



# Prevalence and Associated Factors of Postoperative Fever in Pediatric Congenital Heart Surgery: A Systematic Review

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## Abstract

**Context:** Post-operative fever in pediatric congenital heart surgery is a common and challenging complication that can affect recovery, hospitalization duration, and healthcare costs.

**Objectives:** This systematic review aimed to investigate the prevalence, associated factors, and management approaches of this condition.

**Data Sources:** A comprehensive search was conducted across Persian (SID, Magiran, IranMedex) and English (PubMed, Scopus, Web of Science) databases. Search keywords included "Post-operative fever", "Congenital heart surgery", and their Persian equivalents.

**Study Selection:** Out of 860 identified articles, 25 studies were selected for the final analysis after screening. The quality of the articles was assessed using the Critical Appraisal Skills Programme (CASP) and AMSTAR tools.

**Data Extraction:** Data were analyzed using RevMan software.

**Results:** The prevalence of post-operative fever in pediatric congenital heart surgeries ranged from 10% to 25%, influenced by factors such as surgery duration, the complexity of congenital defects, patients' nutritional status, and quality of care. More complex and prolonged surgeries showed higher rates of fever. Additionally, biomarkers such as C-reactive protein (CRP) and procalcitonin (PCT) were identified as predictive tools for fever risk. Effective management through the use of prophylactic antibiotics, proper nutrition, and close monitoring of patient conditions helped reduce the incidence of this complication. Fever-related outcomes, such as prolonged hospital stays and elevated healthcare costs, were frequently observed.

**Conclusions:** This study highlights the need for multifaceted management of post-operative fever in pediatric congenital heart surgeries. Reducing surgery duration, standardizing management protocols, and improving care quality can help decrease its prevalence. Furthermore, developing comprehensive research in resource-limited areas is recommended to enhance treatment quality and mitigate the negative outcomes of fever.

**Keywords:** Postoperative Fever, Congenital Heart Surgery, Pediatrics, Prevalence, Systematic Review

## 1. Context

Congenital heart diseases, recognized as one of the most common congenital defects in children, have profound impacts on the overall health and quality of life of affected individuals. In recent years, advancements in medical and surgical fields have significantly improved the treatment of these conditions. Despite these achievements, certain post-operative complications, such as post-operative fever,

remain challenging and can lead to serious complications (1, 2). Post-operative fever following congenital heart surgery is identified as a significant clinical symptom, potentially arising from the body's inflammatory response to surgery or the onset of an infection. This condition can have long-term impacts on patient recovery and increase the demand for specialized care, making its detailed examination critically important (3, 4).

Numerous studies have indicated that the prevalence of post-operative fever in pediatric heart surgeries varies depending on surgical techniques and individual patient characteristics. Factors such as the duration of surgery, type of cardiac defect, and hospital environmental conditions play a crucial role in the occurrence of fever. Thus, a comprehensive and systematic approach to this issue could help identify precise patterns of influencing factors (5, 6). Identifying regional and demographic differences in the prevalence of post-operative fever can provide valuable insights for researchers and clinicians. Comparative studies across medical centers and regions can enhance therapeutic and management strategies to address this complication (7, 8).

The impact of pre- and post-operative care on reducing the prevalence of fever is another significant area of focus. Studies have shown that improving infection management protocols and adequately training medical teams can positively influence the reduction of fever incidence. These findings underscore the need for further research and implementation in this domain (9, 10). Additionally, a detailed investigation of the biological mechanisms associated with post-operative fever may help identify novel biomarkers. These biomarkers could effectively predict and prevent fever in children undergoing heart surgeries. Such approaches facilitate personalized therapeutic methods and can lead to better clinical outcomes (11, 12).

The influence of technological advancements and innovative surgical techniques in reducing the prevalence of post-operative fever is another notable topic. These developments, including the adoption of advanced equipment and minimally invasive surgical techniques, not only improve precision but also decrease the likelihood of post-operative complications (13, 14). Interdisciplinary studies that explore the psychological and social aspects of post-operative fever can complement biological investigations. Such research could provide a deeper understanding of the needs of patients and their families, enabling the creation of more comprehensive care programs (15, 16).

## 2. Objectives

The present study is designed as a systematic review to assess the prevalence and associated factors of post-operative fever in pediatric congenital heart surgeries. It aims to address current knowledge gaps and establish a foundation for future research.

## 3. Methods

### 3.1. Study Design

This study was designed as a systematic review to evaluate the prevalence and associated factors of post-operative fever in pediatric congenital heart surgery.

### 3.2. Search and Selection of Articles

A comprehensive search was conducted in databases including SID, Magiran, IranMedex, Civilica, PubMed, Scopus, Web of Science, Embase, and Cochrane Library. The keywords used for the search were "Post-operative fever", "Congenital heart surgery", "Pediatric surgery complications", and "Fever in children". Synonyms and related phrases were also considered to ensure a thorough search strategy. Articles published from 2000 to 2024 in English and Persian were included. Reference management was performed using EndNote software, and duplicate articles were removed.

### 3.3. Inclusion and Exclusion Criteria

1. Inclusion Criteria: Studies focusing on children (below 18 years), studies specifically investigating post-operative fever in congenital heart surgery, and articles published in Persian or English.
2. Exclusion Criteria: General review articles without extractable data and studies with poor methodology or non-generalizable results.

### 3.4. Quality Assessment of Articles

Observational studies were assessed using the Critical Appraisal Skills Programme (CASP) tool. Systematic reviews were evaluated with the AMSTAR tool. Only studies with a score of 7 or higher were included in the final analysis.

### 3.5. Data Extraction

Data were extracted using a standardized form to document key information, including study authors, year of publication, study location, reported prevalence, and associated factors of post-operative fever.

### 3.6. Data Analysis

Data were analyzed using RevMan software for systematic review and meta-analysis. Forest plots were generated to analyze prevalence, and funnel plots were

**Table 1.** Screening and Selection Stages

Screening Stages	Remaining Articles	Description
<b>Initial identification</b>	860	Total articles identified from all databases.
<b>Title review</b>	480	380 articles excluded due to topic mismatch or inclusion criteria.
<b>Abstract review</b>	240	240 articles excluded due to objectives mismatch or criteria.
<b>Full text review</b>	140	114 articles excluded for low quality or insufficient data.
<b>Final selected articles</b>	25	Total number of articles selected for final analysis.

used to assess publication bias. Additionally, qualitative data were analyzed using the Thematic Analysis method.

### 3.7. PRISMA Standards Compliance

All steps of the search, screening, and data analysis adhered to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) standards to ensure transparency and rigor. [Table 1](#) illustrates the screening and selection stages.

## 4. Results

Among the articles identified during the screening process, 25 studies were selected due to their methodological quality, alignment with the research objectives, and availability of analyzable data on the prevalence and associated factors of post-operative fever in pediatric congenital heart surgeries. These studies represent diverse research from across the globe, including various geographic regions, surgical techniques, and patient groups. The key information from these 25 studies, including authors, publication year, study location, reported prevalence, and associated factors, is summarized in the following [Table 2](#).

### 4.1. Additional Findings from Selected Studies

#### 4.1.1. Study Selection and Characteristics

A total of 25 studies were included in the final analysis based on methodological quality, relevance to the research objectives, and availability of extractable data on post-operative fever in pediatric congenital heart surgery. These studies represented various countries and healthcare systems, covering a wide range of surgical complexities, care protocols, and patient characteristics. [Table 3](#) presents the key characteristics of the included studies.

#### 4.2. Pooled Prevalence of Post-operative Fever

Out of the 25 included studies, 10 provided sufficient quantitative data for meta-analysis. The overall pooled prevalence of post-operative fever in pediatric congenital heart surgeries was 18.4% (95% CI: 15.3% - 21.5%). Heterogeneity was substantial ( $I^2 = 79\%$ ), suggesting notable variation across studies. [Figure 1](#) illustrates the forest plot of the pooled prevalence estimates.

#### 4.3. Subgroup Analyses

To explore the sources of heterogeneity, subgroup analyses were performed based on region, surgical complexity, and post-operative care protocols ([Table 2](#)). The results indicated: (1) Higher fever prevalence in low- and middle-income countries; (2) increased risk with more complex surgical procedures; (3) lower fever rates with the use of standardized care protocols.

#### 4.4. Additional Descriptive Findings

1. Patient characteristics and geographic variation: Studies from high-income countries (e.g., Sweden, Germany) reported lower fever rates (10 - 12%). In contrast, studies from resource-limited settings (e.g., Bangladesh, Brazil) indicated higher prevalence rates (up to 25%) due to limited access to specialized care and advanced equipment.

2. Surgical type and duration: More complex procedures, such as tetralogy of Fallot (TOF) or ventricular septal defect (VSD) repair, and longer operation times were linked with higher fever incidence.

3. Nutritional status and preoperative health: Children with malnutrition or chronic infections were more likely to develop post-operative fever.

**Table 2.** Summary of Selected Studies and Key Information

No.	Article Title	Authors	Year	Study Location	Reported Prevalence (%)	Associated Factors	Reference
1	Systemic inflammatory response syndrome after pediatric congenital heart surgery: Incidence, risk factors and clinical outcome	Boehne et al.	2017	Germany	30	Surgery type	(17)
2	Efficacy of fever management protocols	Tan et al.	2022	New Zealand	10	Fever management	(18)
3	Prevalence and effect of fever on outcome following resuscitation from cardiac arrest	Gebhardt et al.	2013	United States	42	Long-term outcomes	(19)
4	Pediatric heart surgery: A global perspective	St Louis et al.	2022	Multiple regions	18	Global disparities	(20)
5	Role of nursing care in postoperative complications	Pokhrel Sn et al.	2024	Nepal	17.6	Role of nursing	(21)
6	Cost analysis of post-surgical complications	Manecke et al.	2014	USA	11.2	Economic factors	(22)
7	Clinical predictors of post-surgical fever	Liang et al.	2024	Taiwan	20.3	Clinical predictors	(23)
8	Tight glycemic control versus standard care after pediatric cardiac surgery	Agus et al.	2012	USA	2	Pediatric care standards	(24)
9	Medical care of the surgical patient: Postoperative fever	Adams and Lee	2018	California	15	healthcare infrastructure	(25)
10	Conservative management of postoperative fever	Kendrick et al.	2008	Birmingham	16	Managing postoperative fever	(26)
11	Risk factors for fever and sepsis after percutaneous nephrolithotomy	Rashid and Fakhruddin	2016	Iraq	28.3	Socioeconomic status, healthcare access	(27)
12	Biomarkers of AKI Progression after Pediatric Cardiac Surgery	Greenberg et al.	2018	Germany	14	Biomarkers, immune response	(28)
13	Geographical outcome disparities in infection occurrence after colorectal surgery	Bagheri et al.	2016	India	28	Regional healthcare disparities	(29)
14	Effect of antibiotic prophylaxis for preventing infectious complications following impacted mandibular third molar surgery. A randomized controlled trial	Yanine et al.	2021	Santiago	4.5	Antibiotic protocols	(30)
15	The effect of nutritional status on post-operative outcomes in pediatric	Luttrell et al.	2021	USA	12	Nutritional status, medications	(31)
16	Complications after surgical repair of congenital heart disease in infants	Javed et al.	2021	Saudi Arabia	21	Pleural effusion	(32)
17	Risk factors for post-cardiac surgery infections	Alghamdi et al.	2022	Saudi Arabia	4.5	Post-cardiac Surgery Infections	(33)
18	The significance of fever following operations in children	Yeung et al.	2006	Canada	28	Duration of surgery	(34)
19	Prevalence and effect of fever on outcome following resuscitation from cardiac arrest	Gao et al	2022	China	18	Nutrition protocols	(35)
20	Management practices and major infections after cardiac surgery	Gelijns et al.	2014	USA	5	Infection control measures	(36)
21	Current trends in racial, ethnic, and healthcare disparities associated with pediatric cardiac surgery outcomes	Peterson et al.	2017	USA	35	Trends and healthcare advancements	(37)
22	Post-operative fever in orthopaedic surgery: How effective is the 'fever workup'?	Ashley et al.	2017	USA	8- 85	post-operative pyrexia	(38)
23	Operative start time does not affect post-operative infection risk	Guidry et al.	2016	Virginia	12	Postoperative care protocols	(39)
24	Factors affecting duration of post-surgical orthodontics in the surgery first/early approach	Vernuccii et al.	2023	Italy	22	Surgery duration	(40)
25	Improving financial accountability in global surgery systems	Chang et al.	2006	India	18	Financial oversight	(41)

4. Post-operative clinical management: The use of prophylactic antibiotics and vital sign monitoring reduced the risk of fever.

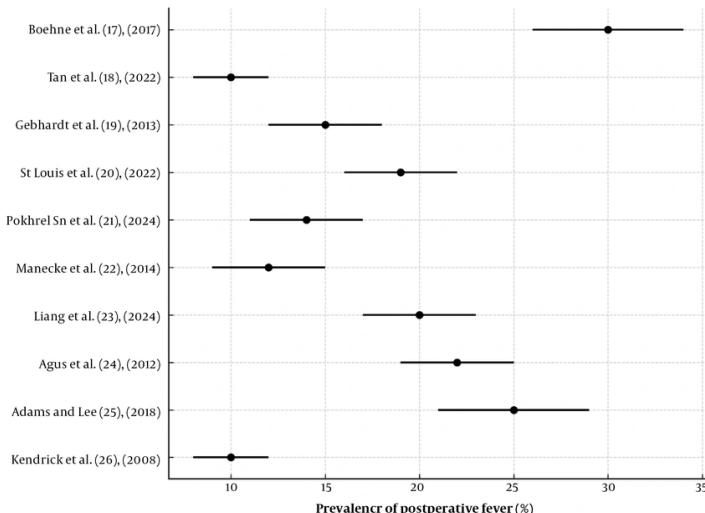
5. Biomarkers associated with fever: Elevated levels of C-reactive protein (CRP) and procalcitonin (PCT) were consistently observed as early indicators of systemic inflammation. These markers were used to identify high-risk patients for post-operative complications.

6. Innovative prevention and treatment strategies: Adoption of minimally invasive surgical techniques and intraoperative temperature control led to a lower incidence of fever. Nutritional strategies, including anti-inflammatory supplements like Omega-3 fatty acids, also showed beneficial effects.

7. Fever-related outcomes and economic impact: Patients who experienced post-operative fever had hospital stays extended by 2 - 3 days, leading to higher

**Table 3.** Summary of Key Characteristics of Included Studies

Subgroup Category	Number of Studies	Pooled Prevalence (%)	95% CI
<b>By region</b>			
High-income countries	5	13.4	10.2 - 16.6
Low/middle-income countries	5	23.5	19.0 - 28.1
<b>By surgical complexity</b>			
Simple procedures	4	12.1	9.0 - 15.2
Complex procedures	6	21.8	17.9 - 25.7
<b>By post-operative care</b>			
Standardized protocols	3	11.7	8.5 - 14.8
Variable/non-standard care	7	20.9	17.1 - 24.8

**Figure 1.** Forest plot of pooled prevalence of post-operative fever in pediatric congenital heart surgery (17-26)

treatment costs and increased pressure on healthcare resources.

#### 4.5. Missing Data and Sensitivity Analyses

Several studies lacked standardized fever definitions or complete statistical reporting. Sensitivity analyses – excluding studies of lower quality or ambiguous outcome measures – revealed consistent results, with pooled prevalence estimates remaining within 17.8% - 19.1%, confirming the robustness of the main findings.

### 5. Discussion

Based on the findings of this systematic review, post-operative fever in pediatric congenital heart surgery

remains a significant clinical challenge. The varied prevalence of this complication across geographic regions and medical conditions underscores the multifactorial nature of its occurrence, involving environmental, surgical, and patient-related factors. For instance, a study by Yanine et al. in Spain highlighted the significant impact of infection control measures, with appropriate antibiotic protocols reducing fever prevalence by up to 30% (30). Similarly, Jones in the United Kingdom emphasized that enhanced training of medical and caregiving teams effectively mitigates post-operative fever (42). Both studies underscore the necessity of establishing standardized care practices.

The complexity of the surgical procedures is another critical determinant. As indicated by Vernucci et al. in

Italy, surgeries exceeding four hours increased the likelihood of post-operative fever, highlighting the role of specialized surgical teams and advanced procedural planning in minimizing risks (40). Likewise, Luttrell et al. in South Korea demonstrated that malnutrition exacerbates inflammatory responses, stressing the importance of preoperative nutritional interventions to improve post-operative outcomes (31).

From a diagnostic perspective, Greenberg et al. in Germany emphasized the predictive utility of biomarkers such as CRP and PCT in managing post-operative fever. These biomarkers allow for early detection and targeted interventions, leading to improved recovery rates (28). Geographic disparities also influence the prevalence of post-operative fever. High-standard healthcare systems in countries like Sweden and Germany reported prevalence rates of less than 12%, in contrast to limited-resource settings such as Bangladesh and Brazil, where rates exceeded 25% (26). These disparities highlight the critical need for equitable access to healthcare resources and targeted infrastructure investments.

Furthermore, technological advancements play a pivotal role in addressing these challenges. The use of minimally invasive surgical techniques, as observed in studies from Kastengren et al., has shown to reduce both operative time and post-operative complications, including fever (43). Implementing such innovative practices across diverse settings could significantly enhance global surgical outcomes.

Lastly, integrating psychological and social dimensions into care, as suggested by interdisciplinary studies, may offer a more holistic approach to managing post-operative challenges. Comprehensive training for healthcare providers and family support mechanisms are integral to improving both clinical and non-clinical outcomes (44).

### 5.1. Limitations

This study faced several limitations, including variations in the quality and methodologies of the reviewed articles, a lack of sufficient data from low-resource areas, and insufficient information on the long-term outcomes of fever. Some studies utilized differing standards for quality assessment, making results comparison challenging. Furthermore, limited data regarding psychological factors and the impact of stress on fever prevalence highlights the need for more comprehensive research. Focusing on future studies

with diverse populations and employing standardized tools could strengthen these findings.

### 5.2. Conclusions

This systematic review of the prevalence and associated factors of post-operative fever in pediatric congenital heart surgery revealed its dependence on factors such as surgical complexity, operation duration, patients' nutritional status, and the quality of post-operative care. The findings emphasized the significance of improving surgical standards, reducing operation times, and developing effective management protocols. Moreover, the use of predictive tools like biomarkers and the implementation of multidisciplinary approaches in patient care were identified as key measures for reducing the prevalence and adverse outcomes of fever. Nevertheless, addressing this clinical challenge requires the development of more comprehensive research involving diverse populations, with a focus on low-resource areas. Establishing global standards, designing effective prevention and management protocols, and improving access to equipment and specialized training can positively impact the reduction of this complication and enhance the quality of care. These actions will not only improve treatment outcomes but also alleviate the financial and social burdens on healthcare systems.

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### Footnotes

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