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The prevalence of AKI in Iranian children with CHD; A Systematic Review and Meta-analysis

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Abstract

Introduction
Congenital cardiac abnormalities affect roughly 6 to 8 out of every thousand live newborns, with more than half requiring surgery during the first year. Acute postoperative renal injury(AKI) is a frequent consequence after cardiac surgery. this meta-analysis was conducted to assess the prevalence of AKI in Iranian children with CHD
Methods
The PubMed, Embase, and Cochrane libraries were used for systematic retrieval of texts based on a predetermined search strategy."Acute kidney injury," "AKI," "Acute renal failure," "ARF," "Congenital heart disease," "CHD," "Congenital heart defect," and "Iran" were among the used keywords.Using a pre-designed data collecting form, two researchers (MS, PO) independently screened relevant studies.Stata 10.0 was used to conduct all meta-analyses
Results
A total of 634 CHD patients with a mean age of 3 ± 1.2 years old were enrolled in this study.Our results showed that the pooled prevalence of AKI in Iranian children with CHDwas10.3%(95% CI: 8.1%-12.6%, I^2:97.1%).
Conclusion
The incidence of AKI in patients with CHD was 10.3% in this investigation. These findings highlight the significance of future research into the precise causes of AKI as well as effective prevention interventions.

Keywords: AKI, Acute kidney injury, Pediatrics, CHD, Congenital heart disease

Introduction

Heart disease is one of the most serious hazards to human society's health. Heart disease affects around 17 million people in the United States each year.Patients with coronary artery disease (CAD) account for 64.7 percent, valvular lesions for 29.4%, and congenital heart abnormalities for 5.8% (1).Congenital cardiac abnormalities affect roughly 6 to 8 out of every thousand live newborns, with more than half requiring surgery during the first year (2).Congenital heart disease prevalence varies by nation, with 6.61 per thousand live births in the United States, 3.17 in the United Kingdom, 1.95 in Finland, 6.18 in Denmark, 3.57 in Sweden, 4.31 in Australia, and 12.5 per 1000 live births in Canada.Unfortunately, there are no good statistics on the frequency and incidence of congenital cardiac disease in Iran due to a lack of registration (3). Children's mortality and surgical age have dropped in recent years due to substantial breakthroughs in cardiac surgery and postoperative care (4).So far, 45 congenital cardiac illnesses have been identified, with ventricular septal defect (VSD) (20-25%), atrial septal defect (ASD) (8-13%), open arterial duct (PDA) (6-11%), and aortic coarctation (75%) being the most prevalent (5).Nearly a third of operations, according to research, are diagnosed with at least one ailment (6). These methods may cause cardiac, lung, gastrointestinal, brain, blood, renal, and other negative effects and death.Complications are more likely to arise during or after open-heart surgery due to pulmonary bypass cardiomyopathy (CPB), which has various effects on different body organs (5).A cardiovascular pump (CPB) is used in over 400,000 open heart operations across the world, with about 6% of those being children (7).Identifying the processes, incidence, and risk factors play a key role in effectively controlling these complications and improving the operation's prognosis.Acute postoperative renal impairment (AKI), a frequent consequence after cardiac surgery (8), is a clinical condition defined by water, electrolyte, and acid-base balance, as well as the buildup of nitrogenous wastes, as a result of a fast loss in glomerular filtration capacity (9).AKI affects 70-2.7 percent of CHD patients who have cardiac surgery (10,11). The variable frequency of AKI in CHD patients might be due to changes in patient demographic, sample size, and criteria for recognizing and categorizing AKI among studies.AKI can also lead to extended mechanical ventilation and hospitalization and a high risk of morbidity and death (12-15).Several prior systematic investigations and meta-analyses mostly looked at the incidence of AKI in patients with total hip arthroplasty (16) or heart transplantation (17); however, there was no meta-analysis evaluating AKI incidence in CHD patients among the relevant studies.As a result, this meta-analysis was conducted to assess the prevalence of AKI in Iranian children with CHD.

Methods

Search strategy

The PubMed, Embase, and Cochrane libraries were used for systematic retrieval of texts based on a predetermined search strategy."Acute kidney injury," "AKI," "Acute renal failure," "ARF," "Congenital heart disease," "CHD," "Congenital heart defect," and "Iran" were among the used keywords.The deadline for recovery was April 20, 2022. Furthermore, a manual search for possible research relevant to the references of the papers supplied was done.

Selection criteria

The study comprised the following sorts of studies: (1) those include Iranian children with CHD who have had heart surgery but have never had a kidney transplant (2).As a consequence of the study, some studies reported the incidence of AKI. (3) Those who diagnosed AKI using the RIFLE, AKIN, and KDIGO diagnostic criteria. And (4) cohort studies, whether prospective or retrospective.(1) Reviews, letters, or comments, and (2) research that featured the most recent or comprehensive information among repeated or numerous studies that utilized the same data were removed.

Data extraction

Using a pre-designed data collecting form, two researchers (MS, PO) independently screened relevant studies.The first author's name, year of publication, research field, time of employment, age, sample size, kind of retrieval, type of operation, and definition of AKI were all included in the study. Any discrepancies were addressed by a discussion with two additional researchers once the data was extracted.

Methodological quality assessment

The methodological characteristics of the included studies were assessed using the Health Research Agency and the Recommended Quality Scale (18). The scale assigns a 0 to 11-point final score to research based on an 11-item checklist. Low, medium and high-quality procedures were assigned to studies with scores of less than 4, between 4 and 7, and > 7.

Statistical analyses

Stata 10.0 was used to conduct all meta-analyses (Stata Corporation, College Station, TX, USA). The effect value was calculated using incidence rates with 95 percent confidence intervals (CIs).The Cochrane Q test (19) and the I2 test were used to determine study heterogeneity (20).When the P-value of the Q statistic was less than 0.05 or the value of I2 was greater than 50%, statistically significant heterogeneity across the studies was evaluated, and the results were integrated using a meta-analysis random-effects model. The fixed-effects model was utilized in the other cases. To investigate the link between these parameters and the research outcome, subgroup analysis was done based on study location, kind of surgery, type of cohort, age, and AKI criteria. Furthermore, in the meta-analysis, diffusion bias is likely to lead to the impacts of smaller studies, with smaller studies showing bigger therapeutic benefits. The Egger test is a statistical test for minor study effects that can uncover rising bias as the number of trials using a linear regression model grows (21,22).The Egger test was used to assess emission bias in this investigation. The significance of $P<0.05$ values was statistically significant.

Results

Figure 1 depicts the outcomes of the article retrieval and screening procedure. PubMed (n = 170), Embase (n = 105), and other databases yielded a total of 619 citations. A total of 100 duplicate articles were eliminated from the database. After reading the entire material, 39 articles remained. In addition, 35 papers were removed because they were duplicate research or did not provide the expected results. Ultimately, three publications were chosen to be included in the meta-analysis. The features of three investigations, published between 2013 and 2017, and distributed throughout Tehran, Jahrom, and Mashhad, are shown in Table 1.A total of 634 CHD patients with a mean age of 3 ± 1.2 years old were enrolled in this study. Out of three included studies, one belonged to Tehran, one to Mashhad and one to Jahrom. Two of the included studies were prospective and one was retrospective.

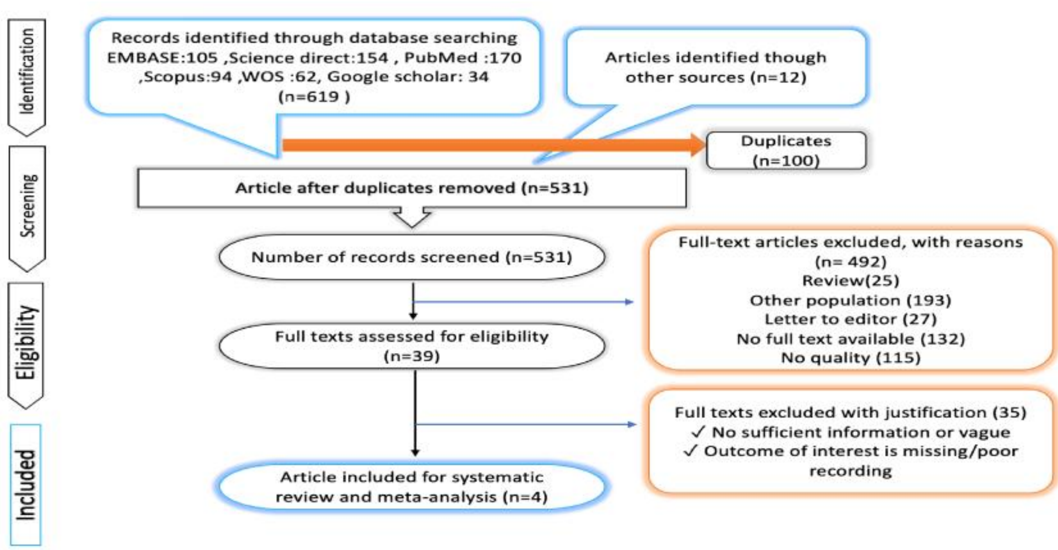

Figure1.Prisma Flow Diagram

Author	Mean Age	Female/Male	Sample Size	City	year	Prevalence	Design
Roodpeyma et al.	4.5 ± 4.9	95/107	202	Tehran	2013	4(6.8%)	prospective
Mirzaei et al.	3.65±4.47	99/104	113	Jahrom	2015	3.9%	retrospective
Amini et al	3.64±3.35	260/259	319	Mashhad	2017	150(28.9)	prospective

Table 1. Characteristics of the included studies evaluating the prevalence of AKI among children with CHD

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. metan P se, label(namevar=Author, yearvar=Year) fixed

           Study     |     ES    [95% Conf. Interval]     % Weight
---------------------+---------------------------------------------------
Roodpeym (2013)      |  0.070       0.035     0.105          40.93
Mirzaei (2015)       |  0.040       0.004     0.076          38.74
Amini (2017)         |  0.290       0.240     0.340          20.33
---------------------+---------------------------------------------------
I-V pooled ES        |  0.103       0.081     0.126         100.00
---------------------+---------------------------------------------------

  Heterogeneity chi-squared =  69.32 (d.f. = 2) p = 0.000
  I-squared (variation in ES attributable to heterogeneity) =  97.1%

  Test of ES=0 : z=   9.00 p = 0.000
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Figure 2. Meta-analysis of the prevalence of AKI in Iranian children with CHD

Methodological quality assessment

The source of information, inclusion and exit criteria, patient recruitment duration, data collection thoroughness, and so on were all supplied in all research. Most of the studies included, however, lacked information on confounding assessment, missing data processing, and follow-up clarity. All of the studies that were included were of excellent quality.

Meta-analyysis of the prevalence of AKI in Iranian children with CHD

Our results showed that the pooled prevalence of AKI in Iranian children with CHDwas10.3%(95% CI: 8.1%-12.6%, I^2:97.1%).(figure 2)

Discussion

The incidence of AKI in individuals with CHD was 38.4% in this meta-analysis. However, there was no significant difference in the incidence of AKI between men and women.AKI was also seen in other types of surgery, such as full hip arthroplasty (6.3 percent) [23], heart transplantation (47.1 percent) [24], and liver transplantation (40.8 percent) [25], according to previous meta-analyses.AKI was found to be between 30 and 45 percent in patients with CHD, which was greater than other forms of surgery.

Different clinical viewpoints and economic costs can be blamed for differences in surgery estimations.AKI following congenital heart surgery is usually associated with cardiopulmonary bypass (CPB), young age, preoperative AKI, preoperative mechanical ventilation, and preoperative peritoneal dialysis [26, 27, and 28].AKI is also a substantial risk factor for poor long-term outcomes, such as chronic kidney disease and end-stage renal disease, according to the evidence [29].As a result of these findings, improved techniques for AKI prediction and patient risk classification, as well as better preventative efforts, are needed.

A susceptible population of patients is seen in infants receiving surgery for congenital cardiac disease. Small kidneys in preoperative renal ultrasonography may allow early diagnosis of high-risk neonates, and certain other risk factors may be adjusted, according to the research.To reduce the risk of AKI and perhaps FOL, it may be required to address modifiable risk variables such as preoperative aminoglycoside exposure, selective brain perfusion, and CPB time [30].Furthermore, PD catheters may be implanted during surgery if ultrasonography identifies the kidneys of newborns with tiny kidneys prior to surgery.Mirzaei et al. made an attempt. Renal problems are the most prevalent postoperative complication in children with congenital heart disease, according to their research. Blood urea (41.4 percent) and hematuria (27.1 percent) were the most common renal consequences.After cardiopulmonary bypass, hemoglobin urea and hematuria are common [31]. Due to hemolysis, blood urea is frequently formed during bypass.Hemolysis can occur as a result of prolonged bypass, cardiotomy suction, or severe pump blockage, resulting in elevated hemoglobin levels. Hemoglobin in urine is toxic to the renal tubules and can cause the tubules to generate negatively charged proteins [32].Renal failure was the following consequence, which occurred in 3.9 percent of patients. The incidence of renal failure in children following cardiac surgery was less than 10% in numerous studies, including Hernik et al. (2011) (6%) and Rigden et al. (1996) (5.3%) [33,34].

Conclusion

The incidence of AKI in patients with CHD was 10.3%in this investigation. These findings highlight the significance of future research into the precise causes of AKI as well as effective prevention interventions.

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