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INSTRUMENT FOR ASSESSING RESPIRATORY DISORDERS IN CHILDREN: A SYSTEMATIC REVIEW

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ABSTRACT
Respiratory disorders remain the most common cause of morbidity and mortality in children under 5 years of age worldwide. Pneumonia and asthma are part of this. To reduce pediatric mortality, valid and reliable instruments are needed to guide the further treatment process appropriately. This systematic review aimed to identify the sensitivity and specificity of the Respiratory Index of Severity in Children (RISC) and Test for Respiratory and Asthma Control in Kids (TRACK) instruments in children with pneumonia and asthma. The study was conducted by searching articles from the online databases PubMed, Scopus, JSTOR, ProQuest, Science Direct, and EBSCOhost from 2015 to 2025. Two reviewers independently assessed the study quality using QUADAS-2. Of the 969 articles found, 6 articles were selected for analysis. The RISC instrument obtained various sensitivity values with a cut-off ⩾3, namely 21.3% to 94.1% and specificity values of 73.6% to 89.51%. In the TRACK instrument, the sensitivity values ranged from 75.6% to 81.4% and the specificity values ranged from 70.9% to 80.0% using a cut-off of 80. Both instruments can be used to assess the severity and mortality risk of childhood pneumonia and the assessment of asthma symptoms and control in children.

Keywords: asthma; pneumonia; respiratory index of severity in children; RISC scoring system; test for respiratory and asthma control in kids

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INTRODUCTION

Respiratory disorders are the most common cause of morbidity and mortality in children under 5 years of age worldwide (Windi et al., 2021) which commonly affect children, such as acute respiratory infections (ARI), asthma, pneumonia, bronchitis, bronchiolitis, and tuberculosis (Lestari et al., 2025). Globally, ARI is the leading cause of morbidity and mortality in children under five years of age (WHO, 2022). ARI is estimated to be a major contributor to reduced life expectancy at birth for children in low- and middle-income countries (Odo et al., 2022).

Pneumonia and asthma are part of respiratory problems in children. Pneumonia is an acute infectious disease of the respiratory system caused by various pathogens such as viruses, bacteria, and fungi. It is a major cause of morbidity and mortality in children under five years of age (Alamneh & Adane, 2020; Nasrin et al., 2022). Found mostly in developing countries, it also has a huge impact on healthcare costs in developed countries (Ebeledike & Ahmad, 2023). Data from the World Health Organization in 2019 showed that pneumonia accounted for 14% or approximately 740,180 deaths of children under five years of age (WHO, 2022), causing the death of more than 700,000 children under the age of 5 each year (UNICEF, 2024).

Asthma is the most common chronic non-communicable respiratory disease in children (WHO, 2024) and a cause of morbidity in children, resulting in unscheduled use of medical services, emergency department visits, and hospitalizations (Choi et al., 2019). In 2019, asthma affected 262 million people and caused 455 thousand deaths, mostly in low- and middle-income countries (WHO, 2024). Avoiding asthma triggers can be done by reducing asthma symptoms and

maintaining good asthma control. So it is important to assess the status of airway control in children with asthma to prevent more severe respiratory problems (Choi et al., 2019). Children at risk of severe respiratory distress and complications need to be identified to guide the further treatment process appropriately to reduce pediatric mortality (Verma et al., 2023). Serious cases must be treated immediately; therefore, it is important to assess the child's respiratory condition appropriately at first contact (Singh & Kamble, 2020). Therefore, assessing pediatric respiratory problems requires valid and reliable instruments. However, studies that provide a clear and structured explanation of the assessment instruments used to assess respiratory problems, particularly pneumonia and asthma, are still limited. Therefore, this systematic review aims to identify assessment instruments that can be used in assessing pediatric respiratory problems, specifically in pneumonia and asthma.

METHOD

Design

This systematic review was conducted according to the flow on the PRISMA (Preferred Reporting Items for Systematic Review and Meta-Analysis) diagram, which is used as a detailed guide to reporting items for systematic reviews and meta-analyses.

Eligibility Criteria

Articles analyzed in this study were articles with a cross-sectional research design or validation study of the Respiratory Index of Severity in Children (RISC) or Test for Respiratory and Asthma Control in Kids (TRACK) instruments, which were tested on child participants with respiratory disorders both pneumonia and asthma 1 month to 18 years. Articles that report research results in the form of sensitivity and specificity test values, articles that have been published in the last 10 years, written in English, and free full-text or open-access articles.

Search Strategy

The search strategy in this study was related to the test scores of the Respiratory Index of Severity in Children (RISC) and Test for Respiratory and Asthma Control in Kids (TRACK) instruments. The search was conducted using the keywords Pneumonia AND Instrument "Respiratory Index of Severity in Children" OR "RISC Scoring System" OR "Test for Respiratory and Asthma Control in Kids" AND Sensitivity OR Specificity. The article search used several online databases, namely PubMed, Scopus, JSTOR, ProQuest, Science Direct, and EBSCOhost from 2015 to 2025. Duplicate articles were removed, and articles to be analyzed were selected based on predefined criteria.

Data Extraction and Quality Assessment

The extraction of all articles analyzed in this study was carried out based on author information, year of publication, country, research objectives, respondent characteristics (including sample size, age, inclusion and exclusion criteria), research design and methods, and outcomes. Data extraction and methodological quality assessment of the articles were performed independently by two researchers (LTY and AN). Quality assessment of diagnostic accuracy studies was conducted using QUADAS-2. The domains assessed included patient selection, index test, reference standard, and flow and timing. The results of the assessment based on the domain are divided into 3 categories, namely low risk, unclear, and high risk. However, if there is a difference of opinion between the assessors, it will be discussed with MHH as a mediator and director in this writing to reach an agreement.

Scale

In this study, reviewed 6 studies were reviewed that reported data on the sensitivity and specificity of the Respiratory Index of Severity in Children (RISC) and Test for Respiratory and Asthma Control in Kids (TRACK) instruments, which were developed to focus on the assessment of respiratory disorders in children with pneumonia and asthma. Three articles were found that discussed the RISC instrument test. RISC is an instrument developed to assess severity and predict mortality risk in children with pneumonia. RISC has several assessment items, namely oxygen

saturation, wheezing, presence or absence of feeding refusal, chest retraction, and z-score (Kapoor et al., 2022). The Test for Respiratory and Asthma Control in Kids (TRACK) is a multilingual developed and validated instrument (Choi et al., 2019), used to assess asthma symptom control in preschool-aged children (Leiria-Pinto et al., 2021). The instrument combines two important domains in asthma management, namely impairment (frequency of symptoms and their impact on daily activities) and risk (history of systemic corticosteroid use).

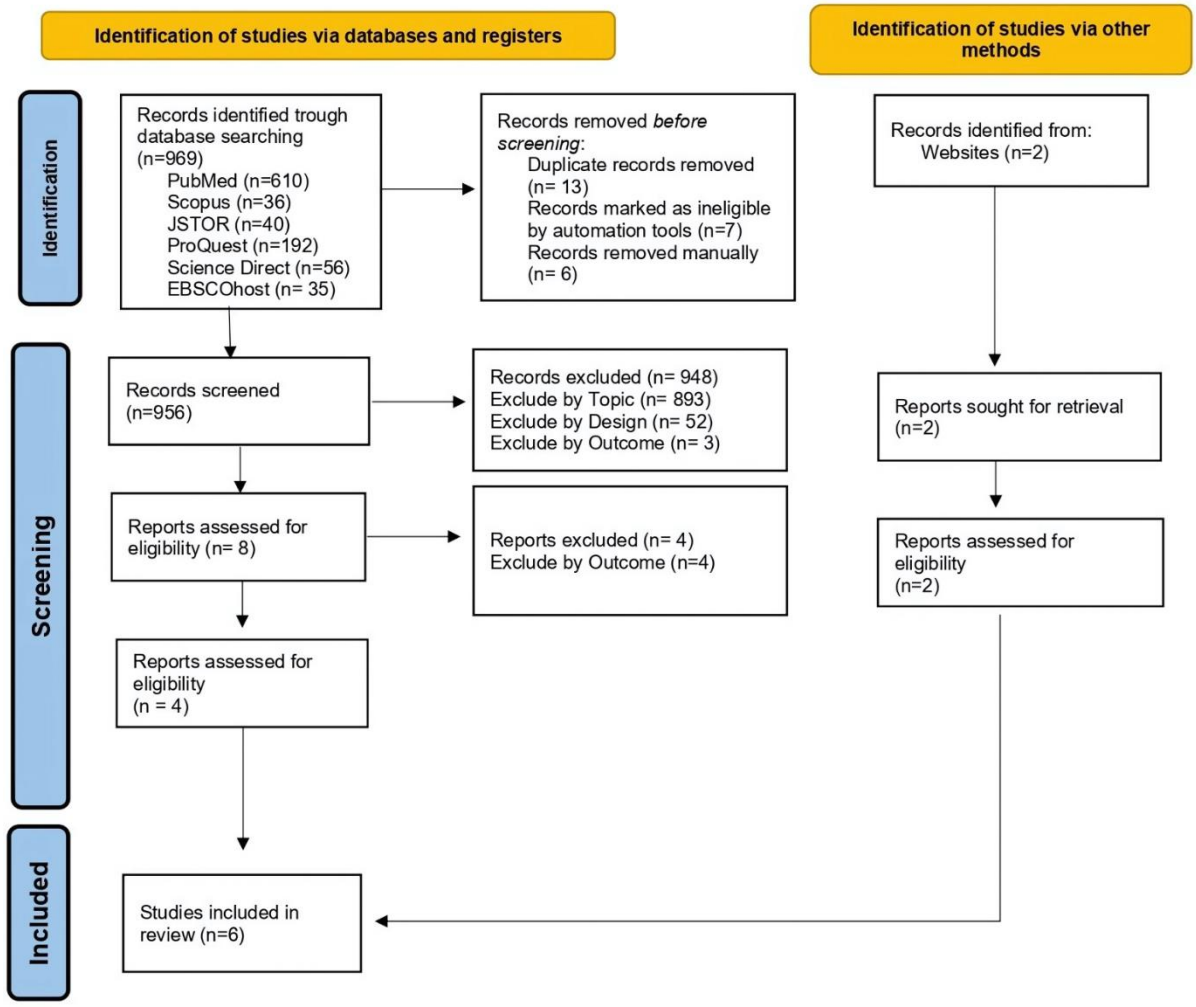

Figure 1. PRISMA flow diagram

RESULT

Search Results

The search results in this study using the online database obtained 969 articles and using search methods outside the database obtained 2 articles. Then, screening the duplicate articles found as many as 7, which were screened using EndNote software, and 6 were found manually. Then excluded articles that did not match the design, participants, topics, and outcomes. In the end, there were 6 articles to be analyzed in this study. The process of identification, screening, and the total number of articles for each step is described in (Figure 1).

Study Characteristics

Of the 6 research articles obtained, 3 articles used the Respiratory Index of Severity in Children (RISC) and 3 articles used the Test for Respiratory and Asthma Control in Kids (TRACK). The results of the analysis reported the sensitivity and specificity test values for both instruments. RISC uses chest x-ray as the gold standard and TRACK uses the Global Initiative for Asthma (GINA). In

general, five articles used a prospective design. The use of a cut-off ≥3 on the RISC instrument and 80 on the TRACK instrument. Overall, participants in this study were aged 1 month to 12 years.

Study Quality

The QUADAS-2 quality assessment of the included studies is presented in Table 2. The methodological quality used in the studies had mixed results with overall good results. Results in the patient selection domain from all articles were low risk with one high risk study due to the use of a case-control study design. In the index test reference standard and flow and timing domains, the results showed varied results with predominantly low risk results, but in some studies it was found that items related to these three domains were not described in detail.

Tabel 1.
Characteristics Included Study

o	Author	Country	Aim	Sample	Method	Outcome
1.	Megied, et al (2023)	Cairo, Egypt.	To assess how effective the RISC score to predicting mortality for infants diagnosed with CAP.	n: 150 Inclusion criteria: 1-24 month, infants with CAP, chest X-ray. Exclusion criteria: Infants with congenital heart disease or immunodeficiency disorder, reject to be participant, died within 24 hours admission.	Prospective cross-sectional study	Sensitivity: 85.71% Specificity: 89.51%.
2.	Pillai, et al (2021)	India	To evaluate the correlation the RISC and WHO interpretation of chest radiographs and the effectiveness of RISC in assessing severity of pneumonia based on chest x-ray.	N: 285 n: 241 Inclusion criteria: 1 month - 12 years, diagnosis with pneumonia, patient of OPD pediatric or treated in the pediatric ward. Exclusion criteria: Children with congenital heart disease, chronic respiratory disorder, congenital lung problem and immunosuppressive conditions or have neuromuscular disorders.	Descriptive study.	RISC score ≥3 had a sensitivity 21.3% and specificity: 88.3%.
3.	Kapoor, et al (2022)	India	To understand the accuracy of RISC for estimating mortality in children with CAP and modified instrument.	N: 200 n: 180 Inclusion criteria: 2-59 months, Children who are hospitalized with severe CAP. Exclusion criteria: Children with congenital lung, immunodeficiency, Pulmonary tuberculosis, HIV infection, refuse to be participant.	Case control study, Prospective.	RISC score at cut-off 3 had sensitivity of 94.1% and specificity of 73.6%.
4.	Wandalsen, et al (2018)	Brazil	To validate TRACK questionnaire to Portugese version.	N: 299 n: 195 Inclusion criteria: Age ≤5 years, medical diagnosis of asthma or history of at least 3 episodes of cough and/or wheeze and/or dypsnea (longer than 24 hours), bronchodilator use, portuguese native Exclusion criteria: Other relevant pulmonary disease, systemic disease, congenital malformations, illiteracy and/or inability of parents to understand the questionnaire.	Observational, Prospective, longitudinal and multicentre evaluation.	At a cut-off <80 had sensitivity 79.9% and specificity 80.0%.
5.	Zhang, et al (2019)	China	To suggest and validate Chinese	N: 321 Inclusion criteria: Outpatient ≤5	Prospective validation	TRACK Score at the baseline

			version of TRACK.	years, received a diagnosis of asthma based on the GINA criteria, parent or guardian provided consent, the caregiver had access to a smartphone Exclusion criteria: had congenital heart disease, gastro-oesophageal reflux, bronchopulmo nary dysplasia or bronchiolitis obliterans, had a previous allergic reaction to an ICS (Inhaled Corticosteroid), involved in a similar trial in the past 3 months.	study.	visit at cut-off 80 had sensitivity 62.1% and specificity 83.3%. TRACK score at the follow-up visit at cut-off 80 had sensitivity 64.0% and specificity 71.5%.
6.	Choi, et al (2019)	Korea	To assess the reability and validity of the Korean version of TRACK questionnaire.	N: 137 Inclusion criteria: a history of 2 or more episodes of wheezing, shortness of breath, or a recurrent cough that lasted > 24 hours, previous asthma diagnosis by a specialist or an improvement in respiratory symptoms with aerosolized bronchodilator use. Exclusion criteria: had respiratory conditions other than asthma that might affect their cardiopulmonary status.	Observasional, Prospective	At baseline visit TRACK Score with cut-off 80 Sensitivity: 75.6% Specificity: 70.9%. And follow-up visit TRACK score, sensitivity 69.0% and specificity 75.3%.

Tabel 2.
Risk of Bias Assessment

Study	Risk of Bias			
	Patient selection	Index test	Reference standard	Flow and timing
(Megied et al, 2023)	Low	Low	Unclear	Low
(Pillai et al, 2021)	Low	Unclear	Unclear	Unclear
(Kapoor et al, 2022)	High	Unclear	Low	Low
(Wandalsen et al, 2018)	Low	Low	Low	Low
(Zhang et al, 2019)	Low	Low	Low	Low
(Choi et al, 2019)	Low	Low	Unclear	Unclear

DISCUSSION

In this study, reviewed 6 studies that reported data on the sensitivity and specificity of the Respiratory Index of Severity in Children (RISC) and Test for Respiratory and Asthma Control in Kids (TRACK) instruments, which were developed to focus on the assessment of respiratory disorders in children with pneumonia and asthma. Three articles were found that discussed the RISC instrument test. All articles used chest x-ray as the gold standard, which is the standard of interpretation for the diagnosis of pneumonia in children (Pillai et al., 2021). The study involved a diversity of respondent ages, ranging from 1 month to 12 years old. The results of the review of the three articles analyzed found that RISC has good sensitivity and specificity results using cut-off >3 (Megied et al., 2023) and cut off ≥ 3 (Kapoor et al., 2022; Pillai et al., 2021). The resulting sensitivity values varied, ranging from 21.3% to 94.1% and specificity values of 73.6% to 89.51%. Although one study reported a fairly low sensitivity value, the results of the study explained that there was a correlation between clinical assessment using RISC and assessment using chest x-ray (Pillai et al., 2021).

This instrument has also been used in several previous studies to assess morbidity or severity and mortality factors in children with respiratory disorders (Arslan et al., 2025; Kapoor et al., 2022;

Megied et al., 2023; Pranathi et al., 2023). RISC score ≥3 was associated with children requiring longer length of stay by 88.89% and ventilation requirement by 19.4% (Tewary et al., 2023). The results obtained from 200 patients included in the study 23 children or equivalent to 12% died associated with an increase in RISC score. Patients with a RISC score ≥4 have a higher mortality rate than patients with lower scores. There is a positive correlation between RISC score and the likelihood of intensive care hospitalization in children (Verma et al., 2023).

A recent study assessed the accuracy of the RISC score in predicting mortality and assessing pneumonia severity in children aged 1-5 years showed that RISC score was significantly higher in children who did not survive compared with those who survived. RISC score >3 resulting in a sensitivity of 71.4% and a specificity of 94.4% (Arslan et al., 2025). There was a statistically significant association between the RISC score and mortality in infants admitted with acute respiratory infections (Pranathi et al., 2023). Another study aimed to assess the predictive respiratory severity in children with ARI using the RISC score, from 154 children aged 1-24 months found that RISC score >4 as a predictor of childhood mortality. This study used the Integrated Management of Neonatal and Childhood Illnes (IMNCI) classification and found that 35 (22.7%) children had severe pneumonia and about 44 (28.7%) children had very severe pneumonia. Based on the assessment using the RISC score, 14 (9.1%) children with a score >4 were found to have a mortality rate of 11 (6.5%) children (Ramavat et al., 2023). In Indonesia, Manajemen Terpadu Balita Sakit (MTBS) 2022 chartbook is also used as a tool that can be used to assess the condition of breathing difficulties in children, which is assessed based on the classification of clinical symptoms experienced by children (Kementerian Kesehatan Republik Indonesia, 2024).

The other three articles analyzed in this study were articles that reviewed, this instrument which was developed and has been used and tested in various countries by developing TRACK on a cross-cultural basis and translated into several languages such as Chinese, Korean and Portuguese. All articles used a cut-off score of 80 on the TRACK instrument and produced a diversity of sensitivity and specificity values. Sensitivity values ranged from 75.6% to 81.4% and specificity values ranged from 70.9% to 80.0% (Choi et al., 2019; Wandalsen et al., 2018; Zhang et al., 2019). The Chinese version of TRACK showed that children who were recommended for treatment improvement by a physician had lower TRACK scores than children who did not receive treatment improvement recommendations (Zhang et al., 2019). Low TRACK scores were classified as poor control in children with asthma and conversely, high scores in the group with good control (Choi et al., 2019).

The instrument combines two important domains in asthma management, namely impairment (frequency of symptoms and their impact on daily activities) and risk (history of systemic corticosteroid use). One study reported that TRACK was designed to be used in preschool children with acute wheezing episodes within the first five days of occurrence and can predict subsequent exacerbations i.e. worsening or recurrence of symptoms such as Emergency Department (ED) visits or corticosteroid requirements in the following 3 months (Sarikloglou et al., 2024). A decrease of 10 TRACK scores has a 38% increased likelihood of future exacerbations (Sarikloglou et al., 2024).

TRACK is a very important assessment instrument for preschool children with asthma when they are diagnosed (Liu et al., 2021). Research involving preschool children with asthma found that TRACK score >60 have a controlled level of asthma and cut-off >62.5 TRACK has a sensitivity 89.3% and apecificity 77.8% (Liu et al., 2021). A prospective study assessing the relationship between TRACK scores and Impulse Oscillometry (IOS) in preschool children with asthma found that TRACK scores were significantly correlated with changes in IOS parameters. Changes in TRACK scores over 12 months were significantly correlated with improvements in IOS parameters, the higher the increase in TRACK scores, the greater the improvement in respiratory function measured using IOS(Wu et al., 2024). To detect asthmatic children with good control at 12 months, the cut-off >95 has a sensitivity value of 80.8% and specificity of 100% (Wu et al., 2024).

CONCLUSION

Based on the results of the systematic review conducted, it can be concluded that the Respiratory Index of Severity in Children (RISC) is an instrument that can be used to assess the severity and risk of mortality in children and the Test for Respiratory and Asthma Control in Kids (TRACK) is an instrument for assessing asthma symptoms and control in children. Nurses, nurse researchers, doctors, midwifes have an important role in this case to develop and test instruments through research and become an evidence-based basis that can be applied in nursing services.

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