	II-2 or (level B)	0.7 to 4.2%
15.	Yehya et al.	2015	Observational single-center study	Level I or (Level A)	2.7%
16.	Parvathaneni et al.	2017	Retrospective cohort study.	II-2 or (level B)	5.8%
17.	Gupta et al.	2018	Retrospective chart review	II-2 or (level B)	9.9%
18.	Wong et al.	2019	Retrospective, nationwide, patient-level analysis	II-2 or (level B)	1% to 4%
19.	Shein et al.	2022	Prospective multicenter study	level II-2 or (level B)	21.3%
20.	Daniel et al.	2025	A retrospective cohort study	II-2 or (level B)	19%

**Table 1.** Prevalence of acute respiratory distress severity in the pediatric.

Regarding risk factors of acute respiratory distress severity in the pediatric, there were 4 studies in 1998, 2000, 2005 and 2007 [37, 21, 6, 18] that reported that sepsis was the most risk factors associated with mortality of acute respiratory distress severity in the pediatric in PICU. However, other two studies in 2005 [38, 39] observed that predominantly pulmonary was the most risk factors associated with mortality of ARDs in PICU. Furthermore, [6,3] found Shock, Sepsis, acute renal failure and disseminated intravascular coagulopathy (DIC) considered the more risk factors associated with

ARDS. While, [7] and [8] as well as [9] confirmed that cardiopulmonary bypass only, multi-organ dysfunction, sepsis and duration of mechanical ventilation, PICU, and hospital stay, diminished lung function and exercise tolerance, reduced quality of life, and diminished neurocognitive function considered the most risk factors associated with ARDs. In this respect [10 ,11] pneumonia with sepsis were the most risk factors associated with ARDs (25, 28). Finally, [12] indicated that Age, longer durations of invasive ventilation, PICU care was associated with the risk of ARDs in PICU, (Table 2).

No	Author	Year	Risk factor for mortality
1.	Goh et al.	1998	Sepsis
2.	Ware et al.	2000	Sepsis
3.	Flori et al.	2005	Sepsis
4.	Ferguson et al.	2005	Organ failures and higher levels of inspired oxygen
5.	Willson et al.	2005	Predominantly pulmonary
6.	Curley et al.	2005	Predominantly pulmonary
7.	Erickson et al.	2007	Sepsis

8.	Chetan et al.	2009	Shock, Sepsis, acute renal failure and disseminated intravascular coagulopathy (DIC)
9.	Cui et al.	2009	Cardiopulmonary bypass only
10.	López-Fernández et al.	2012	Pneumonia, sepsis
11.	Parvathaneni et al.,	2017	Pneumonia, sepsis
12.	Gupta et al.	2018	Multi-organ dysfunction, sepsis
13.	Wong et al.	2019	Duration of mechanical ventilation, PICU, and hospital stay, diminished lung function and exercise tolerance, reduced quality of life, and diminished neuro-cognitive function.
14.	Shein et al.	2022	Age, longer durations of invasive ventilation, PICU care

**Table 2.** Risk Factors of acute respiratory distress severity in the pediatric.

Concerning the mortality rate of ARDs from 1998 till 2025, there were 8 studies conducted in 1998-2009 that reported that the mortality rate among pediatric ARDs in ICU ranged from 22-70%. However, other 7 studies were carried out in

2012-2022 years resulted that the mortality rate among pediatric ARDs in ICU ranged from 21.2% to 57.3%, while Pai et al. in 2025 reported the lower percentage from 16.4%-38.3% (Table 3).

No	Author	Year	Mortality rate
1.	Goh et al.	1998	62%
2.	Ware et al.	2000	40%- 60%
3.	Flori et al.	2005	29%
4.	Ferguson et al.	2005	65.0%
5.	Flori et al.	2005	22%-65%
6.	Erickson et al.	2007	44%
7.	Chetan et al.	2009	70%
8.	Yu et al.	2009	22%-65%
9.	López-Fernández et al.	2012	27.4
10.	Wong et al.	2014	22%-65%
11.	Schouten et al.	2016	33.7%
12.	Parvathaneni et al.,	2017	22.7%
13.	Gupta et al.	2018	57.3%
14.	Wong et al.	2019	24%
15.	Shein et al.	2022	21.2%
16.	Pai et al.	2025	16.4%-38.3%

**Table 3.** Mortality rate of acute respiratory distress severity in the pediatric.

## Discussion

To date, our meta-analysis involved the largest number of patients with pediatric ARDS. It confirmed previous findings of high mortality risk (pooled mortality of 24%) in children with ARDS. In addition, we demonstrated that mortality rates declined over time regardless of study design. Our systematic review highlighted the paucity of good-quality data in pediatric ARDS. Most of the studies were observational and had small sample sizes. In the study by [13] pooled mortality

rate of pediatric ARDS (24%; 95% CI: 19-31) is lower than previously reported in another meta-analysis (34%; 95% CI: 29-40).[14] In addition, although Schouten et al demonstrated lack of improvement of mortality over time, we found a declining mortality rate over time in children with ARDS [9,14] postulate that the differences in findings may be due to methodological differences. [6] reported that during the study period, 748 children were admitted to the PICU. Over three

years, 17 children (6 girls) satisfied the diagnostic criteria for ARDS, giving an incidence of 22.7 per 1,000 admissions. The mean (SD) age of these children was 74.5 (56.32) months, ranging from 6 to 144 months. The reported incidence of ARDS in PICUs varies between 8.5 and 27 cases per 1,000 PICU admissions according to earlier studies. [14-18]

### **Prevalence of Acute Respiratory Distress Severity in the Pediatric**

In a case series of ARDS patients from New Delhi, [19] reported a similar incidence of 20.1 per 1,000 PICU admissions [20]. reported 76 of 112 patients (67.9%) were admitted to the hospital, out of whom 42 (37.5%) were sent to the regular paediatric ward and 32 (28.6%) to SCU / PICU. Another study by [21]. showed that the prevalence of severe respiratory distress was found to be 8%. [22] showed that during the study period, 10,618 patients were admitted to the CHOP PICU, of whom 2,851 were anticipated to be ventilated more than 24 hours. Of these 2,851, 737 patients with arterial catheters underwent screening, and 283 met eligibility criteria. This gave an ARDS prevalence of 2.7% of PICU admissions and 9.9% of those ventilated more than 24 hours. However, [9] showed that during the study period, the total number of invasively mechanically ventilated patients meeting the AECC definition for ARDS was 146 (1.4% of PICU admissions and 8.3% of those who received MV  $\geq$  24 hrs). These patients were the only ones considered for further analysis, representing an incidence of 3.9/100,000/yr in children  $\leq$ 15 years of age. Eighty patients (54.8%) met ARDS criteria at PICU admission. On the other side, [8] showed that the prevalence of ARDS was 9.9% (95% CI: 7.8–12.4). Prevalence was higher 9.75% (4.1, 7.8) with PALICC criteria (35 patients) as compared to the Berlin definition, 4.2% (2.9, 6.1) (26 patients) with moderate agreement between the two (Kappa: 0.51; 95% CI: 0.40–0.62; observed agreement 85%). (2014) reported the prevalence of ARDS in PICU to vary from 0.7 to 4.2% using either AECC or Berlin definitions. Another investigation [19] reported prevalence rate was 20.1/1000 admissions.[10] reported prevalence of ARDS to be 5.8% by PALICC criteria in their study. Pediatric ARDS is relatively rare: its prevalence in children in the United States, Europe and Australia is 2-12.8 cases per 100,000 people/year [24-28] showed that in a multicenter study involving children hospitalized in pediatric intensive care units (PICUs) in North America, 1-4% of children undergoing mechanical ventilation had ARDS. Additionally, [9] showed Despite the low incidence, Spanish researchers have shown that a greater number of ventilated children can develop ARDS during their stay in the ICU.

### **Risk Factors of acute respiratory distress severity in the pediatric**

In the previous study by [6] it showed that Shock was identified as the most common comorbid factor among affected

children and was associated with a 73.3% mortality rate. Sepsis was the next most common comorbidity, linked with 66.6% mortality. Additionally, the development of acute renal failure and disseminated intravascular coagulopathy (DIC) was associated with 100% mortality, indicating these as strong adverse prognostic factors. Shock, followed by sepsis, was the most common accompanying condition and was associated with a high risk of mortality. This is likely related to the involvement of multiple organ systems, forming part of a more severe multiorgan dysfunction syndrome (MODS). The presence of sepsis, initial severity of arterial hypoxemia, non-pulmonary organ dysfunction, and chronic underlying diseases have all been reported to significantly increase mortality risk in pediatric ARDS. [29,25,30] Additionally, ventilatory variables and indexes of lung severity were found to be significantly associated with mortality [31,25], Also, [6] showed that shock occurred in 88% of patients with ARDS, indicating it as a predominant risk factor contributing to poor outcomes. Nearly 41% of the children were poorly resuscitated victims of accidents or poisoning referred to from distant rural areas, suggesting that delayed or inadequate initial management and limited access to critical care services may have increased disease severity and mortality.

### **Mortality of Acute Respiratory Distress Severity in the Pediatric**

In the study by [6] showed that Out of the 17 children with ARDS, 12 (70%) did not survive. Mortality was highest in children under 2 years of age. The presence of comorbid conditions such as shock, sepsis, acute renal failure, and DIC markedly increased the risk of death [6]. showed that Children who developed acute renal failure or disseminated intravascular coagulopathy (DIC) had 100% mortality, indicating these as the most severe prognostic indicators. Overall, mortality was strongly linked to the presence of multiple organ involvement and the degree of respiratory and systemic compromise. Although the mortality of ARDS has decreased over the years due to advances in ventilatory strategies and supportive care [29,32,33]

We demonstrated that there is an improving mortality trend in pediatric ARDS. There are several plausible explanations for this. In the past, the incidence of pediatric ARDS was underestimated as most patients were diagnosed according to their underlying diseases.[34] With increasing awareness, there is possibly an increase in prompt recognition/diagnosis of pediatric ARDS enabling earlier treatment. Moreover, since the advent of peripheral capillary oxygen saturation (SpO<sub>2</sub>)-based indices, clinicians can diagnose ARDS without the need for measurement of arterial oxygenation [35,36] Lastly, improvements in mortality may reflect general improvements in pediatric critical care support. [37]

### **Strength and Limitation of the Study**

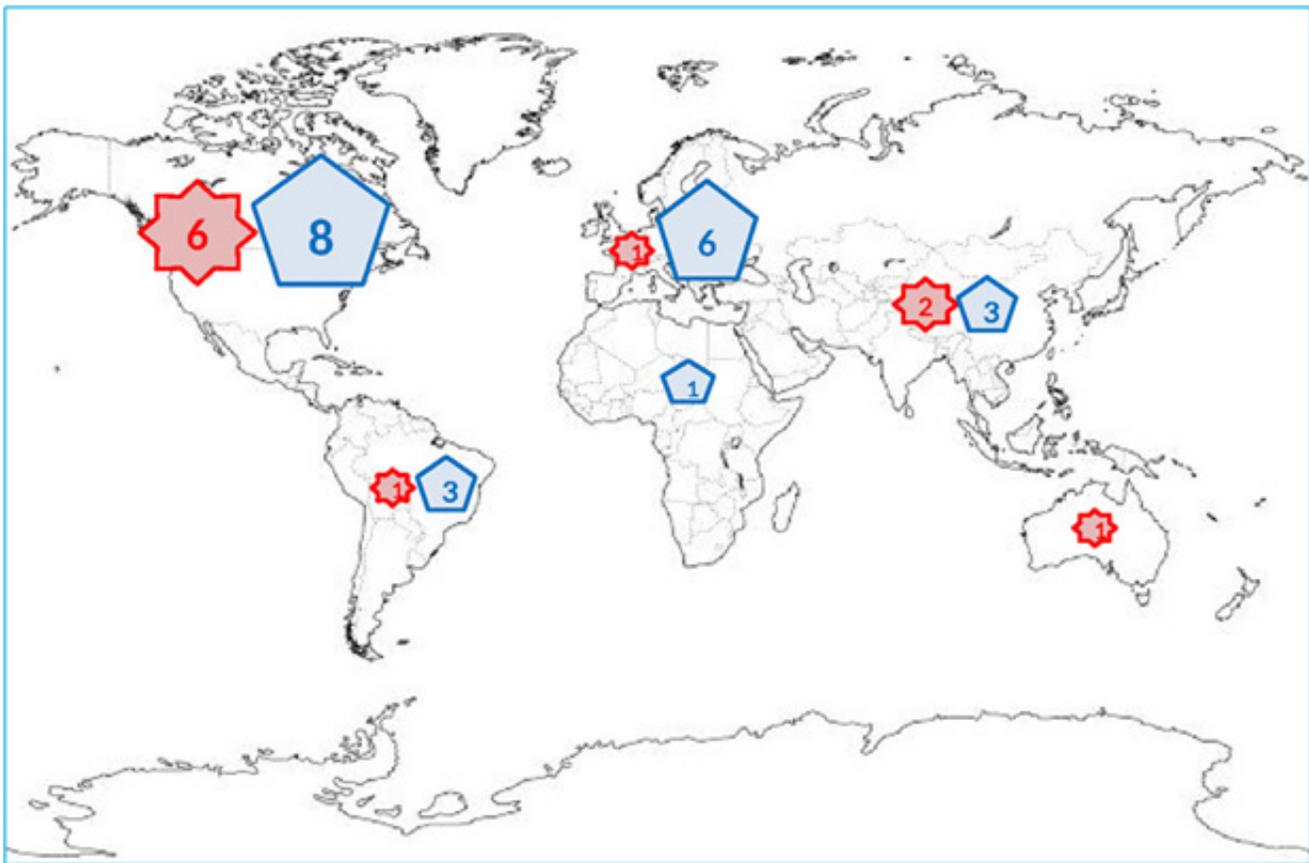
One of the main strengths of this systematic review is the

inclusion of a comprehensive search conducted without the search term "mortality," which identified many relevant studies that would have otherwise been missed. It is also timely to determine the pooled mortality following the publication of the PALICC group recommendations that promote optimization and consistency of care for children with pediatric ARDS to provide a baseline for comparison for future trials. However, the findings of our review should be interpreted in the context of the limitations. Firstly, many studies did not report important details. Also, due to the small number of eligible studies, we were unable to enter these important clinical variables into the meta-regression model as well as other variables such as geographical location and case mix. The studies also reported various mortality rates. Lastly, there is

a paucity of good-quality data in pediatric ARDS, with the majority of studies originating from North America (Figure 2). This can potentially limit generalizability of the results.

## Conclusion

The prevalence of acute respiratory distress severity in the pediatric in intensive care units were widely differed from 0.2% to 21.3% during the years studied from 1998 till 2025. Studies conducted and published later were associated with better survival. The prevalence Overall mortality rate among ARDS in pediatric intensive care units is high, with previous estimates varying widely between 21.2%-70%. Earlier years of publication was an independent factor adversely affecting mortality in pediatric ARDS regardless of study design.



**Figure 2.** World map showing the distribution of studies across continents. Red stars signify the number of randomized controlled trials. Blue pentagons signify the number of prospective observational studies. All countries involved in multicenter studies were counted separately to reflect the research energy in each continent.

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