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REVIEW

Post-traumatic stress disorder in children after discharge from the pediatric intensive care unit: a scoping review

Maoting Tang[1,2] · Ping Lei Chui[1] · Mei Chan Chong[1] · Xianliang Liu[3]

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Abstract

As the prevalence of post-traumatic stress disorder (PTSD) among children discharged from pediatric intensive care unit (PICU) continues to rise, corresponding research efforts have also increased. This scoping review aimed to review the PTSD prevalence, influencing factors, and tools used for PTSD measurements in children discharged from the PICU. This review employed the five-stage framework proposed by Arksey and O'Malley. The data sources included PubMed, Web of Science, Ovid, ScienceDirect, Springer, Scopus, CNKI, and WANFANG. Studies in English or Chinese published up to September 2023 were eligible for inclusion. The search yielded a total of 3536 results, with 31 articles meeting the inclusion criteria. The included studies reported that the prevalence of PTSD ranged from a minimum of 13% to a maximum of 84.6%. Risk factors for PTSD included medical interventions, child-related factors, and family environment. A total of 17 assessment tools for PTSD in PICU patients were reported. Given the significance of PTSD in this pediatric population, further attention, research, and intervention are warranted to help alleviate the burden of PTSD.

Keywords Post-traumatic stress disorder · Pediatric intensive care unit · Scoping review · Risk factors · Mental health

Introduction

The pediatric intensive care unit (PICU) is a specialized ward in a hospital, offering critical medical care at the highest level to children with severe illnesses or injuries [1]. With advancements in medical treatment and technology in recent years, the survival rate of PICU patients has increased significantly [2]. However, the number of PICU patients continues to grow, with 1.5 million children annually admitted to the PICU in the United States [2]. Many of these pediatric survivors experience ongoing post-traumatic stress disorder (PTSD) following discharge from the PICU, underscoring the importance of addressing psychological issues [2, 3].

PTSD is a psychological disorder in individuals experiencing or witnessing severe traumatic events such as war, sexual assault, accidents, or natural disasters, leading to prolonged and persistent psychological and emotional distress [4]. In the context of PICU, PTSD manifests in children undergoing treatment who exhibit re-experience, avoidance, and hypervigilance of traumatic experiences following severe illness, surgery, or other significant medical interventions [2, 5]. For instance, Als et al. examined 88 children discharged from the PICU after 5 months and found that 20% of the children exhibited symptoms of PTSD such as excessive arousal, restlessness, hyperactivity, and behavioral issues [6]. Compared with healthy peers, 7–12% of children discharged from the PICU experience more depressive emotions and social difficulties, indicative of PTSD avoidance behaviors [7]. Traumatic memories, including delusional recollections, flashbacks, and hallucinations, have been reported in children after discharge from the PICU [8], posing adverse effects not only on their

✉ Ping Lei Chui
chuipinglei@um.edu.my

1 Department of Nursing Science, Faculty of Medicine, Universiti Malaya, Kuala Lumpur, Wilayah Persekutuan, Kuala Lumpur 50603, Malaysia

2 Department of Pediatric Intensive Care Unit Nursing, West China Second University Hospital, West China School of Nursing, Key Laboratory of Birth Defects and Related Diseases of Women and Children, Sichuan University, Ministry of Education, Chengdu, Sichuan, China

3 School of Nursing and Health Studies, Hong Kong Metropolitan University, Homantin, Kowloon, Hong Kong, China

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quality of life but also on their learning abilities and social skills [9–11].

De Pellegars et al. conducted a systematic literature review of factors influencing PTSD in PICU patients and included English and French literature published between January 1, 2004, and January 31, 2022 [12]. The present study extended this search to Chinese and English articles published until September 2023, not only aiming to summarize the impact of PTSD in PICU patients following discharge, but also providing an overview of the incidence of PICU-related PTSD and presenting a review of commonly used assessment tools for PTSD in pediatric patients to establish the foundation for clinical practice and future research in the PICU.

Aims

We aimed to determine the incidence of PTSD in patients discharged from the PICU, identify the factors influencing the development of PTSD in these patients, and evaluate the available assessment tools for measuring PTSD in patients post-PICU discharge.

Methods

Trustworthiness and rigor

This scoping review followed Arksey and O'Malley's [13] five-stage framework, which adopts a rigorous and transparent process, increasing the reliability of research outcomes. This five-stage scoping review model includes the following: (i) Defining the research query; (ii) Pinpointing pertinent research; (iii) Selecting research articles; (iv) Visualizing data; and (v) Summarizing and presenting findings [13].

Defining the research question

The central question guiding this scoping review was as follows: What is the prevalence of PTSD in children after discharge from the PICU, and what are the associated risk factors and tools used to measure it?

Keywords used for searching

Expert input from the field of child psychology was sought to refine the search terms and identify the most appropriate databases for obtaining the desired search results. Various search techniques, including the use of PTSD descriptors and Boolean operators, such as "and," "or," and "not" or "and not" were employed to refine, expand, and combine literature searches. Table 1 contains a descriptive list of the key search terms devised to direct the exploration.

Table 1 Key search terms

("*Pediatric Intensive Care Unit" or "PICU*" or "ICU*" or "intensive care*" or "critical care child*") AND ("PTSD*" or "post-traumatic stress disorder*" or "post-intensive care syndrome*" or "chronic post traumatic*") AND ("child*" or "kid*" or "adolescent*")

PICU: pediatric intensive care unit; PTSD: post-traumatic stress disorder; ICU: intensive care unit

Table 2 Inclusion and exclusion criteria

Criterion	Inclusion	Exclusion
Time frame	Database creation up to September 2023	Studies conducted after September 2023
Language	English, Chinese	Studies not written in English or Chinese
Article category	Medical or psychological articles, qualitative or quantitative studies, observational or interventional research	Non-primary literature (e.g., case reports, case series, reviews, conference papers, meta-analyses, and commentary articles)
Study focus	PTSD was considered as a primary or secondary outcome	There are no objectives or outcomes related to PTSD in the article
Population	Patients under 18 years old admitted to the PICU	Non-PICU (e.g., neonatal intensive care unit or adult ICU)
Follow-up time	At least 1 week	Less than 1 week

PICU: pediatric intensive care unit; PTSD: post-traumatic stress disorder; ICU: intensive care unit

Eligibility criteria

Inclusion and exclusion criteria were established by the research team to ensure that the scope aligned with the research objectives and maximized relevance to the research query. Table 2 presents a comprehensive list of the inclusion and exclusion criteria.

Search methods

The scoping review protocol was registered on INPLASY (No. INPLASY2023110 068) and adhered to the Preferred Reporting Items for Systematic Reviews (PRISMA) guidelines. Using key search descriptors, we searched the PubMed, Web of Science, Ovid, ScienceDirect, Springer, Scopus, CNKI, and WANFANG databases. An example keyword search strategy from PubMed is presented in Table 3.

Table 3 Search strategy from PubMed (date of search: 06/09/23)

#	Searches	Results
1	'Pediatric Intensive Care Unit'	48,141
2	'PICU'	7480
3	'ICU'	180,308
4	'intensive care'	656,843
5	'critical care child'	57,731
6	1 OR 2 OR 3 OR 4 OR 5	680,428
7	'PTSD'	55,294
8	'post-traumatic stress disorder'	49,967
9	'post-intensive care syndrome'	662
10	'chronic post traumatic'	6226
11	7 OR 8 OR 9 OR 10	61,564
12	'child'	3,147,481
13	'kid'	3253
14	'adolescent'	2,352,956
15	12 OR 13 OR 14	4,316,921
16	6 AND 11 AND 15	744

PICU: pediatric intensive care unit; PTSD: post-traumatic stress disorder; ICU: intensive care unit

Study selection

All identified article references were imported into the EndNote X9 citation management software (Thomson Reuters, Philadelphia, PA, USA). Subsequently, one researcher removed duplicates and independently assessed the articles based on their titles and abstracts to gauge their relevance to the research question (Fig. 1). Then, two reviewers (T.M.T. and C.M.C.) independently screened the full-text articles strictly according to the inclusion and exclusion criteria and cross-checked the results. In cases of disagreement, the two reviewers discussed any disputes with the third reviewer (C.P.L.), who made the final decision.

Data extraction

Standardized data extraction forms were created by the research team. Two reviewers independently extracted and compared the data. The abstract information encompassed details such as author, publication year, study location, research design, assessment tools, and follow-up time.

Quality assessment

The quality of the studies included in this review was assessed using the Mixed Methods Appraisal Tool (MMAT) [14]. The MMAT serves as a valuable quality assessment instrument applicable to a range of study types, including quantitative, qualitative, and mixed-method research. Although the MMAT was employed to assess the studies' quality in this review, no studies were excluded solely based on their scores.

Data analysis

Using descriptive synthesis, we organized the outcomes of the included articles. Initially, essential details such as authors, study design, assessment tools, and post-discharge follow-up duration were extracted from each study. Because the articles contained limited numerical data, a meta-analysis could not be conducted. The data were thematically organized and visually presented through tables to synthesize the information, and concise summaries were provided for the primary findings of each study. Finally, limitations in the literature were reflected upon, and potential future research directions were discussed.

Results

Attributes of the included studies

Following the application of the inclusion and exclusion criteria, a considerable number of articles were deemed ineligible, had inappropriate study subjects or research settings, or were abstracts or duplicates. A total of 87 papers were chosen for a thorough review. Of these, 56 publications were excluded due to inappropriate study participants, inappropriate research settings, and abstract-only publications or duplicates. Ultimately, 31 articles were included in this review. Figure 1 shows a PRISMA flow chart.

This scoping review identified 31 independent studies from 10 countries: Australia [15–20], the Netherlands [1, 21, 22], the United Kingdom (UK) [5, 6, 23–30], Canada [31, 32], the United States (US) [33–37], Thailand [38], France [39], Egypt [40], China [41] and India [42]. These included 20 prospective studies [1, 5, 6, 15–23, 26, 29, 30, 32–34, 39, 42], two retrospective studies [24, 38], two randomized trials [37, 41], two case–control studies [25, 28], two secondary data analyses [31, 35], and one of each of the following study types: exploratory study [27], longitudinal study [36], and comparative cross-sectional study [40]. The PICU sample sizes varied from eight [34] to 272 [19], with a mean of 72 participants. Patients' ages ranged from 0 [1] to 18 years [24], and the study follow-up time ranged from 1 week [38] to 1 year [16]. Table 4 presents the full details of the included studies and provides insights into the attributes and outcomes of each study.

Quality of the included studies

The quality assessment results of the MMAT indicated that most of the studies fell within the moderate to good range. Among the 29 quantitative non-randomized studies, two had dropout rates exceeding 20% [20, 33], and one with a

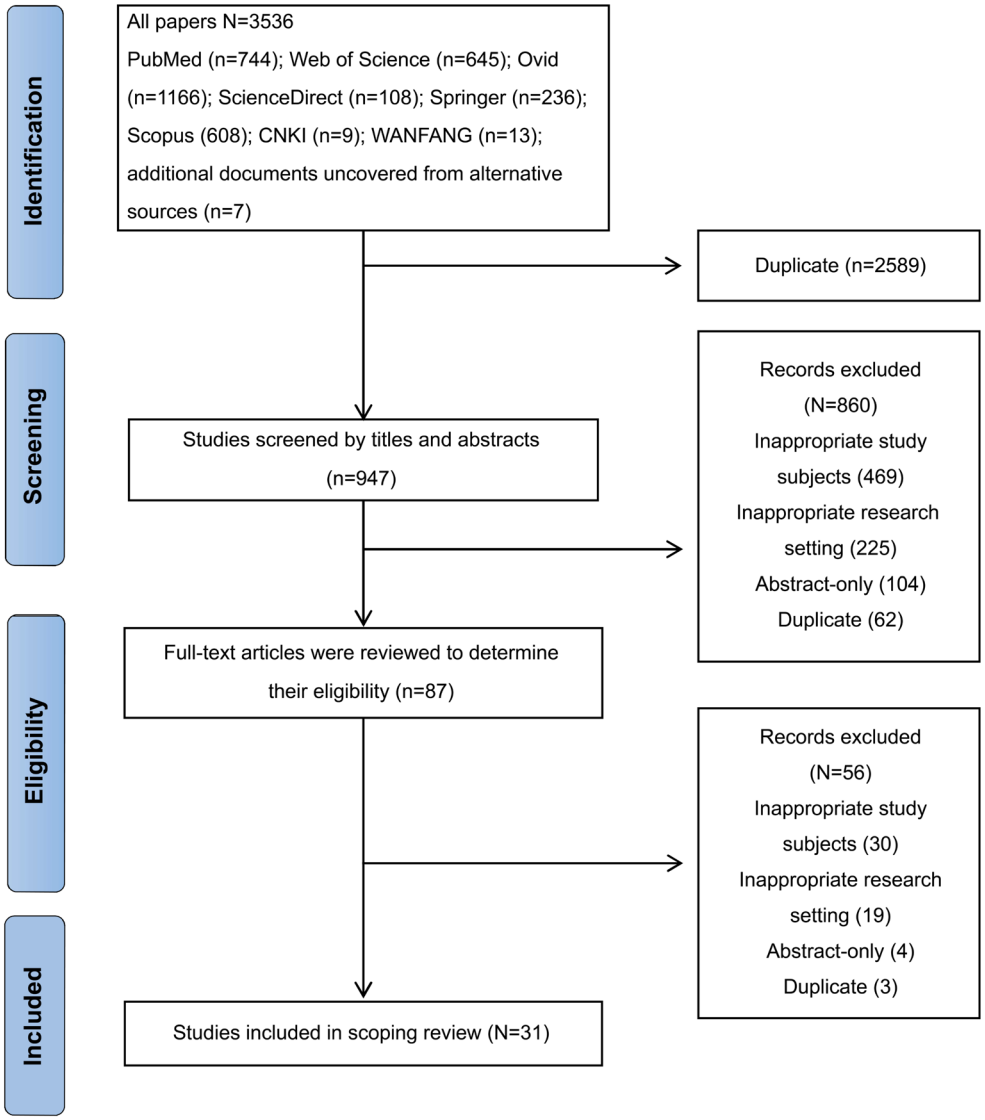

Fig. 1 PRISMA flowchart

1-year follow-up had a dropout rate exceeding 30% [39]. Of the two quantitative randomized controlled trials, one study implemented blinding for outcome assessors [37], and the other employed a random number table method [41].

PTSD in pediatric patients after discharge from the PICU

A study conducted in the Netherlands that compared child survivors (8–17 years) of a major fire incident using the Dutch Children's Responses to Trauma Inventory (CRTI), found that more than one-third (34.5%) of these children in the PICU had subclinical PTSD [21]. Another study conducted in the PICU on Multisystem Inflammatory Syndrome in Children (MIS-C) at 3–6 months post-discharge found that among 30 children, 10 (33%) were at an increased risk of developing PTSD [1]. Boeschoten et al. [22] compared Dutch children in the PICU with those from regular wards at 5 months post-discharge, and higher scores on the PTSD questionnaire were reported among children in the PICU. Another study in the UK found that 62% of children exhibited PTSD symptoms following discharge from the PICU, with 10% displaying characteristics of acute stress disorder [23]. A study conducted in India compared a group of PICU patients to a control group with a similar number of comorbidities and comparable temperament and found that experiences of PTSD-related intrusive thoughts were significantly higher in the PICU group (43%) than in the control group (6.7%) [42]. However, a study performed in America that randomly assigned 1360 pediatric patients from the PICU to a sedation protocol group and a standard care group [37] revealed no statistically significant difference in PTSD scores 6 months after discharge [37].

Table 4 Overview of the studies incorporated in the systematic review

Author (year)	Country	Study design	Participants sample	Assessment measures	Follow-up time after discharge	Outcomes
(1) Long et al. [16]	Australia	Prospective longitudinal cohort study	2–16 yrs PICU = 265	TSCYC	1 m, 3 m, 6 m, 12 m	Within the 12 months following discharge from the PICU, approximately 24% of children displayed elevated PTSS. Notably, 1 month after discharge, children who had received midazolam therapy were more likely to experience elevated PTSS.
(2) Dow et al. [17]	Australia	Prospective longitudinal cohort study	6–16 yrs PICU = 95	CRIES-13	3 w	This study reveals that clinical markers of disease severity alone are insufficient in accounting for the elevated occurrence of PTSS in children after their PICU stay. It indicates that subjective and cognitive factors, such as how children perceive and recall their PICU experience, play a crucial part in the emergence of PTSD.
(3) Dow et al. [15]	Australia	Prospective study	6–16 yrs PICU = 59	CPTSDI	6 m	At the 6-month mark, the PTSD-AA scale was identified as the most reliable gauge for assessing PTSD. The removal of Criterion C3 resulted in an enhancement of the accuracy of Criterion C.
(4) Dow et al. [18]	Australia	Part of a prospective longitudinal study	6–16 yrs PICU $n = 55$	CRIES-8, CRIES-13	6 m	The CRIES-13 scale appeared to provide more practical value compared to the CRIES-8 scale, which differs from prior research observations.
(5) Le Brocque et al. [19]	Australia	Prospective longitudinal design	2–16 yrs PICU = 272	TSCYC	3, 6, and 12 m	Children exhibiting heightened trauma symptoms after intensive care require prompt and efficient intervention. Conducting screenings shortly after PICU admission may help identify those children who are likely to experience persistent, long-term post-traumatic distress symptoms and facilitate focused treatment for at-risk children.
(6) Dow et al. [20]	Australia	Prospective longitudinal study	6–16 yrs PICU = 55	CRIES-13, CPTSDI	6 m	An analysis of mediation revealed that the impact of peri-trauma emotions on PTSS at the 6-month mark was not direct but occurred indirectly through its influence on cognitive processing.
(7) Otten et al. [1]	Netherlands	Prospective cohort study	0–17 yrs PICU = 49	CRIES	4 m	Of the 30 children with MIS-C, 10 (33%) displayed an increased risk of developing PTSD.
(8) Bronner et al. [21]	Netherlands	Prospective study	8–17 yrs PICU = 28 Volendam disaster = 355	CRTI	3 and 9 m	Over a third (34.5%) of the children exhibited subclinical symptoms of PTSD, and 13.8% were probable candidates for meeting the PTSD criteria.
(9) Boeschoten et al. [22]	Netherlands	Prospective multicenter study	8–18 yrs PICU = 110 General ward = 111	CRTI	3 m to 9 m	The symptoms of post-traumatic stress reported by parents and the emotional and behavioral issues observed in their children after admission to either a PICU or general ward were similar in both groups.
(10) Judge et al. [23]	UK	Prospective study	2–15 yrs PICU = 29	IES	3–12 m	We observed that there was a 20% risk of psychiatric disorders in children overall. Specifically, 62% of the children exhibited symptoms of PTSD, and 10% displayed characteristics indicative of a stress disorder.
(11) Rees et al. [24]	UK	Retrospective cohort study	5–18 yrs PICU = 35 Non-PICU = 33	CAPS-C, IES	6–12 m	Children who had been in the PICU demonstrated notably higher levels of PTSD symptoms, particularly in the form of increased irritability and ongoing efforts to avoid reminders of their admission.
(12) Als et al. [25]	UK	Exploratory case–control study	5–16 yrs PICU = 47 Healthy controls = 56	IES-8	3–6 m	In the PICU group, a noteworthy positive correlation was discovered between post-traumatic stress symptoms and evening cortisol levels (combining waking and 12 h later) with a p-value of 0.004.

Table 4 (continued)

Author (year)	Country	Study design	Participants sample	Assessment measures	Follow-up time after discharge	Outcomes
(13) Corbet Burcher et al. [26]	UK	Prospective Cohort study	8–16 yrs PICU = 53	IES-8	3–6 m	The administration of corticosteroids could potentially be linked to a reduction in post-traumatic stress symptoms and decreased evening cortisol levels in children with sepsis after their PICU admission.
(14) Colville et al. [5]	UK	Prospective study	7–17 yrs PICU = 102	CRIES	3 m	This study suggests that nearly one-third of children reported having delusional memories, and these memories were linked to both the duration of opiate/benzodiazepine usage and the risk of developing post-traumatic stress.
(15) Caspani et al. [27]	UK	Exploratory study	4–16 yrs PICU = 71	IES-8	3–6 m	The long-term psychiatric risk among the participants in this study was found to be related to abnormal lymphocyte counts during their admission. In pediatric sepsis cases, partial correlation analyses, while considering age and gender, unveiled connections: (i) between SDQ scores and reduced lymphocyte counts, and (ii) between IES-8 scores and elevated CRP levels. Notably, these associations retained their significance even after correcting for multiple comparisons.
(16) Elison et al. [28]	UK	Case–control study	5–16 yrs PICU = 16 Controls = 16	IES	3–7 m	In the PICU group, notable correlations were observed between cognitive functioning and emotional/behavioral scores.
(17) Als et al. [6]	UK	Prospective cohort study	5–16 yrs PICU = 88 Healthy controls = 100	IES-8	3–6 m	Children who were admitted to the PICU performed less favorably in comparison to the healthy control group, with 34% exhibiting high levels of post-traumatic stress symptoms.
(18) Colville and Pierce [29]	UK	Prospective longitudinal cohort	7–17 yrs PICU $n = 66$	CRIES-8	3 m and 12 m	Children displayed elevated post-traumatic stress scores at the 3-month mark (14 compared to eight, $p = 0.017$). Children who exceeded the specified threshold at the 12-month mark also exhibited higher post-traumatic stress scores at 3 months (18 compared to seven, $p = 0.001$) and elevated PIM scores upon admission.
(19) Colville and Pierce [30]	UK	Prospective cohort study	> 7 yrs PICU = 97	CRIES-8	3 m and 12 m	While the overall PedsQL scores at the 1-year mark were not linked to measures of illness severity during hospitalization, they exhibited a significant negative association with concurrent post-traumatic stress symptom scores.
(20) Rennick et al. [31]	Canada	Secondary data analysis	6–17 yrs PICU = 60	CIES	6 w, 6 m	Children classified in the high-risk group exhibited a greater occurrence of psychological consequences both 6 weeks and 6 months after discharge. The primary predictor of group distinctions at the 6-week mark was exposure to a high number of invasive procedures.
(21) Rennick et al. [32]	Canada	Prospective cohort design	6–17 yrs PICU = 60	CIES	6 w, 6 m	Younger children, those with more severe illness, and those who underwent a greater frequency of invasive medical procedures experienced notably higher levels of medical fears, a diminished feeling of autonomy in managing their health and persistent post-traumatic stress responses for up to 6 months after discharge.
(22) Nelson et al. [33]	USA	Prospective, longitudinal, multi-informant observational study	8–17 yrs PICU = 69	UCLA PTSD-RI	3 m	Three months after follow-up, 53% of the children still reported experiencing post-traumatic stress, with 13% meeting the criteria for PTSD.
(23) Board and Dai [34]	USA	Prospective, correlational design	6–12 yrs PICU = 8	CPTS-RI	2 w and 3 m	The majority of children with moderate or high levels of anxiety displayed different levels of post-traumatic stress symptomatology, whereas children with low anxiety showed either minimal or inconclusive symptoms of PTSD.

Table 4 (continued)

Author (year)	Country	Study design	Participants sample	Assessment measures	Follow-up time after discharge	Outcomes
(24) Olszewski et al. [35]	USA	Non-prespecified secondary analysis of a randomized clinical trial	> 8 yrs PICU = 102	CPSS	6 m	It is prevalent for children to screen positive for PTSD after experiencing acute respiratory failure, and this is linked to reduced HRQL and a decline in cognitive function.
(25) Stowman et al. [36]	USA	Longitudinal design	9–17 yrs PICU = 50	CPTSDI	4–7 w	A significant proportion of youth (26%) and parents (24%) experienced the development of substantial symptoms of PTSD.
(26) Watson et al. [37]	USA	Cluster randomized trial	2 w–17 yrs PICU $n = 40$ Usual care $N = 62$	CPSS	6 m	Approximately 30% of individuals exhibited scores suggesting a risk of PTSD, and there was no notable difference between the two treatment groups.
(27) Tippayawong and Chaiyakulsil [38]	Thailand	Retrospective chart review cohort study	1 m–15 yrs PICU $n = 95$	DSM-V	1 w	Out of 95 children, 78 (82.1%) exhibited abnormalities in at least one domain. Mental morbidity was found in 13.7% of the children.
(28) Fergé et al. [39]	France	Longitudinal, prospective, observational study	12–17 yrs PICU = 46	CRIES-8	12 m	Among adolescents, PTSD was found in 33% of cases. Prior exposure to threat (odds ratio [95% CI], 19.4 [1.9-201.2]; $p = 0.01$) and symptoms of anxiety and depression (odds ratio [95% CI], 9.6 [1.4–63.7]; $p = 0.02$) were established as independent factors linked to "likely" PTSD.
(29) Rady et al. [40]	Egypt	Comparative cross-sectional study	6–13 yrs PICU = 65 general ward = 65	IES-R	discharged from the PICU	The PICU group exhibited markedly higher rates of PTSD when compared to the general ward group. (84.6% vs. 6.2%, respectively; $p < 0.001$).
(30) Mingming et al. [41]	China	Randomized controlled trial	6–14 yrs PICU = 67 general ward = 67	PCL-C	4–6 m	Following significant car accidents, children commonly experience PTSD. Implementing psychological care interventions based on the stress response system theory can alleviate the PTSD in affected children and promote their post-traumatic growth.
(31) Muranjan et al. [42]	India	Prospective cohort study	> 5 yrs PICU = 30 General ward = 30	IES	1 m	A significantly larger percentage of patients in the PICU exhibited intrusive thoughts (43%) in comparison to the control group (6.7%). The development of intrusive thoughts was significantly correlated with the extent of medical intervention.

CAPS-C, Clinician-Administered Post-traumatic Stress Disorder Scale for Children; CIES, Children's Impact of Events Scale; CPSS, Child Post-traumatic Stress Disorder Symptom Scale; CPTSDI, Children's Post-traumatic Stress Disorder Inventory; CPTS-RI, Child Post-traumatic Stress Reaction Index; CRIES, Children's Revised Impact of Event Scale; CRIES-8, 8-item Children's Revised Impact of Event Scale; CRIES-13, Children's Revised Impact of Event Scale; CRP, C reactive protein; CRTI, Dutch Children's Responses to Trauma Inventory; DSM-V, Diagnostic and Statistical Manual of Mental Disorders, fifth edition; HRQL, health-related quality of life; IES, Impact of Event Scale; IES-R, Impact of Events Scale Revised; MIS-C, Multisystem Inflammatory Syndrome in Children; PCL-C, Post-traumatic Stress Disorder Checklist Civilian Version; PICU: pediatric intensive care unit; PIM, Pediatric Index of Mortality; PTSD, post-traumatic stress disorder; PTSS, Post-traumatic stress score; PedsQL, Pediatric Quality of Life Inventory; SDQ, Strengths and Difficulties Questionnaire; TSCYC, Trauma Symptom Checklist for Young Children; UCLA PTSD-RI, University of California Los Angeles Post-traumatic Stress Disorder Reaction Index; UK, United Kingdom; USA, United States of America

Risk factors for PTSD

The development of PTSD is a complex process influenced by many factors that interact with each other [16, 19, 26]. Colville et al. [5] conducted a study on 102 children in the PICU using the Impact of Event Scale (IES), and they found that the duration of opioid/benzodiazepine use was associated with PTSD-related intrusive memories at 3 months after discharge (odds ratio, 4.98; 95% confidence interval [CI], 1.3–20.0; $P < 0.023$). In a study involving two PICUs in Australia, Long et al. [16] found that intubation, PICU length of stay, and use of midazolam, propofol, and morphine were significantly associated with PTSD 1 month after discharge [16]. Dow et al. [20] found that treating pediatric patients with ketamine in the PICU had a significant impact on PTSD at 6 months post-discharge.

Three studies investigated the relationship between PTSD and cortisol [25, 26, 34]. One study examined the baseline cortisol levels of 47 children in the PICU, revealing a significant positive correlation between PTSD and nighttime cortisol concentrations ($p = 0.004$) [25]. Another UK-based study that collected saliva samples from pediatric patients with sepsis in the PICU found that the use of corticosteroids may be associated with fewer PTSD symptoms and lower nighttime cortisol levels [26]. A study conducted in the US involving eight PICUs found that the severity of PTSD symptoms increased over time, while salivary cortisol levels decreased at 2 weeks and 3 months post-discharge [34]. Besides cortisol research, a study involving 71 pediatric patients from two PICUs found a significant positive correlation between IES-8 scores and high C-reactive protein levels ($r = 0.823$; $p = 0.006$, $n = 11$) during follow-up [27].

Rennick et al. [31] conducted a study involving 60 PICU patients in Canada and found that children exposed to a high number of invasive surgeries had higher PTSD scores at 6 weeks after discharge. Through a follow-up study of 120 PICU patients, they also found that individuals who underwent more invasive surgeries exhibited significantly greater medical phobia and sustained traumatic stress reactions at 6 months post-discharge [32]. However, Tippayawong et al. [38] demonstrated a negative correlation between mechanical ventilation and PTSD. Le Brocque et al. [19] conducted a study in Australia and found that the length of stay in the PICU for children aged 2–16 years was a potential risk factor for PTSD 12 months after discharge. Als et al. [6] extracted data from 88 PICU patients and compared them with 100 healthy individuals; they found that the length of stay in the PICU was a predictive factor for PTSD [6].

Five studies found cognitive and emotional factors to be associated with PTSD [17, 20, 28, 36, 39]. Among them, Dow et al. [17] conducted research on 95 PICU patients aged 6–16 and found that cognitive/emotional factors were related to PTSD at 3 weeks after discharge. In another study, cognitive processing and traumatic memory significantly and independently influenced PTSD in children 6 months post-discharge [20]. Elison et al. [28] compared a group of PICU patients to a control group and found a significant correlation between PTSD and emotional/behavioral scores in the PICU group. Another study discovered that anxiety and depression symptoms might also be independent factors affecting PTSD in PICU patients [39]. Stowman et al. [36] found that anxiety, negative emotions, and hospital-related fear among adolescents in the PICU mediated initial acute stress disorder symptoms and later PTSD symptoms in youths.

Three studies found an association between the age of PICU patients and PTSD [17, 19, 32]. Dow et al. [17] conducted an investigation of 95 children in the PICU, Le Brocque et al. [19] conducted a study of Australian children in the PICU, and Rennick et al. [32] performed a study comparing 120 PICU children with children in regular wards; they all found that younger age was associated with greater distress and PTSD.

Le Brocque et al. [19] found that pre-illness functioning, the mothers' perception of threat to life, and the mothers' acute distress had an impact on PTSD in pediatric patients in the PICU. Additionally, Bronner et al. [21] found that maternal PTSD was the strongest predictive factor for PTSD in children in the PICU. Furthermore, Rennick et al. [32] discovered that children with more severe medical conditions were more susceptible to developing PTSD.

Assessment tools for measuring PTSD

This scoping review included 17 distinct assessment tools [43–59] related to PTSD which are listed in Table 5.

Discussion

The long-term psychological and life consequences for PTSD-affected children constitute a complex and extensive issue. These enduring effects encompass a spectrum of challenges, including anxiety, depression, traumatic memories, and emotional distress [29]. Moreover, PTSD may have adverse effects on academic performance, disrupt social relationships, and even lead to a breakdown of family dynamics for children [60].

In this scoping review, the included studies reported the prevalence of PTSD, ranging from a minimum of 13% [33] to a maximum of 84.6% [40]. The lowest incidence was reported by Nelson et al., who found that among 69 PICU patients aged 8–17 years in California, 13% were found to have PTSD at 3 months after discharge [33]. The highest

Table 5 Tests according to PTSD

Test	Reliability		Validity
TSCYC	PTS-I	Reliability coefficient = 0.87 [43]	Alpha internal consistency = 0.81 for Sexual Concerns to 0.93 for PTSD-Total, with an Average scale alpha of 0.87 [43]
	PTS-AV	Reliability coefficient = 0.82 [43]	
	PTS-AR	Reliability coefficient = 0.85 [43]	
	PTS-TOT	Reliability coefficient = 0.93 [43]	
	SC	Reliability coefficient = 0.81 [43]	
	ANX	Reliability coefficient = 0.86 [43]	
	DEP	Reliability coefficient = 0.84 [43]	
	DIS	Reliability coefficient = 0.91 [43]	
	ANG	Reliability coefficient = 0.91 [43]	
CRIES	Cronbach's alpha = 0.87 [44] Cronbach's alpha for the intrusion items = 0.82 [44] Cronbach's alpha for the avoidance items = 0.82 [44] Cronbach's alpha for the five new arousal items = 0.70 [44]		
CRIES-8	Cronbach's alpha = 0.70 [45]		Convergent validity: The correlation between SCAS-20 and CRIES-8 ($r = 0.48$) [45]
CRIES-13	Cronbach's alpha = 0.74 [45]		Convergent validity as the total scores on both the CRIES and CPTS-RI scales exhibited a strong correlation ($r = 0.79$, $p < 0.001$) in the overall sample, as well as in subgroups of boys ($r = 0.76$) and girls ($r = 0.79$) separately [44] Convergent validity: The correlation between SCAS-20 and CRIES-13($r = 0.58$) [45]
IES	Cronbach's alpha = 0.87 [46] Cronbach's alpha for intrusive thoughts = 0.87 [46] Cronbach's alpha for avoidance responses = 0.76 [46]		Convergent validity was demonstrated by a moderate, positive correlation ($r = 0.46$; $p < 0.01$) between the total score of the IES and depression measurements. Furthermore, strong, negative correlations were observed between the IES and self-esteem measures at time two ($r = -0.52$; $p < 0.01$) and time three ($r = -0.58$; $p < 0.01$) [46]
CAPS-C	Interrater reliability: Cohen's Kappa for 10 tapes was 0.85 and for a further six was 0.81 [47]		
IES-8	The interrater reliability = 0.89 [48] The internal consistency = 0.78 [48]		Criterion validity was established at 0.83. The content validity, determined by Spearman's correlations between the subscales (intrusion and avoidance, rho = 0.46, $p = 0.01$) [48]
CRTI	The Cronbach's alpha = 0.92 [49]		Convergent validity was evident as it showed a strong correlation with the CRIES ($r = 0.81$) [49]
UCLA PTSD-RI	The Cronbach's alpha = 0.8-0.95 [33] Test-retest reliability = 0.69 [33]		Convergent validity = 0.79 [33]
CPTS-RI	Interrater reliability = 0.88 [34] Internal consistency = 0.89 [34] Test-retest intraclass correlation coefficient = 0.67 [50]		The French version of the CPTS-RI exhibited a strong correlation with the CAPS-CA ($r = 0.76$, $p < 0.001$) [50]
DSM-V	Intrarater reliability = 0.6–0.8 [51, 52] The test-retest reliability = 0.71 [53]		Correlations with concurrent gambling problem severity measures $r > 0.30$ [53]
CPTSDI	Interrater reliability = 0.95 [15] The Cronbach's alpha for diagnosis = 0.95 [36] test–retest = 0.78–1.00 [36]		Convergent validity: CPTSDI was significantly associated with RCMAS ($r = 0.7$, $p < 0.001$) and ($r = 0.59$, $p < 0.001$) [54]

Table 5 (continued)

Test	Reliability	Validity
CPSS	Test–retest reliability = 0.84 [55]	Convergent validity: CPSS was significantly associated with CPTSD–RI. The correlation coefficient, measured using the Pearson product- moment method, was 0.80 with a significant p-value of less than 0.001 [55]
IES-R	Cronbach's alpha = 0.94 [56], Cronbach's alpha for Intrusion = 0.88 [56], Cronbach's alpha for Avoidance = 0.90 [56], Cronbach's alpha for Hyperarousal = 0.81 [56]	Convergent Validity: Pearson correlations were computed between the IES-R and the threat subscale of the Ice Storm Questionnaire, yielding the following results: intrusion ($r = 0.29$), avoidance ($r = 0.22$), hyperarousal ($r = 0.23$), and the total score ($r = 0.29$) [57]
PCL-C	Internal Consistency = ($\alpha = 0.94$, $n = 471$) [58] Retest reliability ($r = 0.66$; $n = 316$) [58]	Convergent Validity: The correlation between PCL-CMS and the PCL-C was strong, with a coefficient of 0.60. In comparison, the correlations between the PCL-C and all other measures ranged from 0.28 to 0.59 [58]
CIES	Split half reliability= ($r = 0.86$) [59] Cronbach's alpha for Intrusion = 0.78 [59] Cronbach's alpha for Avoidance = 0.82 [59] Test-Retest Reliability = 0.87 [59] Test-Retest Reliability for Intrusion = 0.89 [59] Test-Retest Reliability for Avoidance = 0.79 [59]	

ANG: Anger/Aggression; ANX: Anxiety; CAPS-C: Clinician Administered Post-traumatic Stress Disorder Scale for Children; CAPS-CA: Clinician Administered PTS Scale-Child and Adolescent; CIES: Children's Impact of Events Scale; CMS: Civilian Mississippi Scale; CPSS: Child Post-traumatic Stress Disorder Symptom Scale; CPTSDI: Children's Post-traumatic Stress Disorder Inventory; CPTS-RI: Child Post-traumatic Stress Reaction Index; CRIES: Children's Revised Impact of Event Scale; CRIES-8: 8-item Children's Revised Impact of Event Scale; CRIES-13: 13-item Children's Revised Impact of Event Scale; CRTI: Dutch Children's Responses to Trauma Inventory; DEP: Depression; DIS: Dissociation; DSM-V: Diagnostic and Statistical Manual of Mental Disorders, fifth edition; IES: Impact of Event Scale; IES-R: Impact of Events Scale Revised; PICU: pediatric intensive care unit; PCL-C: Post-traumatic Stress Disorder Checklist Civilian Version; PTS-AR: Post-traumatic Stress-Arousal; PTS-AV: Post-traumatic Stress-Avoidance; PTSD: post-traumatic stress disorder; PTS-I: Post-traumatic Stress-Intrusion; PTS-TOT: Post-traumatic Stress-Total; RCMAS: Revised Children's Manifest Anxiety Scale; SC: Sexual Concerns; SCAS: Spence Children's Anxiety Scale; TSCYC: Trauma Symptom Checklist for Young Children; UCLA PTSD-RI: University of California Los Angeles Post-traumatic Stress Disorder Reaction Index

incidence was reported by Rady et al., who investigated 130 PICU children aged 6–13 years in Egypt. In comparison to the general ward group, the PICU group exhibited a significantly higher prevalence of PTSD after discharge (84.6% and 6.2%, respectively; $p < 0.001$) [40]. This variation may be attributed to several factors, including differences in study design, sample characteristics, cultural variations, PTSD measurement time, and the assessment tools used [21, 23, 33, 36]. In a substantial number of studies, the prevalence of PTSD fell within the range of 20–40%, suggesting that out of every 100 PICU patients, 20–40 may experience PTSD or exhibit PTSD symptoms [29, 36, 39]. This highlights a significant proportion of PICU patients experiencing PTSD, emphasizing the need for further exploration into the factors influencing PTSD and the development of tailored interventions. These findings also underscore the necessity of addressing psychological issues in PICU patients to foster their recovery and holistic development.

This scoping review summarizes PTSD risk factors, encompassing medical interventions (medication use, invasive surgeries, and mechanical ventilation) [5, 31, 38], child-related factors (age, cortisol levels, and cognitive and emotional factors) [19, 32], and family environment (maternal psychological status and the presence of maternal PTSD) [19].

For medical interventions, the studies suggested that commonly used medications in the PICU, including opioids, benzodiazepines, and midazolam, are associated with PTSD in children [5, 16, 20]. This may be because prolonged or excessive use of opioids and benzodiazepines can lead to tolerance and dependency, with withdrawal symptoms upon discontinuation, potentially affecting psychological well-being [5]. The use of midazolam may be linked to the processing of memories and emotions related to trauma. These substances enhance the action of the neurotransmitter gamma-aminobutyric acid, producing inhibitory effects. In certain situations, this influence may interfere with the normal processing of trauma [16]. A strong association was found between treatments in the PICU, particularly invasive procedures such as intubation, surgery, blood draws, and catheter placement, and PTSD in pediatric patients [31, 32]. This might be because invasive procedures are often accompanied by pain and physiological discomfort, especially for pediatric patients. They may feel fear, anxiety, or helplessness, feeling a loss of control over their own situation [31]. These memories may leave a profound impression on the

child's psyche, becoming potentially triggering factors for PTSD.

In this scoping review, we included a diverse range of assessment tools for PTSD measurements in pediatric patients discharged from the PICU. These tools demonstrated varying degrees of reliability and validity, making them suitable for research and clinical applications related to PTSD. Notably, the Trauma Symptom Checklist for Young Children, developed for the assessment of trauma-related symptoms in children ages 3–12, exhibited strong internal consistency across its various subscales [43]. The Children's Revised Impact of Event Scale (CRIES), designed for use with children aged 8 years and above who are able to read independently, showed high internal consistency and was effective in measuring intrusion, avoidance, and arousal symptoms. [45]. Other versions, such as CRIES-8 and CRIES-13, displayed acceptable psychometric properties and were useful in distinguishing children with and without PTSD symptoms [45, 46]. The IES demonstrated good internal consistency and was moderately correlated with depression and self-esteem measures, and it is validated for use in children aged 8 and older [47]. The Clinician-Administered Post-Traumatic Stress Disorder Scale for Children (CAPS-C) showed strong interrater reliability, enhancing its clinical utility for younger children; information from parents is used to assess symptoms using the CAPS-C [48]. The CRTI exhibited excellent internal consistency and strong convergent validity with the CRIES, and is used for children aged eight to 18 [50]. These tools offer valuable options for assessing PTSD in pediatric patients post-PICU discharge, with the choice depending on research or clinical needs. The diversity of these tools underscores the complexity of evaluating PTSD in this population; research goals, age groups, cultural sensitivity, and psychometrics should be considered when selecting an assessment tool. Future research and clinical work should choose suitable tools to improve accuracy in diagnosing and treating PTSD in children discharged from the PICU.

Limitations

This scoping review has some limitations. First, it was confined to the availability of accessible published literature containing defined or related terms. Second, the scoping review only included articles written in English and Chinese; thus, articles in other languages may have provided additional evidence. Third, with regard to the quality assessment of the literature, some entries of the MMAT lacked objective evaluation criteria, and the assessment of the results may have involved some degree of subjectivity. Finally, some of the included studies used assessment tools beyond their intended age range, which could have potentially affected the results.

Practice implications

This review reports a wide prevalence range for PTSD in children discharged from PICUs, ranging from 13 to 84.6%. It also sheds light on the multitude of risk factors associated with the development of PTSD in children discharged from PICUs, including medical procedures, child characteristics, and the family environment. This review serves as a valuable resource for healthcare professionals, equipping them with the knowledge needed to identify high-risk individuals and administer appropriate care. By considering the risk factors, doctors, nurses, and psychologists can tailor treatment plans effectively, ultimately mitigating psychological distress in children. The review also highlights 17 assessment tools that can be utilized in clinical settings, offering guidance on selecting the most suitable methods for different patient groups. This serves to enhance the precision and efficacy of diagnosis, thereby improving overall patient care.

Conclusions

In summary, PTSD in pediatric patients following PICU hospitalization presents a complex issue with profound effects on children. Variability in the incidence rates and the diversity of influencing factors make the identification of PTSD and subsequent intervention challenging. Future research should focus on in-depth investigations of neuroscience, biology, assessment tools, and cross-cultural factors to facilitate early identification of potential traumatic events in PICU patients, along with providing psychological support, education, and appropriate treatment, which can mitigate or prevent the development of PTSD.

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Declarations

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