

## Systematic Review

# The association between poor oral hygiene and infective endocarditis risk in rheumatic heart disease patients: a systematic review

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Received: 10 May 2025

Revised: 12 June 2025

Accepted: 26 July 2025

Published: 31 July 2025

DOI: [10.24198/pjd.vol37no2.59405](https://doi.org/10.24198/pjd.vol37no2.59405)

p-ISSN [1979-0201](#)

e-ISSN [2549-6212](#)

#### Citation:

Amiria, A. Gumilas, NSA. The association between poor oral hygiene and infective endocarditis risk in rheumatic heart disease patients: a systematic review. *Padj J Dent*, July. 2025; 37(2): 258-267.

## ABSTRACT

**Introduction:** Infective endocarditis (IE) is a heart condition that may result from subacute bacterial infections. One cause of IE is oral bacterial infections, particularly *Streptococcus* species, which enter the blood vessels through injured gingiva during tooth brushing or dental procedures. Rheumatic heart disease (RHD) is a major predisposing factor in developing countries, with viridans streptococci implicated in its etiology. This background highlights the importance of maintaining oral hygiene, especially in RHD patients, to reduce the risk of IE. This systematic review aims to investigate the association between poor oral hygiene and the risk of IE in patients with RHD. **Method:** A systematic review was conducted in accordance with PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines. Articles published between 2014 and 2024 were sourced from PubMed, Scopus, and Google Scholar using specific keyword combinations related to IE, RHD, and oral health. Inclusion and exclusion criteria were applied based on the PECO framework. **Results:** A total of four eligible studies were identified. The findings suggest that RHD patients with poor oral hygiene are more vulnerable to developing IE due to an increased risk of bacteremia originating from oral infections. **Conclusion:** Poor oral hygiene is associated with an increased risk of infective endocarditis in patients with rheumatic heart disease. Bacteria adhering to heart valves form biofilms and cause vegetations on the tissue. Preventive dental care and prophylactic measures should be emphasized in this high-risk population.

## KEYWORDS

Infective endocarditis, rheumatic heart disease, poor oral hygiene, bacteremia.

## INTRODUCTION

Infective endocarditis (IE) is an infection that occurs in the heart, specifically in the endocardial layer. This infection can be caused by bacteria originating from the mouth. IE is caused when bacteria from other body sites enter the heart through the bloodstream, attach to the inner lining of the heart, and damage the heart valves, potentially leading to blood vessel embolism, which can block the blood flow to the heart.<sup>1,2</sup> Despite improved therapeutic management, IE remains a disease with a significant 30-day mortality rate.<sup>2,3</sup>

The morbidity and mortality rates from IE are a considerable global concern. One cause of IE is bacterial infection originating from the oral cavity, specifically *Streptococcus* species.<sup>2,4</sup> These bacteria enter the bloodstream through injured gums during tooth brushing or dental procedures. Once in the bloodstream, these IE-causing bacteria attach to heart valves that have pre-existing issues (such as rheumatic heart disease (RHD), congenital defects, or prosthetic heart valves),

leading to the formation of vegetations. An increase in the number of bacteria attached to this area can enlarge the vegetations and disrupt valvular function. Rheumatic heart disease (RHD) is a primary predisposing factor in developing countries, with viridans streptococci implicated in its etiology.<sup>1,2</sup>

*Streptococcus viridans* bacteria are key contributors to the occurrence of bacteremia. This heterogeneous group of alpha-hemolytic Streptococci is part of the normal flora in the oral cavity. *Streptococcus* bacteria in the oral cavity are often found in cases of dental caries and pericoronitis.<sup>5,6</sup> These bacteria can enter the bloodstream through minor oral injuries caused by tooth brushing and dental procedures.<sup>7</sup> Once in the bloodstream, these bacteria can travel to the endocardial tissue, attach to it, and cause damage.<sup>8</sup> Damage can also occur in heart valves that possess pre-existing vulnerabilities, which may lead to other comorbidities.<sup>9</sup> Age and systemic diseases (diabetes mellitus and cardiovascular disease) can contribute to poor periodontal conditions. Additionally, the chronic use of drugs such as steroids, anticoagulants, and immunosuppressants can lead to alterations in periodontal tissue.<sup>10</sup>

Periodontal disease is a predisposing factor for cardiovascular disease because it is a low-grade chronic infectious disease and is thought to be a risk factor for atherogenesis and thromboembolism.<sup>11</sup> Oral infections are well-known causes for cardiovascular disease, especially bacteremia originating from the oral cavity, which can be a source of infection leading to heart valve damage and subacute bacterial endocarditis.<sup>12</sup> Oral health is closely related to the overall hygiene status of the oral cavity. Poor oral hygiene, smoking, systemic disease, stress, and obesity can all affect periodontal health.<sup>13</sup> There is a close relationship between the incidence of bacteremia after brushing teeth and indicators of oral hygiene and gingival disease (plaque and calculus).<sup>14</sup> Poor oral hygiene is also associated with a high risk of cardiovascular disease and low-grade inflammation.<sup>15</sup>

Oral diseases such as caries, gingivitis, and periodontitis often result from inadequate oral hygiene (OH). A case report by Puspita (2020) documented a patient with IE caused by *Streptococcus viridans* originating from cavities and diseased teeth. In addition, other case reports have found cases of endocarditis caused by manifestations of periodontitis. This forms the background for conducting a scientific study to investigate the importance of maintaining oral hygiene, especially in RHD patients, to reduce the risk of IE.

Despite the established role of oral pathogens, particularly *Streptococcus viridans*, in the pathogenesis of infective endocarditis (IE), there remains a significant gap in the literature regarding the specific risk posed by poor oral hygiene in patients with rheumatic heart disease (RHD). While several studies have examined the general relationship between oral health and cardiovascular infections, few have focused on RHD patients as a distinct high-risk group—particularly in low- and middle-income countries where RHD remains prevalent. This systematic review seeks to address this gap by critically evaluating and synthesizing existing evidence on the association between poor oral hygiene and the risk of IE among individuals with RHD. The novelty of this study lies in its targeted focus on the RHD population, highlighting the overlooked importance of oral hygiene as a modifiable risk factor for preventing life-threatening infections. Specifically, this review aims to assess the impact of oral health conditions—such as periodontitis, caries, and gingivitis—on the incidence of IE in RHD patients, to identify the dominant oral pathogens involved, and to provide evidence-based recommendations for preventive dental care strategies tailored to this vulnerable population.

## METHODS

A systematic review was conducted following the PRISMA 2020 guidelines to ensure transparency and reproducibility. Literature searches were performed across three major electronic databases: PubMed, Scopus, and Google Scholar.

The search strategy utilized Boolean operators, combining with the following keywords: "infective endocarditis," "rheumatic heart disease," "oral hygiene," "periodontitis," and "dental caries."

This methodology comprised four stages: identification, screening, feasibility, and results received. Literature for this systematic review was obtained by searching online electronic databases, including Google Scholar, PubMed, and Scopus. The PECO (Population, Exposure, Comparison, and Outcomes) framework was used to formulate eligibility criteria (Table 1). The inclusion criteria used were scientific journals published from January 2014 to December 2024 (the last 10 years), written in Indonesian and English, and identified using the Boolean operator OR/AND with the main keywords: ('Endocarditis' OR 'Rheumatic Heart Disease') AND 'Oral Hygiene' OR ('Endocarditis' AND 'Periodontitis') OR ('Dental Caries' AND 'Rheumatic Heart Disease' AND 'Endocarditis'). In addition, the articles had to be accessible in full text. Meanwhile, the exclusion criteria used were studies conducted using animal models, studies involving cardiac surgery, review articles, letters to the editor, duplicate publications, case-control study articles, and case reports.

The methodological quality of the included studies was assessed independently by two reviewers, FA (Farah Amiria, Dental Medicine and Biomedical Sciences) and NSAG (Nur Signa Aini Gumilas, Biotechnology and Medical Sciences), using the Newcastle-Ottawa Scale (NOS) for observational studies.<sup>16</sup> Disagreements in scoring were resolved through discussion, and if necessary, a third reviewer was consulted to reach consensus. Each study was rated as having low, moderate, or high risk of bias based on domains of selection, comparability, and outcome assessment.

Data extraction was performed independently by two authors using a standardized data extraction form. Extracted data included study characteristics (author, year, country, design, sample size), population characteristics, oral health variables, and outcomes related to infective endocarditis. Inconsistencies between reviewers were discussed and resolved through consensus, following the recommendations of the Cochrane Handbook.<sup>17</sup>

**Table 1. PECO framework (*population, exposure, comparison, outcomes*)**

Item	Information
<i>Population</i>	Rheumatic Heart Disease
<i>Exposure</i>	Poor Oral Hygiene (OH)
<i>Comparison</i>	Good Oral Hygiene (OH)
<i>Outcomes</i>	Endocarditis

The results of the database search are presented using the PRISMA flow diagram (Diagram 1). All duplicate articles were removed. Next, the remaining articles were screened based on the inclusion criteria and exclusion criteria by evaluating the article type, title, abstract, and full content. Articles that did not meet the inclusion criteria or met any of the exclusion criteria were excluded from the review.

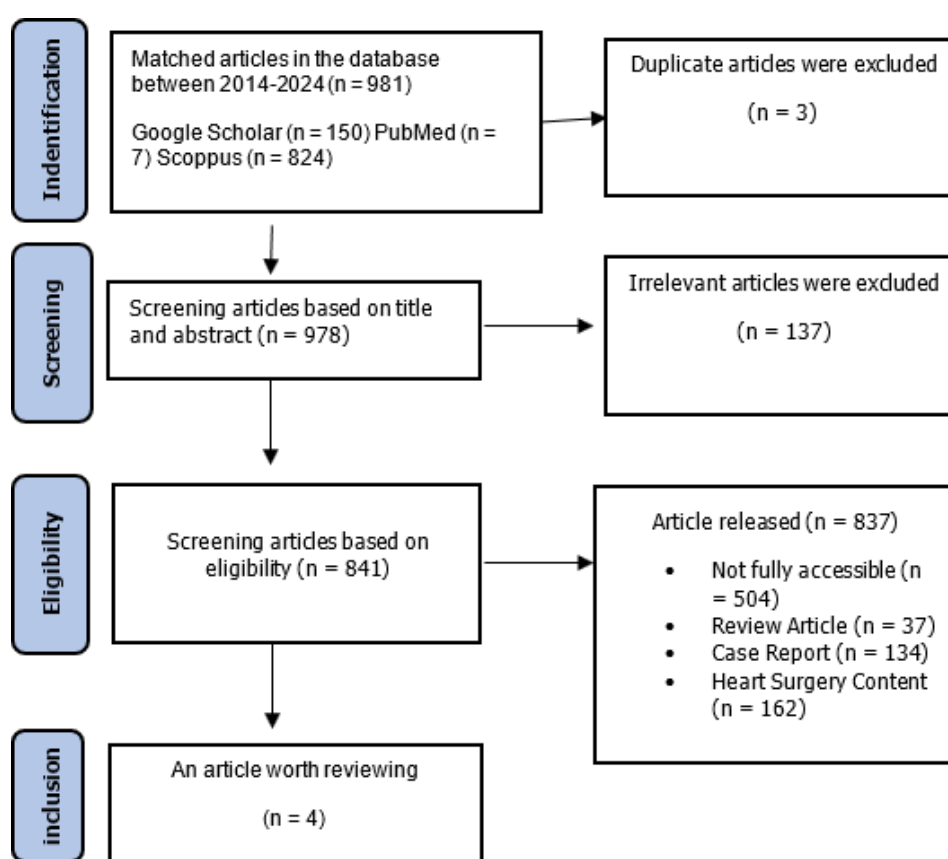


Diagram 1. PRISMA flow chart

## RESULTS

Based on the systematic literature search across three databases, 981 articles were initially identified. After duplicate removal, 978 articles underwent screening by article type, title, abstract, and content relevance to the topic, resulting in 841 articles. These articles were then assessed for eligibility based on full-text accessibility and conformity with inclusion criteria, yielding 4 eligible articles (Table 2).

Tabel 2. Literature search results

No	Research Title	Author and Year	Method	Sample	Observed Research Variables	Result
1	Mendelian Randomization Reveals No Causal Association Between Periodontitis and Infective Endocarditis.	Liu Rui-lin et al., 2024	Mendelian Randomization (MR)	Acute Periodontitis: n = 6; Chronic Periodontitis: n = 12; Aggressive Periodontitis: n = 8	Causal relationship between periodontitis and infective endocarditis	There is no direct causal relationship between periodontitis and infective endocarditis.
2	Oral Health Experiences of Turkish Children with Acute Rheumatic Fever or Rheumatic	Onsuren AS et al., 2022	Cross-sectional	Control Group: n = 43 (Male: 22, Female: 21) Treatment group: n =	Correlation between RHD patients and the oral hygiene index, specifically dental caries	There is a positive correlation between dental caries and acute rheumatic fever. The relationship between sugar

	Heart Disease.			43 (Male: 24, Female: 21)		intake and acute rheumatic fever is significant, particularly due to the involvement of <i>Streptococcus mutans</i> , the causative agent of dental caries. The research also shows that penicillin use in RHD patients may accelerate caries in primary teeth.
3	The Assessment of Antimicrobial Resistance in Gram-Negative and Gram-Positive Infective Endocarditis: A Multicentric Retrospective Analysis.	Budea CM et al., 2023	Retrospective Cohort Study	IE mono-infected gram-negative group: n = 29; IE mono-Infected, gram-positive group: n = 142	Relationship between the bacteria causing IE and the severity of disease, considering comorbidities and predisposing factors	IE caused by gram-negative bacteria resulted in a higher mortality rate than gram-positive IE in this study. However, these findings must be tempered by the small sample size of gram-negative IE cases as well as potential bias factors, as patients with gram-negative infections had a higher proportion of comorbidities and predisposing factors.
4	The Clinical Features and Prognosis of Infective Endocarditis in the Elderly from 2007 to 2016 in a Tertiary Hospital in China.	Wu Zhenzhu et al., 2019	Retrospective Cohort Study	Patient with IE: n = 405; < 50 years: n = 205; 50-64 years: n = 141; > 65 years: n = 59. Patients aged > 65 were divided into survival and mortality groups.	Course and prognosis of IE in patients of different age ranges, based on bacterial causes	IE patients of older age show more comorbidities, poorer oral hygiene, and a more severe prognosis than younger patients. <i>Streptococcus</i> bacteria are the most frequently found microorganisms in this group.

**Tabel 3. Quality assessment using the Newcastle–Ottawa Scale (NOS)**

No.	Author (Year)	Selection (0–4)	Comparability (0–2)	Exposure (0–3)	Total Score (0–9)	Risk of Bias
1	Liu Rui-lin et al. (2024)	2	0	1	3	High
2	Onsuren AS et al. (2022)	3	1	2	6	Moderate
3	Budea CM et al. (2023)	4	1	2	7	Low
4	Wu Zhenzhu et al. (2019)	4	2	3	9	Low

The methodological quality of the included studies was assessed using the Newcastle–Ottawa Scale (NOS), as shown in Table 3. Each study was evaluated based on three domains: Selection (maximum 4 stars), Comparability (maximum 2 stars), and Outcome/Exposure (maximum 3 stars). The total score determined the overall risk of bias, which was classified as Low (7–9), Moderate (4–6), or High (0–3).

## DISCUSSION

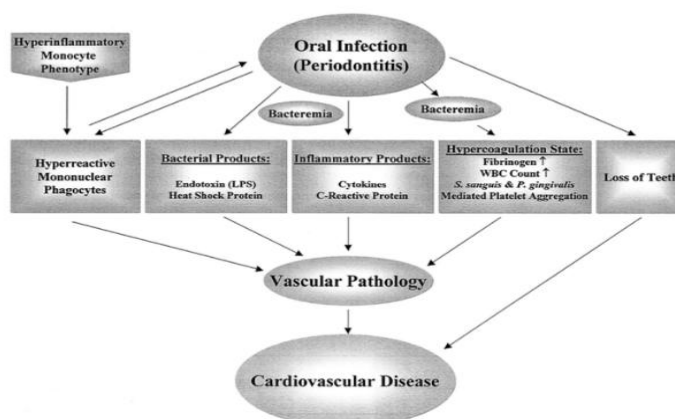
The results of the systematic review reveal variations in the data as summarized in Table 2. Some studies indicate an association between oral hygiene and the risk of infective endocarditis (IE) in rheumatic heart disease (RHD) patients. *Streptococcus* species are part of the normal flora in the oral cavity but can become pathogenic in environments characterized by poor oral hygiene and low pH (acidic conditions). These bacteria can cause dental caries. Besides caries, periodontal disease can also become a focal infection and lead to bacteremia.

Initial supragingival bacterial colonization involves *Streptococcus sanguinis*, *Streptococcus oralis*, *Streptococcus mutans*, *Actinomyces naeslundii*, and *Actinomyces odontolyticus*. This is followed by secondary bacterial colonization, such as by *Fusobacterium nucleatum*.<sup>5,6</sup> The presence of bacteria originating from poor oral hygiene (OH) can result in oral infections, which may enter the bloodstream and contribute to the development of systemic disease.<sup>18</sup>

Poor OH condition is often characterized by oral infections such as caries and periodontal disease, including gingivitis, periodontitis, and abscesses. Periodontitis may influence the host's susceptibility to systemic disease in three ways: (1) through shared risk factors, (2) by subgingival biofilm acting as a reservoir for gram-negative bacteria, and (3) by the periodontium serving as a reservoir for inflammatory mediators.<sup>19</sup> This supports the notion that periodontal disease can be an individual risk factor for cardiovascular disease, considering the wide range of gram-negative species involved, the levels of pro-inflammatory cytokines detected, the immune infiltrate and severe inflammation present, the high association with peripheral fibrinogen, and the white blood cell count. Periodontal disease can trigger pathways that lead to heart disease through the indirect effects of oral bacteria (Figure 1).

Cardiovascular disease is primarily caused by bacteremia originating from the oral cavity as a source of infection. Such infections can damage heart valves and result in subacute bacterial IE. This was confirmed by a study conducted in China in 2024, which found no direct causal relationship between periodontitis and IE. The study showed no statistically significant differences in IE cases among patients with acute, chronic, and aggressive periodontitis. The development of IE appears to result from a combination of infectious factors and individual

endocardial susceptibility. While the presence of bacteremia is a major factor, it alone is not sufficient to cause IE.<sup>20</sup> Therefore, the study of predisposing factors for IE is essential.



**Figure 1. Mechanism of the link between oral infections (periodontitis) and cardiovascular disease.<sup>8</sup>**

The main predisposing factor for infective endocarditis (IE) in developing countries is rheumatic heart disease (RHD). RHD itself is a heart valve disease resulting from damage to these valves. If complications arise and bacteremia leads to infection, RHD can be a predisposing factor for IE. According to research by Onsuren et al (2022), a positive correlation exists between RHD and dental caries. This study links the oral hygiene (OH) index with Acute Rheumatic Fever (ARF) and RHD. Oral hygiene data were collected through intraoral examination using the DMF-T (Decay, Missing, Filling, - Teeth) score. In addition to the DMFT score, the gingival index and plaque index were also examined to assess patients' OH. The DMFT results in this study indicate that the null hypothesis cannot be accepted; the dmft index in the primary teeth of the research group showed significantly higher results compared to the control group ( $p < 0.001$ ).

RHD patients with dental caries had more teeth extracted than filled teeth. This highlights the importance of controlling infection risk scheduled for extraction, which can be anticipated through the use of prophylactic antibiotics.<sup>21</sup> RHD patients with bacterial infections in the oral cavity are at increased risk of developing IE through complex pathophysiological mechanisms. Therefore, RHD patients should undergo regular dental health check-ups and maintain proper OH to minimize the risk of bacteremia originating from the oral cavity.

RHD is a complication of a throat infection caused by *Streptococcus* bacteria. The immune response to this infection can lead inflammation of the heart, especially the heart valves, resulting in damage and structural changes. Chronic inflammation and scar tissue formation on heart valves can create areas highly susceptible to infection. Damaged or abnormal valves can disrupt blood flow and increase turbulence, creating favorable conditions for microorganisms growth. Microorganisms, especially bacteria, can adhere to the surface of damaged valves and form structures called vegetations. This vegetation is composed of platelets, fibrin, and microbes.<sup>18</sup>

This process is often initiated by trauma or damage to the valve surface. The most common microorganisms involved in IE are bacteria, although fungal infections may also occur. When bacteria infect pre-formed vegetation, they can cause further inflammation, worsening valve damage and increasing the risk of embolism. An immune reaction to the infection can also cause further damage to heart tissue. The resulting inflammation can lead to systemic symptoms such as fever, fatigue, and joint pain, which are commonly observed in patients with IE. Complications of IE can include further damage to the valves, heart failure, and

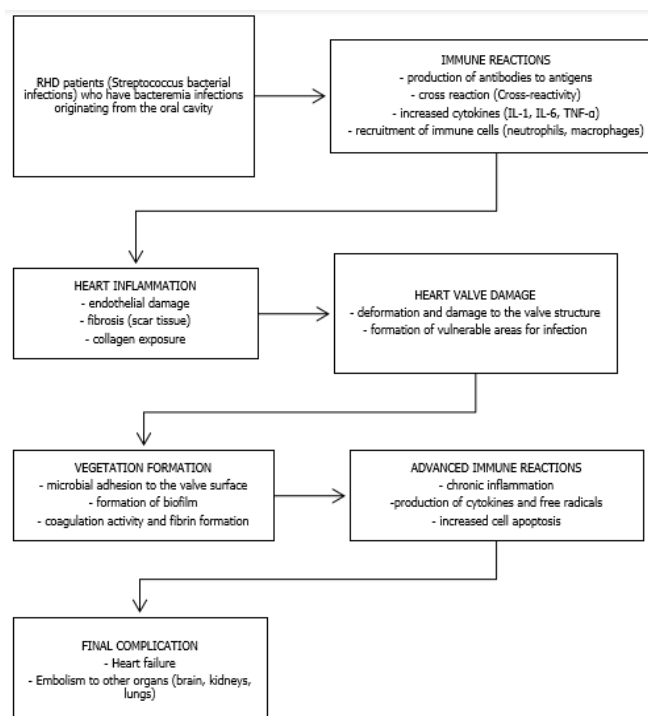


embolism to other organs, which can lead to tissue damage or secondary infections.<sup>6</sup>

The inflammatory reaction caused by dental disease increases plaque formation, which stimulates the thickening of blood vessel walls. Research shows that people with dental disease have twice the risk of developing coronary heart disease. Bacterial endocarditis found in dental plaque is one of the factors causing endocarditis. Bacteria from tooth cavities (*Streptococcus* bacteria) and damaged gums can enter the bloodstream through bleeding gums. These bacteria easily attack heart valves and weakened heart muscles.<sup>22</sup>

In addition to the inflammatory mechanism, *Streptococcus* infection can trigger a strong immune reaction. This immune reaction forms antibodies that can attack heart tissue, resulting in heart inflammation. The ensuing heart inflammation leads to damage to endothelial cells and the formation of scar tissue. This damages the valve, which can change its structure and create a vulnerable area. When bacteria attach to this area, biofilm formation occurs, which then develops into vegetation. This process further triggers an immune reaction, continuing the inflammatory process and worsening tissue damage. The final complication has the potential to cause heart failure and embolism (Diagram 2). It is important for dentists to exercise caution when performing dental procedures on patients with a history of RHD; it is best to administer prophylactic antibiotics beforehand.

High-risk patients require prophylactic antibiotics before the procedure. The prophylactic antibiotic choices include amoxicillin 2 g (30-60 minutes before the procedure) or clindamycin 600 mg (30-60 minutes before the procedure). The treatment of IE requires selecting the appropriate antibiotic, depending on the type of infecting pathogen and the patient's clinical condition. Infections caused by *Streptococcus* bacteria can be treated with penicillin G antibiotics. The recommended dose is 12-18 million units/day IV for 4-6 weeks. Ceftriaxone-class antibiotics may be used as an alternative, particularly for infections caused by *Streptococcus viridans*, at a dose of 2 g every 24 hours for 4-6 weeks.<sup>2</sup>



**Diagram 2. Pathophysiology of infective endocarditis (IE) in RHD patients with poor oral hygiene (OH)<sup>2</sup>**

This review encountered several limitations. Access to full-text articles was restricted in some cases, limiting the depth of data extraction and quality



assessment. Additionally, only a few studies met the strict inclusion criteria, impacting the generalizability of the findings. Differences in NOS scores also indicated methodological heterogeneity across studies.

Future studies should explore larger populations, employ uniform diagnostic criteria for oral hygiene (OH) and infective endocarditis (IE), and consider longitudinal designs that track patients over time. The role of modifiable behavioral factors and adherence to preventive guidelines should also be evaluated. In conclusion, the available evidence highlights the clinical importance of maintaining good OH, especially in high-risk populations such as RHD patients. Integrating dental care into the routine management of RHD could be a valuable preventive strategy against infective endocarditis.

The limitations of this study include challenges in accessing full-text articles and a limited number of studies that met the inclusion criteria, which could affect the generalizability of the findings. Furthermore, the heterogeneity in study designs and methodological quality may affect the overall conclusions of this review. A further limitation of this systematic review lies in the absence of meta-analysis and objective comparison with existing literature.

## CONCLUSION

This review highlights the clinical importance of maintaining good oral hygiene (OH), especially in high-risk groups such as patients with rheumatic heart disease (RHD). Poor oral hygiene facilitates bacteremia and the colonization of bacteria on damaged heart valves, particularly in RHD patients who are more vulnerable due to existing structural heart damage. RHD patients with poor OH are at a significantly higher risk of developing IE. These findings emphasize the importance of improving oral hygiene in at-risk populations. Clinical recommendations include regular oral health maintenance and the use of prophylactic antibiotics prior to dental procedures such as tooth extraction, root canal treatment, and scaling to minimize the risk of IE.

The implication of this research is to provide scientific evidence supporting the integration of dental care into cardiovascular disease prevention protocols, particularly for patients with a history of RHD. This underscores the need for interdisciplinary collaboration between cardiologists and dental professionals to minimize the incidence of IE through preventive oral health strategies. Future research should evaluate the effectiveness of specific oral hygiene interventions and antibiotic prophylaxis protocols in reducing IE incidence, using standardized methods and larger sample sizes.

**Author Contributions:** For research articles with several authors, a short paragraph specifying their individual contributions must be provided. The following statements should be used: "Conceptualization, F.A. and N.S.A.G.; methodology, F.A.; validation, N.S.A.G.; writing original draft preparation, F.A.; writing review and editing, F.A.; visualization, F.A.; supervision, N.S.A.G.; all authors have read and agreed to the published version of the manuscript."

**Funding:** This research received no external funding.

**Institutional Review Board Statement:** Not applicable.

**Informed Consent Statement:** Not applicable.

**Data Availability Statement:** Not applicable.

**Conflicts of Interest:** The authors declare no conflict of interest.

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