The incidence and risk factors of syndromic psychological dysfunction in family members after ICU: A meta-analysis

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Abstract

**Objective** To summarize the risk factors of Post Intensive Care unit-family (PICS-F) mental dysfunction in family members, and to provide evidence for clinical medical staff to identify the risk factors of PICS-F mental dysfunction in advance.

**Methods** Embase, PubMed, Cochrane Library, EBSCO, Web of Science, China Biomedical Database (CBM), CNKI, WanFang Database and VIP database were systematically searched from database establishment to May 2022. Literature on the risk factors of PICS-F mental dysfunction was included. After screening, extraction and quality evaluation, stata17.0 and RveMan5.4 were used to conduct meta-analysis on the incidence and risk factors of PICS-F.

**Results** a total of 10692 subjects were included in 15 literatures. The incidence of pics-f mental dysfunction was 28% (95%CI 0.22 to 0.35). Subgroup analysis showed a 30% incidence in the United States and 27% in other countries. The incidence was 26% in cohort studies, and 43% in case-control and cross-sectional studies. The incidence was 26% at 3 months and 13% at 6 months. Meta-analysis results showed patient age (OR=1.06,95%CI 1.01 to 1.10), gender of family members (OR=4.07,95%CI 2.52 to 6.60) and relationship between family members and patients (OR=2.24,95%CI 1.00 to 4.99), family history of mental illness (OR=3.77,95%CI 1.58 to 8.97), length of ICU stay (OR=4.72,95%CI 2.10 to 10.64), and severity of disease (OR=5.95,95%CI 2.09 to 16.94), death (OR=1.90,95%CI 1.31 to 2.77), family education level (OR=1.07,95%CI 1.02 to 1.12) were the influencing factors of PICS-F psychological dysfunction. It is not clear whether the mode of admission and attendance at family meetings have an effect on PICS-F mental dysfunction.

**Conclusion** The risk factors for PICS-F mental dysfunction are young age, female family member, spouse, history of mental illness, long ICU stay, severity of illness, death and low education level of family members. Clinical medical staff should pay attention to the above risk factors and take corresponding measures to reduce the incidence of PICS-F psychological dysfunction.

**Relevance to clinical practice**

The results of our meta-analysis have important consequences for ICU nurse managers. Our finding of high rate of PICS-F Psychological dysfunction among ICU patients. That more attention should be devoted to develop and apply prevention programs for ICU nurses to manage this global issue.

Introduction

Post-intensive care syndrome (PICS) was first proposed by the American Society of Critical Care Medicine at the 2010 Global Critical Care Conference[1]. PICS is a new or persistent extensive damage in patients after discharge[2], which mainly includes cognitive, psychological and physiological dysfunction[3]. Post-intensive care syndrome family (PICS-F)[4]. Psychological dysfunction is mainly manifested as anxiety, depression and post-traumatic stress disorder[5]. The post-ICU syndrome of patients has been paid attention to by medical staff, and research on related risk factors and intervention measures has been carried out extensively[6]. However, at present, medical staff do not pay much attention to the psychological dysfunction of PICS-F[7], the incidence rate is high, and the research conclusions on risk factors are still inconsistent, and there are certain disputes[8]. Therefore, this study systematically retrieves and summarizes the incidence and risk factors of PICS-F psychological dysfunction at home and abroad, and provides a theoretical basis for the early detection and intervention of PICS-F psychological dysfunction.

1. Materials And Methods

This systematic review of previous systematic reviews and meta-analyses is registered in the International Prospective Registry of Systematic Reviews (PROSPERO) Trials Registry (CRD42022339899).

1.1 Construction retrieval problem

According to the PICOS principle, the research object: family members of hospitalized patients in intensive care unit; exposure factors: sociodemographic factors, patient condition factors, etc. outcome: anxiety, depression, post-traumatic stress disorder and other psychological factors Dysfunction; study type: cohort study\case-control study\cross-sectional survey study.
1.2 Literature sources and retrieval strategies

Foreign language databases: Embase, PubMed, Cochrane library, EBSCO, Web of Science; Chinese databases: China Biomedical Literature Service (CBM), CNKI, WanFang Database, VIP database, and retrieve unpublished grey literature by other means. Using a combination of subject headings and free words, and a combination of Boolean logic operators such as "AND" and "OR", and a search strategy of truncation, search for the occurrence of PICS-F from the establishment of the database to the publication in May 2022. Literature on risk factors for rates and psychological dysfunction. The specific search strategy is as follows: "Post-Intensive Care Syndrome/ PICS/ post intensive care unit syndrome/ post intensive care syndrome-famil/ PICS-F/ post intensive care family syndrome/ Post intensive care family syndrome/ PICS-family/ intensive Care Unit/ / intensive care department/ intensive treatment unit/ general ICU/ Risk Factor*/ Factor, Risk/ Risk Factor/ relative risk/ Social Risk Factor*/ Factor, Social Risk/ Health Correlate*/ Correlate*, Health/ Population at Risk/ Risk Score/ Risk Factor Score*/ Score, Risk Factor". Taking Web of Science as an example, the specific search strategy is as follows:

#1 ((((((((((((((TS=(Post-Intensive Care Syndrome )) OR ALL=(post-intensive care syndrome)) OR ALL=(PICS )) OR ALL=(post ICU syndrome )) OR ALL=(post intensive care unit syndrome)) OR ALL=(post-intensive care syndrome)) OR ALL=(post intensive care unit syndrome)) OR TS=(Post-intensive care syndrome-famil)) OR TI=(family post-intensive care syndrome)) OR TI=(PICS-F) OR TI=(PICS-family) OR TI=(post ICU family syndrome) OR TI=(post intensive care family syndrome) OR TI=(post-intensive care syndrome family members)) OR TI=( Post intensive care syndrome family syndrome)

#2 ((((((((((TS=(intensive Care Unit)) OR ALL=(Unit, Intensive Care)) OR ALL=(ICU Intensive Care Units)) OR ALL=(ICU)) OR ALL=(close attention unit)) OR ALL=(combined medical and surgical ICU)) OR ALL=(combined surgical and medical ICU)) OR ALL=(critical care unit)) OR ALL=(general ICU) OR ALL=(intensive care department)) OR ALL=(intensive therapy unit) OR ALL=(intensive treatment unit)) OR ALL=(special care unit)

#3 ((((((((((((((ALL=(Risk Factor*)) OR ALL=(Factor, Risk)) OR ALL=(Risk Factor)) OR ALL=(relative risk)) OR ALL=(Social Risk Factor*)) OR ALL=(Factor, Social Risk)) OR ALL=(Factor*, Social Risk)) OR ALL=(Risk Factor, Social)) OR ALL=(Social Risk Factor) OR ALL=(Health Correlate*) OR ALL=(Correlate*, Health)) OR ALL=(Population at Risk)) OR ALL=(Risk Score*) OR ALL=(Risk Factor Score*)) OR ALL=(Score, Risk Factor)

#4 # 1 AND #2 AND #3

1.3 Inclusion and exclusion criteria

1.3.1 Inclusion criteria

- Age of the patient's family members is ≥ 18 years old;
- The family members are diagnosed with PICS-F psychological dysfunction (the clinical manifestations are consistent with one or more characteristics of the family members' post-ICU syndrome psychological dysfunction through relevant assessment tools);
- PICS-F is reported The risk factors for psychological dysfunction were the primary outcome indicators, and the incidence of PICS-F was the secondary outcome indicator. The assessment tools for psychological dysfunction were the Hospital Anxiety and Depression Scale (HADS), the Post-traumatic Stress Disorder Screening Look-up table (PTSS-10) and Event Impact Scale Revised (IES-R);
- Types of literature are observational studies, including cohort studies, cross-sectional investigation studies, and case-control studies.

1.3.2 Exclusion criteria

- There is no assessment tool for a clear diagnosis;
- Only the title and abstract of the article are available, and the data and full text cannot be obtained;
- Not in Chinese and English;
- Repeated publication.

1.4 Literature screening

The obtained literature was imported into the literature management software of EndNote 20. After eliminating duplicate literature, two researchers independently screened literature, and excluded literature that did not meet the inclusion criteria, such as those inconsistent with the theme, reviews, conference reports. The literature and a third researcher discussed the decision together. All
literatures that might meet the inclusion criteria were read in full text, and those for which data and full text were not available were excluded.

1.5 Data extraction

The data of the obtained literature was extracted using an Excel table, and the extracted content included general information of the literature: author year, country, literature research type, total sample size, the number of people with PICS-F psychological dysfunction, the incidence of PICS-F psychological dysfunction, and assessment tools, risk factors.

1.6 Evaluation of literature quality

Two researchers assessed the quality of cohort studies and case-control studies by using the Newcastle-Ottawa Scale (NOS). The total score is 9 points, with 7 to 9 points for high-quality literature, 0 to 4 points is classified as low-quality literature\(^{[9]}\). The cross-sectional survey was conducted using the Agency for Healthcare Research and Quality AHRQ, a quality assessment tool recommended by the American Health Care Quality and Research Institute. One item of “unclear”, of which “yes” is counted as 1 point, “no” and “unclear” are both 0 points, and the total score is 11 points. 8 to 11 are classified as high-quality literature, 4 to 7 as medium-quality literature, and 0 to 3 as low-quality literature. Only high-quality literature was included in this study.

1.7 Statistical methods

Meta-analysis of the incidence of PICS-F was performed by stata17.0, and Meta-analysis of the risk factors of PICS-F psychological dysfunction was performed by RevMan5.4. The dichotomous variables used odds ratio (OR) and 95% confidence interval (confidence interval CI) represents the effect size, and the size of heterogeneity was judged according to \(I^2\). If \(I^2 \geq 50\%\) was considered to have heterogeneity, a random effect model was used for meta-analysis, and the source of heterogeneity was explored through sensitive analysis. If \(I^2 < 50\%\), the heterogeneity was considered to be small, and a fixed-effect model was used for meta-analysis, and descriptive analysis was used for literatures that could not be subjected to meta-analysis. The publication bias of the included studies was evaluated by funnel plot and Egger test, and the difference was considered statistically significant at \(P < 0.05\).

2. Results

2.1 Literature search results

A total of 1474 literatures were initially retrieved, including 444 Chinese literatures and 1030 foreign literatures. According to the literature screening process and literature quality evaluation, a total of 15 literatures were included. The literature screening process is shown in Fig. 1.

2.2 Basic features of the included literature

The 15 papers were published between 2008 and 2022, and the publication countries were concentrated in the United States, the Netherlands, Germany, Sweden and Japan. Among the literature types, there were 13 cohort studies, 1 case-control study, and 1 cross-sectional survey study. A total of 10,692 subjects were included in the study, and the incidence of PICS-F psychological dysfunction was 14–55%. The basic characteristics of the literature are shown in Table 1.

2.3 Evaluation of literature quality

Cohort studies and case-control studies were evaluated for literature quality according to the NOS scale, with scores ranging from 7 to 9 points, indicating high-quality literature. See Table 2 for literature quality evaluation. The cross-sectional study evaluated the quality of the literature according to the AHRQ scoring standard\(^{[10]}\). In which “if not the source of the population, whether the research object is continuous” and “whether the researcher's subjective factors mask other aspects of the research object” were rated as “unclear”, and the rest were rated as “yes”, with a total score of 9 points, indicating high-quality literature.

2.4 Incidence of PICS-F Psychological Dysfunction

The results of the study showed that the incidence of psychological dysfunction in PICS-F was 28% (95%CI 0.22 to 0.35), and there was high heterogeneity between studies (\(I^2 = 95.0\%, P < 0.001\)), so a random-effects model was used to conduct Meta Analysis, the
results are shown in Fig. 2. Subgroup analyses were performed to explore sources of heterogeneity by country, study type, and follow-up time.

<table>
<thead>
<tr>
<th>Author and year of publication</th>
<th>Types of Literature Research</th>
<th>country</th>
<th>total sample size</th>
<th>PICS-F: Number of People with Psychological Dysfunction</th>
<th>Incidence (%)</th>
<th>follow-up time (month)</th>
<th>assessment tool</th>
<th>risk factors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Petrinec2018[11]</td>
<td>cohort study</td>
<td>America</td>
<td>48</td>
<td>22</td>
<td>45.8%</td>
<td>3 months</td>
<td>HADS/PCL-C</td>
<td></td>
</tr>
<tr>
<td>Warren2016[12]</td>
<td>case control study</td>
<td>America</td>
<td>82</td>
<td>32</td>
<td>39.0%</td>
<td>3 months</td>
<td>PC-PTSD</td>
<td></td>
</tr>
<tr>
<td>Lefkowitz2020[13]</td>
<td>cohort study</td>
<td>America</td>
<td>127</td>
<td>29</td>
<td>22.8%</td>
<td>3 months</td>
<td>PTSS-10</td>
<td></td>
</tr>
<tr>
<td>Lee2019[14]</td>
<td>cohort study</td>
<td>America</td>
<td>164</td>
<td>51</td>
<td>31.1%</td>
<td>6 months</td>
<td>PHQ-9/PCL-C</td>
<td></td>
</tr>
<tr>
<td>Zanten2016[15]</td>
<td>cohort study</td>
<td>America</td>
<td>94</td>
<td>20</td>
<td>21.2%</td>
<td>3 months</td>
<td>CSI/TSQ</td>
<td></td>
</tr>
<tr>
<td>Kross2011[16]</td>
<td>cohort study</td>
<td>America</td>
<td>226</td>
<td>32</td>
<td>14.1%</td>
<td>3 months</td>
<td>PCL/(PHQ)-8</td>
<td></td>
</tr>
<tr>
<td>Gries2020[17]</td>
<td>cohort study</td>
<td>America</td>
<td>218</td>
<td>39</td>
<td>47.5%</td>
<td>3 months</td>
<td>HADS/IES-R</td>
<td></td>
</tr>
<tr>
<td>Nadig2021[18]</td>
<td>cross-sectional study</td>
<td>America</td>
<td>82</td>
<td>39</td>
<td>15.2%</td>
<td>3 months</td>
<td>SRS-PTSD</td>
<td></td>
</tr>
<tr>
<td>Harris2021[19]</td>
<td>cohort study</td>
<td>America</td>
<td>93</td>
<td>14</td>
<td>25.1%</td>
<td>3 months</td>
<td>HADS/IES-R</td>
<td></td>
</tr>
<tr>
<td>Bronner2008[20]</td>
<td>cohort study</td>
<td>America</td>
<td>247</td>
<td>62</td>
<td>32.7%</td>
<td>3 months</td>
<td>HADS/IES-R</td>
<td></td>
</tr>
<tr>
<td>Milton2022[21]</td>
<td>cohort study</td>
<td>America</td>
<td>92</td>
<td>41</td>
<td>44.5%</td>
<td>3 months</td>
<td>PTSS-10</td>
<td></td>
</tr>
<tr>
<td>Beesley2018[22]</td>
<td>cohort study</td>
<td>Germany</td>
<td>143</td>
<td>79</td>
<td>55.2%</td>
<td>3 months</td>
<td>HADS/IES-R/PTSS-10</td>
<td></td>
</tr>
<tr>
<td>matt2017[23]</td>
<td>cohort study</td>
<td>Germany</td>
<td>83</td>
<td>13</td>
<td>15.7%</td>
<td>3 months</td>
<td>PTSS-10</td>
<td></td>
</tr>
<tr>
<td>wintermann2016[24]</td>
<td>cohort study</td>
<td>Japan</td>
<td>8940</td>
<td>1140</td>
<td>12.8%</td>
<td>6 months</td>
<td>PTSS-10</td>
<td></td>
</tr>
</tbody>
</table>

Note: PICS-F: Post-intensive care unit syndrome in family; NOS: Newcastle-Ottawa Scale; AHRQ: American Institute for Health Care Quality and Research; HADS: Inpatient Anxiety and depression Scale; PCL-5: Post-traumatic stress Disorder checklist; PC-PTSD: primary care screening for post-traumatic stress disorder; PTSS-10: Post-traumatic stress Disorder screening form; PHQ-9: Health questionnaire 9-item Depression Scale; PCL-C: Checklist for Post-traumatic Stress Disorder-Civilian version; Gad-7:7-item Generalized Anxiety Disorder Scale; CSI: Caring stress Scale; TSQ: Trauma screening questionnaire; PCL: Checklist for post-traumatic stress disorder; IES-R: Revised Version of the Event Impact Scale; SRS-PTSD: Post-traumatic stress Disorder Self-rating Scale; # Time to stay in ICU; $ family members have a history of mental disorders; ☞ Severity of the disease; ☞ Gender of family members; ☞ family education level; ☞ Whether the patient died; ☞ Age of patients; ☞ Family and patient relationship; ☞ Admission mode of patients; ☞ Early family meetings.
Table 2
Quality evaluation of cohort studies and case-control studies

<table>
<thead>
<tr>
<th>Include literature</th>
<th>Research object selection</th>
<th>Cohort comparability</th>
<th>outcomes measurement</th>
<th>NOS(totalpoints)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Petrinec2018[11]</td>
<td>1 1 1 1</td>
<td>2</td>
<td>1 1 1</td>
<td>9</td>
</tr>
<tr>
<td>Warren2016[12]</td>
<td>1 1 1 0</td>
<td>2</td>
<td>1 1 0</td>
<td>7</td>
</tr>
<tr>
<td>Lefkowitz2010[13]</td>
<td>1 1 1 1</td>
<td>1</td>
<td>1 1 0</td>
<td>7</td>
</tr>
<tr>
<td>Lee2019[14]</td>
<td>1 1 0 1</td>
<td>2</td>
<td>1 1 1</td>
<td>8</td>
</tr>
<tr>
<td>Zanten2016[15]</td>
<td>1 1 1 0</td>
<td>2</td>
<td>1 1 0</td>
<td>7</td>
</tr>
<tr>
<td>Kross2011[16]</td>
<td>1 1 1 1</td>
<td>2</td>
<td>1 0 1</td>
<td>8</td>
</tr>
<tr>
<td>Gries2010[17]</td>
<td>1 1 1 1</td>
<td>2</td>
<td>1 1 0</td>
<td>8</td>
</tr>
<tr>
<td>Nadig2021[18]</td>
<td>1 1 1 1</td>
<td>2</td>
<td>1 1 0</td>
<td>8</td>
</tr>
<tr>
<td>Harris2021[19]</td>
<td>1 1 1 0</td>
<td>2</td>
<td>1 1 0</td>
<td>7</td>
</tr>
<tr>
<td>Bronner2008[20]</td>
<td>1 1 1 1</td>
<td>2</td>
<td>1 1 0</td>
<td>8</td>
</tr>
<tr>
<td>Milton2022[21]</td>
<td>1 1 1 1</td>
<td>2</td>
<td>1 1 1</td>
<td>9</td>
</tr>
<tr>
<td>Beesley2018[22]</td>
<td>1 1 1 1</td>
<td>2</td>
<td>1 1 1</td>
<td>9</td>
</tr>
<tr>
<td>matt2017[23]</td>
<td>1 1 1 1</td>
<td>1</td>
<td>1 1 0</td>
<td>7</td>
</tr>
<tr>
<td>wintersmann2016[24]</td>
<td>1 1 1 1</td>
<td>2</td>
<td>1 1 0</td>
<td>8</td>
</tr>
</tbody>
</table>

Note: ▪ Representativeness of exposed cohort; □Representativeness of non-exposed cohort; ▪ Determination of exposure factors; □ There were no outcome indicators before the study began; ▪ Measurement of outcome indicators; □ Whether the follow-up time is sufficient; □ Whether the follow-up is complete.

The results of subgroup analysis showed that: The incidence of PICS-F mental dysfunction was 30% in 9 studies in the United States and 27% in other countries. Study type: The incidence of PICS-F mental dysfunction was 26% in 13 cohort studies, and 43% in 2 other cohort studies. Follow-up time: The incidence of PICS-F mental dysfunction at 3 and 6 months was 26% and 13%, respectively, as shown in Table 3.

After each study was deleted one by one, the incidence of PICS-F mental dysfunction did not change significantly, as shown in Fig. 3.
Table 3
Results of subgroup analysis on the incidence of PICS-F mental dysfunction

<table>
<thead>
<tr>
<th>subgroup</th>
<th>Number of included references</th>
<th>Heterogeneity test results</th>
<th>model</th>
<th>ES Value(95%CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>country</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>American</td>
<td>9</td>
<td>91.4% p&lt;0.001 random</td>
<td></td>
<td>0.30(0.21~0.38)</td>
</tr>
<tr>
<td>Others</td>
<td>6</td>
<td>96.3% p&lt;0.001 random</td>
<td></td>
<td>0.27(0.15~0.39)</td>
</tr>
<tr>
<td>Type of Study</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>cohort study</td>
<td>13</td>
<td>94.5% p&lt;0.001 random</td>
<td></td>
<td>0.26(0.20~0.32)</td>
</tr>
<tr>
<td>Others</td>
<td>2</td>
<td>18.4% P=0.268 Fixed</td>
<td></td>
<td>0.43(0.36~0.51)</td>
</tr>
<tr>
<td>follow-up time</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3months</td>
<td>12</td>
<td>91.9% p&lt;0.001 random</td>
<td></td>
<td>0.26(0.24~0.28)</td>
</tr>
<tr>
<td>6months</td>
<td>3</td>
<td>91.9% p&lt;0.001 random</td>
<td></td>
<td>0.13(0.12~0.14)</td>
</tr>
</tbody>
</table>

2.5 Meta-analysis of risk factors for psychological dysfunction in PICS-F

2.5.1 Patient age

A total of 5 studies\cite{16,17,19,20,23} reported the relationship between patient age and PICS-F psychological dysfunction. According to the heterogeneity test results ($I^2 = 0\%$, $P = 0.97$), a fixed effect model was used for Meta-analysis, and the results showed that the patient's younger age was a risk factor for psychological dysfunction in PICS-F (OR = 1.06, 95%CI 1.01 to 1.10). The younger the patient's age, the greater the risk of family members developing PICS-F psychological dysfunction. The meta-analysis results are shown in Fig. 4.

2.5.2 Gender of family members

A total of 5 studies\cite{14,17,19,22,23} reported the relationship between family members' gender and PICS-F psychological dysfunction. According to the results of heterogeneity test ($I^2 = 0\%$, $P = 0.89$), a fixed effect model was used for Meta-analysis, and the results showed that the gender of the patient's family members was female as a risk factor for family members to develop psychological dysfunction (OR = 4.07, 95%CI 2.52 to 6.60). The results of the Meta-analysis are shown in Fig. 5.

2.5.3 Relationship between family members and patients

4 studies\cite{17,21,23,25} reported the influence of family-patient relationship on PICS-F psychological dysfunction, and there was large heterogeneity among the studies ($I^2 = 64\%$, $P = 0.05$), so the random effects model was used for meta-analysis, and the results showed that the relationship with the patient as a spouse was a risk factor for the occurrence of PICS-F psychological dysfunction (OR = 2.24, 95%CI 1.00 to 4.99). The meta-analysis results are shown in Fig. 6. Through sensitivity analysis, after excluding the study of Miyamoto et al\cite{25}, the other 3 studies had less heterogeneity ($I^2 = 0\%$, $P = 1.00$). The fixed effect model was used for meta-analysis, and the results showed that the relationship with the patient was a spouse. Time was a risk factor for the occurrence of PICS-F psychological dysfunction (OR = 3.64, 95%CI 1.86 to 7.12), and the comparison between the two groups was statistically significant ($p < 0.001$).

2.5.4 Whether family members have a history of mental illness

4 studies\cite{12,14,17,19} reported the relationship between the history of mental illness and PICS-F psychological dysfunction. According to the results of heterogeneity test ($I^2 = 0\%$, $P = 0.95$), the fixed effect model was used for meta-analysis, and the results showed that family members with a history of mental illness were at risk of developing PICS-F psychological dysfunction (OR = 3.77, 95%CI 1.58 to 8.97). The meta-analysis results are shown in Fig. 7.
2.5.5 ICU admission time of patients

3 studies\textsuperscript{[11,18,24]} reported the relationship between patients' ICU stay and PICS-F psychological dysfunction. According to the results of heterogeneity test ($I^2 = 0\%$, $P = 0.79$), the results showed that the long stay in the ICU was a risk factor for the occurrence of PICS-F psychological dysfunction (OR = 4.72, 95\%CI 2.10 to 10.64). The meta-analysis results are shown in Fig. 8.

2.5.6 Severity of patient disease

5 studies\textsuperscript{[13,14,18,21,25]} reported the relationship between patient disease severity and PICS-F psychological dysfunction. According to the results of the heterogeneity test ($I^2 = 45\%$, $P = 0.76$), The effect model was used for Meta-analysis, and the results showed that severe illness was a risk factor for the occurrence of PICS-F psychological dysfunction (OR = 5.95, 95\%CI 2.09 to 16.94). The results of the Meta-analysis are shown in Fig. 9.

2.5.7 Patient death

Two studies\textsuperscript{[13,16]} reported the relationship between death and PICS-F psychological dysfunction. According to the results of the heterogeneity test ($I^2 = 0\%$, $P = 0.68$), the fixed effect model was used for analysis, and the results showed that Patient death was a risk factor for the occurrence of PICS-F psychological dysfunction (OR = 1.90, 95\%CI 1.31 to 2.77). The meta-analysis results are shown in Fig. 10.

2.5.8 Educational level of family members

Two studies\textsuperscript{[15,17]} reported the relationship between family education level and PICS-F psychological dysfunction. According to the results of heterogeneity test ($I^2 = 0\%$, $P = 0.80$), Meta-analysis was carried out using a fixed effect model, and the results showed that Low education level of family members was a risk factor for PICS-F psychological dysfunction (OR = 1.07, 95\%CI 1.02 to 1.12). The meta-analysis results are shown in Fig. 11.

2.5.9 Others

One study\textsuperscript{[18]} reported the effect of patient admissions on PICS-F psychological dysfunction, so a meta-analysis could not be performed. In this study, by comparing the two admission methods of transfer and direct admission, the results showed that admission by transfer was a risk factor for the occurrence of PICS-F psychological dysfunction (OR = 5.19, 95\%CI 0.35 to 10.03). Kross found through the study that after the patient was hospitalized, the family members who participated in the family meeting were the risk factors for PICS-F psychological dysfunction (OR = 4.06, 95\%CI 0.88–7.23). Since only one study was included, so Meta-analysis was not performed\textsuperscript{[16]}.

2.6 Publication Bias Analysis

The Egger test was used to evaluate the publication bias of the included literature, and the results showed that ($t = 2.14$, $p = 0.052$), the scatter distribution in the funnel plot was relatively symmetrical, and it could be considered that the literature included in this study had no publication bias. See Fig. 12.

3 Discussion

3.1 The incidence of psychological dysfunction in PICS-F

Studies\textsuperscript{[26–29]} show that the incidence of PICS-F psychological dysfunction is 21–54\%. The incidence of PICS-F psychological dysfunction in this study is 28\%, which is similar to the results of previous studies. Subgroup analysis found that from the follow-up time, the incidence of PICS-F psychological dysfunction was 26\% at 3 months and 13\% at 6 months. Studies have shown a gradual decline in the incidence over time\textsuperscript{[11]}. Compared with Germany, Sweden, Japan and other countries, the incidence of PICS-F in the United States is relatively high. This may be due to the higher medical level in the United States. The number of ICU admissions is as high as 4 million per year, which is higher than other countries. Therefore, the occurrence of PICS-F psychology The number of people with functional impairment is higher\textsuperscript{[30]}. In terms of study type, the reported incidence of PICS-F psychological dysfunction in the cohort study was 26\%, which was similar to the results of other studies. The cross-sectional survey study\textsuperscript{[18]} and the case-control
study\textsuperscript{[12]} reported the incidence of PICS-F psychological dysfunction was 43\%, which was higher than the results reported in the cohort study, because the subjects included in the above two studies There are brain trauma and acute respiratory failure in middle-aged patients, and the patient's condition is more serious, which has a greater impact on the psychological function of family members and has a higher incidence rate\textsuperscript{[12,18]}

\section*{3.2 Risk factors for psychological dysfunction in PICS-F}

Younger patient age is a risk factor for psychological dysfunction in PICS-F. The study confirmed that when the patients were children or young adults, the incidence of PICS-F psychological dysfunction was higher than that when the patients were elderly\textsuperscript{[16]}. From the perspective of family members, the younger the patient is, the more important it is to the family, and the family members are more likely to have psychological dysfunction after the patient is ill\textsuperscript{[31]}. Studies have shown that when the main caregivers of patients are women, women are more sensitive to stress, have lower psychological endurance than men, and have higher scores on anxiety, depression and post-traumatic stress disorder than men, with statistically significant differences\textsuperscript{[32]}. The familiarity of the relationship between family members and the patient will also have different effects on the family members' psychological functions. When the patient is the spouse of the family member, due to the higher degree of closeness with the patient and a long time of living together, when one party develops the disease, the spouse will not be affected. There is a higher level of concern for the patient, more concern about the patient's prognosis, and therefore greater risk of psychological dysfunction\textsuperscript{[33,34]}

The risk of developing PICS-F in family members with a history of mental disorders is 3.77 times that of family members without a history of mental disorders. Decreased ability will lead to poor communication between family members and patients, increase the care burden of family members, and thus have a greater risk of developing PICS-F psychological dysfunction\textsuperscript{[35]}

Studies have shown that when patients stay in the ICU for more than 6 days, the risk of family members developing PICS-F psychological dysfunction is 2.09 times that of less than 6 days, and prolonged hospitalization will lead to an increase in patient mortality\textsuperscript{[23]}. Due to the high medical expenses and the management regulations of restrictive visits in the ICU ward, family members cannot timely understand the disease status of the more seriously ill patients, resulting in more psychological problems\textsuperscript{[36]}. When family members receive news of a patient's death, family members have a higher incidence of post-traumatic stress disorder (PTSD) that lasts for more than a year\textsuperscript{[37]}

The educational level of family members also has an impact on psychological dysfunction. When the education level is below the middle school level, the economic ability and psychological endurance of the family members are lower. Due to the limited medical-related knowledge, the choice of coping style is more negative, resulting in a higher incidence of PICS-F psychological dysfunction\textsuperscript{[38]}

\section*{3.3 Study limitations}

In this study, there are few research literatures on the influence of patients' admission methods and family members' participation in family meetings on the occurrence of PCS-F psychological dysfunction, and more literatures need to be included to improve the reliability of the conclusions. Second, because PICS-F lacks specific assessment tools for psychological dysfunction, it can only be assessed according to different clinical manifestations. Therefore, there may be some heterogeneity in the research results.

In conclusion, this study conducted a Meta-analysis on the incidence and risk factors of PICS-F psychological dysfunction, and the quality of the included literature was high. This study found that the incidence of PICS-F psychological dysfunction was 28\%, the patient was young, the family member was female, the relationship with the patient was a spouse, the family member had a history of mental illness, the patient stayed in the ICU for a long time, the patient was seriously ill, the patient died, and the education level of the family member Low is a risk factor for psychological dysfunction in PICS-F. More in-depth research is needed in the future to determine whether factors such as patient admissions and participation in family meetings are related to the occurrence of psychological dysfunction in PICS-F. In addition to paying attention to the patient itself, clinical medical staff should also pay attention to the psychological state of the patient's family members and conduct early intervention to reduce the incidence of PICS-F.

\section*{Declarations}
Conlicts of interest

All authors declare no conict of interest

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Authors’ contributions

zhiqiang cheng, baozhen zhang analyzed this data and wrote manuscript; jiaoyun xia revised this manuscript; xiaoxing wang edited the language. All authors read and approved the nal manuscript.

Ethics statement

This article does not address ethical issues

Consent for publication

No applicable.

Author details

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References


**Figures**
Figure 1

Flow chart of literature screening for meta-analysis of risk factors for psychological dysfunction in PICS-F
Figure 2

Meta-analysis of the incidence of psychological dysfunction in PICS-F

Figure 3

Sensitivity analysis of the incidence of psychological dysfunction in PICS-F

Figure 4

Forest plot of the effect of patient age on PICS-F psychological dysfunction

Figure 5
Forest map of the effect of family gender on PICS-F psychological dysfunction

<table>
<thead>
<tr>
<th>Study or Subgroup</th>
<th>Log Odds Ratio</th>
<th>SE</th>
<th>Weight</th>
<th>IV, Fixed, 95% CI</th>
<th>IV, Random, 95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Giles2010</td>
<td>1.3763</td>
<td>1.0675</td>
<td>11.3%</td>
<td>3.96 [0.49, 32.09]</td>
<td></td>
</tr>
<tr>
<td>mahl2017</td>
<td>1.2705</td>
<td>0.3725</td>
<td>34.9%</td>
<td>3.69 [1.73, 7.84]</td>
<td></td>
</tr>
<tr>
<td>Milon2022</td>
<td>1.3269</td>
<td>1.5407</td>
<td>6.2%</td>
<td>3.77 [0.18, 77.22]</td>
<td></td>
</tr>
<tr>
<td>Miyamoto2021</td>
<td>0.2548</td>
<td>0.9955</td>
<td>47.6%</td>
<td>1.20 [0.10, 1.57]</td>
<td></td>
</tr>
<tr>
<td><strong>Total (95% CI)</strong></td>
<td><strong>100.0%</strong></td>
<td></td>
<td></td>
<td><strong>2.21 [100, 4.99]</strong></td>
<td></td>
</tr>
</tbody>
</table>

Heterogeneity: Tau^2 = 0.34, Chi^2 = 8.43, df = 3 (P = 0.04), I^2 = 84%
Test for overall effect: Z = 1.95 (P = 0.05)

Figure 6

Forest diagram of the relationship between family members and patients on psychological dysfunction in PICS-F

<table>
<thead>
<tr>
<th>Study or Subgroup</th>
<th>Log Odds Ratio</th>
<th>SE</th>
<th>Weight</th>
<th>IV, Fixed, 95% CI</th>
<th>IV, Random, 95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Giles2010</td>
<td>1.8126</td>
<td>2.5648</td>
<td>3.1%</td>
<td>6.32 [0.65, 65.55]</td>
<td></td>
</tr>
<tr>
<td>Harris2021</td>
<td>1.6543</td>
<td>0.0774</td>
<td>51.4%</td>
<td>4.59 [40, 157.3]</td>
<td></td>
</tr>
<tr>
<td>Law2018</td>
<td>1.1592</td>
<td>1.5025</td>
<td>6.7%</td>
<td>3.22 [0.17, 61.19]</td>
<td></td>
</tr>
<tr>
<td>Warren2020</td>
<td>1.0144</td>
<td>0.7295</td>
<td>36.8%</td>
<td>2.76 [0.86, 11.52]</td>
<td></td>
</tr>
<tr>
<td><strong>Total (95% CI)</strong></td>
<td><strong>100.0%</strong></td>
<td></td>
<td></td>
<td><strong>3.77 [1.58, 9.07]</strong></td>
<td></td>
</tr>
</tbody>
</table>

Heterogeneity: Chi^2 = 0.36, df = 3 (P = 0.95), I^2 = 0%
Test for overall effect: Z = 3.00 (P = 0.003)

Figure 7

The influence of family members with or without a history of mental illness on the psychological dysfunction of PICS-F

<table>
<thead>
<tr>
<th>Study or Subgroup</th>
<th>Log Odds Ratio</th>
<th>SE</th>
<th>Weight</th>
<th>IV, Fixed, 95% CI</th>
<th>IV, Random, 95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nadig2021</td>
<td>2.6467</td>
<td>1.3264</td>
<td>9.8%</td>
<td>10.45 [0.78, 140.12]</td>
<td></td>
</tr>
<tr>
<td>Peetoom2015</td>
<td>1.874</td>
<td>1.4655</td>
<td>8.0%</td>
<td>6.51 [0.37, 114.7]</td>
<td></td>
</tr>
<tr>
<td>Winternmann2016</td>
<td>0.4265</td>
<td>0.4573</td>
<td>82.2%</td>
<td>4.16 [1.70, 10.20]</td>
<td></td>
</tr>
<tr>
<td><strong>Total (95% CI)</strong></td>
<td><strong>100.0%</strong></td>
<td></td>
<td></td>
<td><strong>4.72 [2.10, 10.64]</strong></td>
<td></td>
</tr>
</tbody>
</table>

Heterogeneity: Chi^2 = 0.48, df = 2 (P = 0.79), I^2 = 0%
Test for overall effect: Z = 3.75 (P = 0.002)

Figure 8

Forest plot of the effect of ICU stay time on psychological dysfunction in PICS-F

<table>
<thead>
<tr>
<th>Study or Subgroup</th>
<th>Log Odds Ratio</th>
<th>SE</th>
<th>Weight</th>
<th>IV, Fixed, 95% CI</th>
<th>IV, Random, 95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Litt2015</td>
<td>2.6810</td>
<td>0.5484</td>
<td>31.8%</td>
<td>16.82 [2.89, 100.25]</td>
<td></td>
</tr>
<tr>
<td>Leckwitz2010</td>
<td>1.4532</td>
<td>1.3763</td>
<td>17.5%</td>
<td>4.26 [0.35, 53.18]</td>
<td></td>
</tr>
<tr>
<td>Milon2022</td>
<td>1.7221</td>
<td>1.8101</td>
<td>11.0%</td>
<td>5.60 [0.24, 131.35]</td>
<td></td>
</tr>
<tr>
<td>Miyamoto2021</td>
<td>1.2543</td>
<td>1.3402</td>
<td>15.8%</td>
<td>3.51 [0.25, 48.47]</td>
<td></td>
</tr>
<tr>
<td>Nadig2021</td>
<td>1.0438</td>
<td>1.0892</td>
<td>24.0%</td>
<td>2.84 [0.34, 24.9]</td>
<td></td>
</tr>
<tr>
<td><strong>Total (95% CI)</strong></td>
<td><strong>100.0%</strong></td>
<td></td>
<td></td>
<td><strong>5.95 [2.09, 16.91]</strong></td>
<td></td>
</tr>
</tbody>
</table>

Heterogeneity: Chi^2 = 1.86, df = 4 (P = 0.75), I^2 = 0%
Test for overall effect: Z = 3.35 (P = 0.001)

Figure 9

Forest plot of the effect of disease severity on PICS-F psychological dysfunction
Figure 10

Forest plot of the effect of patient death on psychological dysfunction in PICS-F

<table>
<thead>
<tr>
<th>Study or Subgroup</th>
<th>Log(Odds Ratio)</th>
<th>SE</th>
<th>Weight</th>
<th>IV (Fixed, 95% CI)</th>
<th>Odds Ratio</th>
<th>IV (Fixed, 95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kross2011</td>
<td>1.5592</td>
<td>2.2708</td>
<td>0.7%</td>
<td>4.90 [0.05, 419.65]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lefkowitz2010</td>
<td>0.6368</td>
<td>0.1917</td>
<td>95.3%</td>
<td>1.98 [1.30, 2.95]</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total (95% CI)</strong></td>
<td><strong>1.00 [1.31, 2.77]</strong></td>
<td></td>
<td></td>
<td></td>
<td><strong>1.00 [1.31, 2.77]</strong></td>
<td></td>
</tr>
</tbody>
</table>

Heterogeneity: $\chi^2 = 0.17$, df = 1 ($P = 0.69$), $I^2 = 0$
Test for overall effect $Z = 3.37$ ($P = 0.0008$)

Figure 11

Forest diagram of the effect of family education level on PICS-F psychological dysfunction

Figure 12

Meta-analysis funnel plot of publication bias