Dunia Keperawatan: Jurnal Keperawatan dan Kesehatan @JDK 2025
DOI: 10.20527/dk.v13i1.782 eISSN: 2541–5980; pISSN: 2337-8212
Received November 2024, Accepted March 2025

Risk Factors for Acute Kidney Injury in Children: A Literature Review

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ABSTRACT
The incidence of acute kidney injury (AKI) in children has shown a recent increase. Several contributing factors include the emergence of new diseases such as COVID-19 and the use of nephrotoxic drugs. This literature review aims to identify the risk factors associated with AKI in pediatric populations. The method used was a literature review conducted across three databases: ScienceDirect, PubMed, and Google Scholar, using the search keywords "children," "acute kidney injury," and "risk factors." A total of 10 primary articles were selected for review. The findings indicate that risk factors for AKI in children include comorbidities such as diabetes mellitus with diabetic ketoacidosis, COVID-19, acute gastroenteritis, malaria, post-cardiac surgery, liver transplantation, wasp stings, critical illnesses requiring intensive care, the use of nephrotoxic substances such as ethylene glycol and diethylene glycol, and blood transfusions. The increasing prevalence of these risk factors has significant implications for nursing care. Nurses are expected to enhance their understanding of AKI to improve management strategies and reduce morbidity and mortality related to acute kidney injury in children.

Keywords: Acute Kidney Injury, Children, Risk Factors

Cite this as: Wea LD. (2025). Risk Factors for Acute Kidney Injury in Children: A Literature Review. Dunia Keperawatan; 13(1): 97-105. DOI: 10.20527/dk.v13i1.782

INTRODUCTION

Acute kidney injury (AKI), also known as acute renal failure, is a condition characterized by an increase in serum creatinine levels and nitrogenous waste products due to the kidneys' failure to perform their primary function of urine production (1). AKI is common among critically ill children. In 2022, the Indonesian Ministry of Health (Kemenkes) and the Indonesian Pediatric Society (IDAI) reported a rise in AKI cases among children, particularly those under the age of five, with a total of 206 reported cases (2). Identified predictors of AKI in children include age over two months, elevated serum creatinine, comorbid conditions, use of inotropes and diuretics, nephrotoxic drug exposure, multiple organ dysfunction syndrome (MODS), and coagulopathy (3).

In the post-COVID era of 2022, cases of atypical progressive AKI in children were reported, associated with the use of medications containing ethylene glycol (EG) and diethylene glycol (DEG) (4). These substances have been proven to cause AKI through the formation of calcium oxalate monohydrate crystals and necrosis of renal tubules, respectively (5,6). The Indonesian Food and Drug Supervisory Agency (BPOM) detected EG and DEG contamination in 103 syrup-based medications, with levels exceeding acceptable quality standards for solvents (7).

The risk of AKI in children with COVID-19 is exacerbated by decreased glomerular filtration rate (GFR), abnormal urinalysis results, and requires conservative preventive management (8). Nursing management of AKI involves managing electrolyte

imbalances and hypervolemia, as well as recommending medication dose adjustments or alternative treatments to physicians to minimize nephrotoxicity (9). Most studies tend to group all infectious causes of AKI together—bacterial, viral, fungal, or parasitic—without distinguishing among them, which limits understanding of the specific impacts of pathogens such as sepsis, dengue, or malaria on kidney function. Moreover, emerging infectious diseases like COVID-19 have been reported to cause renal complications (10). This review aims to identify the current risk factors for acute kidney injury in children and examine their implications for pediatric nursing care.

METHODS

The method used in this study is a literature review, with sources obtained from ScienceDirect, PubMed, and Google Scholar. The search strategy applied the PICO framework as follows:

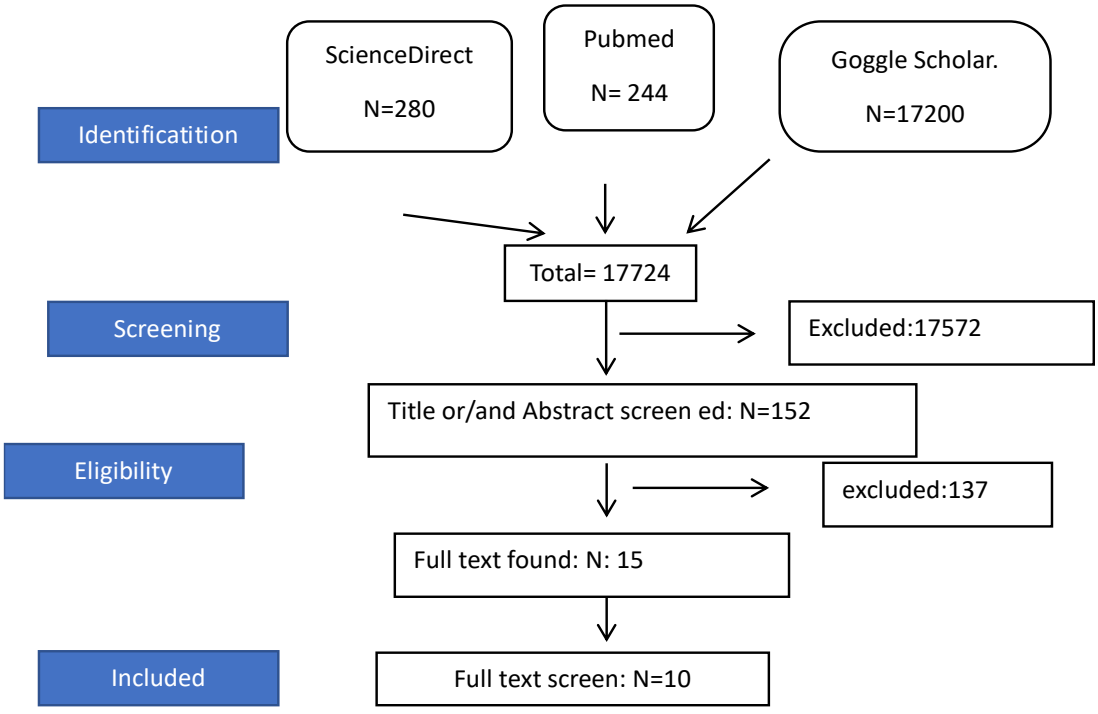
1. Population: Children
2. Context: Acute kidney injury
3. Outcome: Risk factors

The article selection process was guided by the PRISMA flowchart, resulting in 10 articles included in the final review.

RESULTS AND DISCUSSION

AKI, or the sudden failure of kidney function, is characterized by an increase in serum creatinine levels and a decrease in urine output (9). This literature review compiles various risk factors for acute kidney injury in the pediatric population, including comorbidities and nephrotoxic agents.

Diabetes is an independent risk factor for acute kidney injury. The need for concurrent hospitalization and complications such as diabetic ketoacidosis in children with diabetes increases the risk of AKI (21). Diabetic ketoacidosis is characterized by hyperglycemia, which leads to volume



Picture 1.PRISMA Flowchart

Table 1. Reviewed Articles

No	ID	Design	Sample	Data Collecting	Result	Conclusion and Recommendation
1	(11)	Prospective observational study	240 participants	The measurement of serum creatinine criteria of 6 months to 12 years old Type 1 Diabetes Mellitus and ketoacidosis	41 events (15.5%) of Moderate to severe AKI. Age (OR:0,78, p <0.001), GCS below 14 (OR:4,66, p =0.004) and serum chloride levels (OR:1,10, p=0.01) were the moderate factors of AKI	Children with T1DM hospitalized for DKA have a higher risk for AKI, AKI is also predicted by young age, low GCS, and elevated serum chloride levels.
2	(12)	Retrospective study	166 medical records of children with covid-19	Data collection was carried out retrospectively using medical record data of children aged ≤18 years treated for acute COVID-19 treatment or MIS-C.	AKI occurred in 11.8% of the study. With 8.2% in children with acute COVID-19 history and 18.2% in children with MIS-C history.	The AKI related with covid-19 in children predicted poor prognosis and prolonged length of stay.
3	(13)	Cross-sectional study	16 patients	Secondary data obtained from the medical record of the children with AKI at a referral hospital in Jakarta, Indonesia were collected. AKI diagnosed based on KDIGO criteria.	Majority patients had high anion gap metabolic acidosis with mean pH 7.33 ± 0.07 and mean anion gap 15.6 ± 7.8 mEq/L.	AKI in children requires early diagnosis and prompt therapy to prevent morbidity and mortality.
4	(14)	Retrospective study	114 children	Acute Gastroenteritis clinical and biochemical data were collected. Kidney Disease/Improving Global Outcomes creatinine	The prevalence of AKI on Acute Gastroenteritis children is as much as 24,6%	AGE could cause AKI and increase the length of stay

Table 1. Reviewed Articles (Continued)

No	ID	Design	Sample	Data Collecting	Result	Conclusion and Recommendation
				criteria ere used to define AKI		
5	(15)	Retrospective study	48 children	Demographic data, clinical manifestations, laboratory findings, management and clinical outcomes were collected, and analyzed to identify early indicators or risk factors for AKI.	The prevalence of AKI on Children with sever wasp stings were as much as 20 (41,7%)	Risk factor of AKI on chidren after wasp stings can be evaluated through cola colored urine.
6	(16)	Retrospective study	73 children postcardiac surgery	Inpatient files were reviewed for patients who underwent surgical procedures for congenital heart disease (CHD) during 2022.	AKI occurred in 35.6% of children undergoing cardiac surgery. The majority of cases were infants or had cyanotic heart disease (42.5% and 25.8%, respectively).	Almost one-third of postcardiac surgery patients develop AKI. Monitoring for AKI postoperatively is especially necessary in infants and patients with cyanotic CHD.
7	(17)	Cross-sectional monocentric observational study	1131 patient admitted to PICU	The data collected on 29 days to 17 years old children in the PICU; were observed the factors associated to AKI occurrence.	Older age, use of ventilator, and vasoactive amines medications were the factors related to AKI.	Adequate renal perfusion management is taken for patients with risk factors to reduce the mortality.
8	(18)	Prospective cohort study	598 children	AKI were defined by using The Kidney Disease Improving Global Outcomes (KDIGO) criteria on	The prevalence of AKI was 45,3%.	Children with severe malaria-associated AKI are at risk of AKD and post hospitalization death.

Table 1. Reviewed Articles (Continued)

No	ID	Design	Sample	Data Collecting	Result	Conclusion and Recommendation
				children with 1 mont post discharge of severe malaria.		
9	(19)	Cohort cross-sectional study	52 patients	Post liver transplantation children were observed.	28.8% had AKI.	Kidney disease (acute and chronic) were the common long term complication of children post liver transplantation.
10	(20)	Analytic cohort	2318 patients	Children aged 1-18 years old with blood transfusion in the ACS pediatric Trauma Quality Improvement Program (TQIP) database (2015-2018) were observed on the outcome.	Deep venous thrombosis (DVT), acute kidney injury (AKI), CLABSI and severe sepsis were the significant outcomes of children with massive transfusion.	Massive transfusion increase the risk of AKI

depletion through osmotic diuresis (22). The accumulation of glucose in the renal tubules causes tubular injury and increases urine volume, resulting in further fluid loss (23,24).

AKI has also been reported in pediatric patients with COVID-19, with approximately 20% of hospitalized children affected (25). Respiratory distress contributes to AKI through systemic mechanisms such as prolonged hypoxia, vascular congestion, and decreased cardiac output. Additionally, SARS-CoV-2 induces cytokine release, causing inflammation in the kidneys (26).

One study demonstrated that acute gastroenteritis can lead to AKI in children through hypoperfusion and decreased renal blood flow, resulting in reduced urine output (14,27). Other diseases contributing to AKI include malaria, mediated by an overactive inflammatory response (28); liver transplantation, due to prolonged operative time and preoperative anemia (29); and wasp stings, which cause rhabdomyolysis, hemolysis, and toxicity from the venom (30). Critical illness in children is also a major risk factor for AKI, especially due to the use of nephrotoxic medications (31).

Post-cardiac procedures that require mechanical ventilation may impair drug excretion, leading to prolonged exposure to nephrotoxic agents (32). Agents such as ethylene glycol (EG) and diethylene glycol (DEG) were identified as risk factors for AKI during the 2022 incident in Indonesia, when these substances were used as solvents in cold syrups (7). EG and DEG induce AKI through the formation of calcium oxalate crystals, which obstruct filtration in the renal cortex (33). Another risk factor for AKI is blood transfusion, particularly after cardiac surgery, which can damage tubular cells due to myeloid-related proteins present in donor red blood cells (34).

LIMITATIONS

The strength of this review lies in its comprehensive compilation of various risk factors for acute kidney injury. However, the broad scope of the review presents challenges in interpreting individual studies and drawing specific nursing implications. Pediatric AKI management requires early detection and timely intervention. This includes closely monitoring rapid changes in a patient's condition, which underscores the importance of understanding renal physiology. Effective management involves collaborative care, fluid balance monitoring, and early identification and prevention strategies (35,36).

RESEARCH ETHIC

This literature review was conducted using secondary data from previously published articles. Ethical approval was not required as the study did not involve direct human or animal subjects. However, the authors ensured that all included articles in this review had obtained appropriate ethical clearance from their respective institutional review boards and adhered to ethical research practices, including informed consent and confidentiality where applicable. The selection and analysis of articles followed a transparent and reproducible process in accordance with PRISMA guidelines to ensure integrity and objectivity.

CONFLICT OF INTEREST

The author declares no potential conflicts of interest.

ACKNOWLEDGEMENT

The author extends sincere appreciation to the Faculty of Health Sciences, Universitas Katolik Indonesia Santu Paulus Ruteng, for facilitating the publication of this study. This research received no financial support from public, commercial, or not-for-profit funding bodies. The corresponding author will provide access to the dataset upon reasonable request.

CONCLUSION

Nurses are often the first to detect subtle signs of deterioration in children. Therefore, it is recommended that future studies develop and validate nursing-specific early warning tools to identify children at risk of AKI, focusing on early changes in urine output, fluid balance, and vital signs. Proper identification and management of risk factors—including thorough assessment and prompt treatment—may help reduce the incidence of acute kidney injury in children.

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