BULLETIN OF STOMATOLOGY AND MAXILLOFACIAL SURGERY
Volume 22, Issue 1

DOI:10.58240/1829006X-2025.22.1-26

REVIEW ARTICLE

THE ASSOCIATION BETWEEN ORAL HEALTH AND RECURRENT RESPIRATORY INFECTIONS IN CHILDREN: A SYSTEMATIC REVIEW

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Received: *Dec 18. 2025;* ***Accepted:*** *Jan 18, 2026;* ***Published:*** *Jan. 20, 2026*

Abstract

Background. The association between major dental diseases and recurrent upper and lower respiratory tract infections is of interest due to their high prevalence in the child population. The aim of our study is to analyze the literature where this problem has been studied.

Materials and methods. In accordance with the PRISMA 2020 protocol, a search was performed in four databases: PubMed (including Medline), Web of Science, eLibrary.Ru и Google Scholar. The search resulted in 526 publications from databases. After the identification and screening phases, eight articles were included in the qualitative analysis.

Results. Studies presented in publications show that children with frequent respiratory infections have a deterioration of oral hygiene, impairment of the properties of the mouth fluid, increased activity of caries of temporary and permanent teeth. The results published in three articles show that the presence of early childhood caries increased the frequency of episodes of respiratory infection in children. However, one study did not reveal a significant association between caries, dental plaque and the number of episodes of acute respiratory viral infections in children.

Conclusion. In the last 10 years, a small number of articles have been published on dental problems of children with recurrent respiratory infections. There is no information on the condition of periodontal tissue and mucosa of the mouth in this category of children. The association between tooth decay and children's susceptibility to respiratory infections remains unclear.

Keywords : dental health, recurrent respiratory tract infections, children, systematic review

1.INTRODUCTION

Developing oral health in children remains a pressing issue in modern dentistry and pediatrics. Dental health is an important component of a person's somatic health. According to the WHO, it is defined as "a state of physical, mental and social well-being." However, major oral diseases are the most common non-communicable diseases. They affect almost half of the world's population (45 % or 3.5 billion people) throughout their lives, from early childhood to old age[1].

Children's oral health is influenced by genetic, social and environmental risk factors[2]. Systemic diseases also play a negative role. Studies show that children with respiratory diseases are more likely to develop caries, tooth erosion, enamel defects, gingivitis and periodontitis [3].

There are a large number of publications that highlight dental problems in children with bronchial asthma [4,5] allergic rhinitis [6,7], obstructive sleep apnea syndrome[8], adenoid hypertrophy[9], cystic fibrosis[10].

The dentomaxillofacial complex and the respiratory system are anatomically and functionally integrated. Here, the biological principle of the relationship and interdependence of form and function is fully realized. This issue has attracted the attention of scientists and has been the subject of numerous publications. It has been proven that, on the one hand, skeletal abnormalities such as micrognathia of the upper jaw and retrognathia of the lower jaw lead to obstruction of the upper respiratory tract and impaired breathing

function. On the other hand, compensatory mouth breathing associated, for example, with an adeno-tonsillar hypertrophy, a deflection of the nasal septum, chronic rhinosinusitis is a cause of disruption of craniofacial development in children and the formation of dento-facial anomalies[11,12]. Children with mouth breathing have been found to have a higher frequency of anterior dental caries[13], halitosis[14], gingivitis, deterioration of oral fluid properties and oral hygiene[15,16]. However, in a number of studies this relationship has not been confirmed[17,18].

Mouth breathing has been shown to increase susceptibility to upper respiratory tract infection[19]. Recurrent respiratory infections are not only a medical problem but also have serious social and economic consequences, putting a considerable strain on a healthcare system[20]. The prevalence of recurrent upper respiratory tract infections in children under 5 years of age ranges from 5 to 10%[21]. Increased susceptibility to respiratory tract infections can be due to many reasons namely the relative immaturity of the child's immune system, adverse pre- and antenatal factors, smoking of parents, early kindergarten attendance, environmental pollution, low socio-economic status and allergic diseases[22]. Poor dental health can also contribute negatively.

It has been established that dysbiosis of the oral microbiome in children is associated with increased susceptibility to recurrent infections, and scientists emphasize the importance of maintaining a microbial balance for optimal respiratory health[23].

The oral cavity is the gateway for microbial agents to enter the human body and the protective mechanisms of the oral cavity are one of the first barriers encountered by respiratory pathogens [24]. For example, the saliva can promote the innate immune response in the early stages of infection. The saliva contains various antibacterial and antiviral components, including cathelicidin, lactoferrin, lysozyme, mucins, peroxidase, salivary agglutinin (gp340, DMBT1), sIgA, secretory leukocyte protease inhibitor (SLPI), α-defensins and β-defensins[25].

Dental plaque is a potential reservoir of respiratory pathogens, especially in the presence of periodontal diseases. Evidence was presented of the impact of poor oral health on the development of lower respiratory tract infections[26,27,28]. However, these studies were conducted mainly in a cohort of adults and the elderly.

The mutual influence of frequent respiratory infections and dental diseases in the child population remains uncertain. It is of interest to systematize knowledge about the dental status of children suffering from frequent respiratory infections.

Objective of the study

To conduct a systematic review of the literature that describes the state of oral hygiene, dental firmness and periodontal apparatus in children with recurrent respiratory infections and to answer the question: Are children with recurrent respiratory infections at higher risk of developing dental diseases?

In the formulation of the question, we used the system "Population, Intervention, Comparator, Outcome" (PICO).

Population: children up to 18 years

Intervention: recurrent respiratory infections

Comparator: people with single episodes of ARVI, healthy people

Outcome: increased risk of developing dental diseases

An additional question was asked: Does the level of oral health affect the frequency of respiratory tract infections in children?

MATERIAL AND METHODS

A systematic review of the research results was conducted according to the protocol PRISMA 2020 (PRISMA – The Preferred Reporting Items for Systematic reviews and Meta-Analyses)[29].

Eligibility criteria:

Data obtained from the literature searches were filtered according to the criteria described below.

Inclusion criteria:

- studies examining the relationship between dental health and recurrent respiratory infections;
- age of the population under 18 years;
- studies conducted in the format of "case-control", cohort and cross-sectional studies;
- human studies published in Russian, Ukrainian and English from 2015 to 2025.

Exclusion criteria:

- studies conducted on animals;
- review articles, opinion articles, news reports, articles, bibliographies, conference abstracts, letters;
- studies that included children with systemic chronic diseases, hereditary diseases, cleft lip and palate.

Information sources

The search for publications was carried out in the following electronic databases: PubMed (including Medline), Web of Science, eLibrary.Ru и Google Scholar.

A manual search was carried out in the bibliographies of the relevant articles to identify additional sources that may have not been included in the digital search.

Search strategy and Selection process

The following terms were used to search for information: "respiratory tract infections", "oral health", "oral hygiene", "plaque", "dental caries", "gingivitis", "dental enamel hypoplasia" combined with the logical operators OR (any of the keywords) and AND (all keywords combined).

In the PubMed/Medline database, the search was carried

out on the terms of the Medical Subject Headings (MeSH) dictionary.

The first stage (identification) included not only automatic system search according to the stated selection criteria, but also subsequent selection when studying the titles of studies.

A total of 526 publications initially met the combined database search criteria (Fig. 1). After identifying articles by their titles and articles, 374 publications that were not relevant to the objective of the review were removed from the search results. Three publications in PubMed and Web of Science duplicated each other and were also excluded. To reduce bas, two researches independently determined the eligibility of articles for inclusion. If their views differed, consensus was reached after a general discussion.

The identification phrase resulted in the selection of 152 studies on the subject of the review. In the screening phase, as a result of the independent work of two researches, a total of 144 studies were collectively excluded from the review. The main reasons for the exceptions were the inconsistency with the main topic of the study and the aged of the population studied. As a result, 8 publications met the eligibility criteria and were included in the qualitative systematic review. From each article we extracted information about the country, year, study design, sample size, age of surveyed and results obtained.

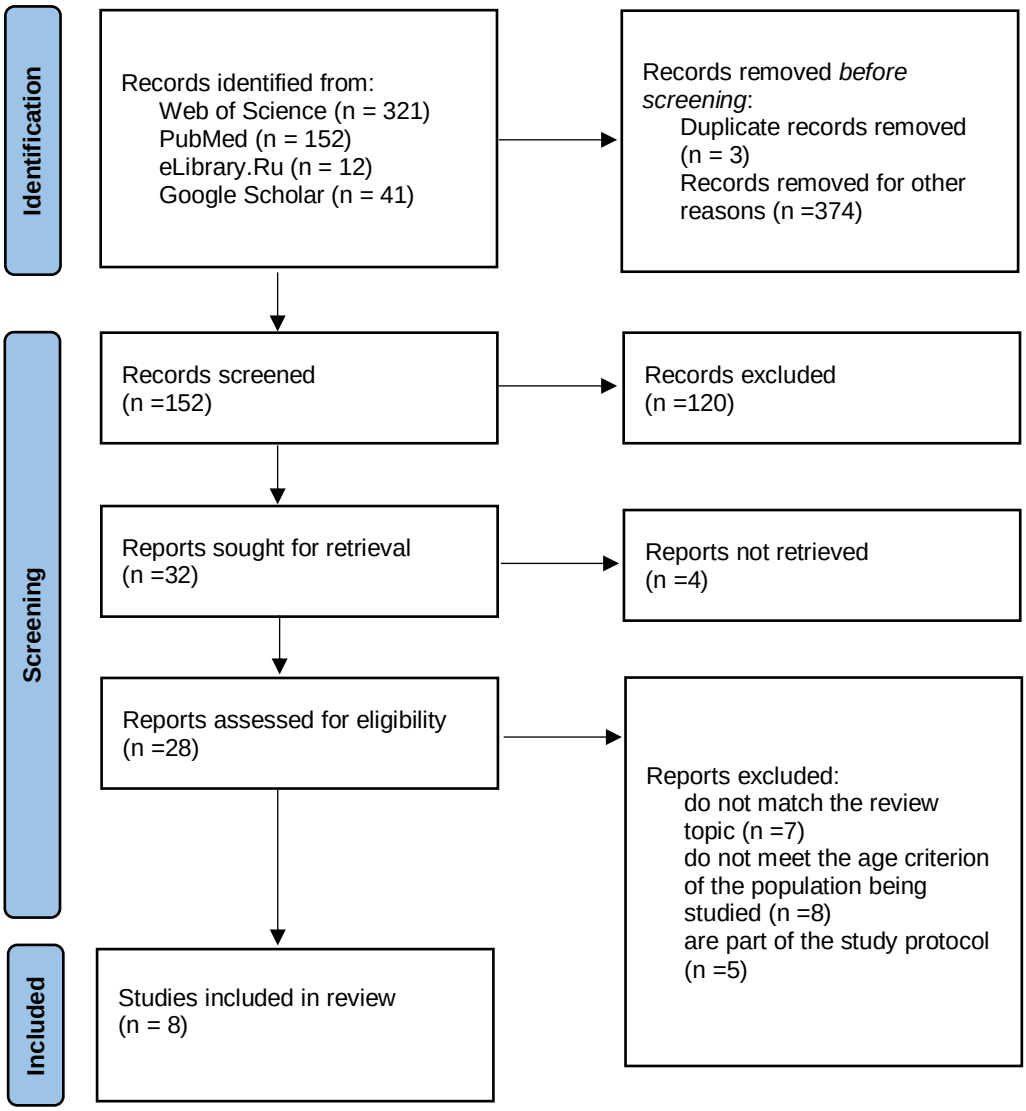

Figure 1. Systematic overview diagram. Used PRISMA 2020 layout [Page M.J. et al., 2021].

RESULTS

A brief description of the eight articles included in the review are presented in tables 1 and 2.

Table 1. Characteristics of the included studies

Authors	Country of study	Type of Study	Total sample	Study Population	Age group
Kaskova L.F., Pavlenkova O.S., 2015	Ukraine	Case-Control Study	200	Case: 111 children with recurrent respiratory infections Control: 89 healthy children	6-7 years
Kaskova L.F., Pavlenkova O.S., 2015	Ukraine	Case-Control Study	80	Case: 60 children with recurrent respiratory infections Control: 20 healthy children	6-7 years
Rantala A.K. et al., 2016	Finland	Prospective population-based cohort study	1623		0-7 years 27 years
Zhou Y. et al., 2018	China	Prospective cohort study	288		4 years
Samarina T.I., 2019	Belarus	Case-Control Study	464	Control: 168 healthy children Case: 49 children with recurrent respiratory infections Control: 247 children with minimal risk factors	3-4 years
Albelali A. et al, 2021	USA	Retrospective cohort study	497	Case: 117 children with early caries Control: 380 children without caries	1-3 years 4-6 years
Matsumoto N. et al., 2021	Japan	Longitudinal study	42812 38540 34124		2,5 years 5,5 years 10 years
Chowdhury N.et al., 2022	Cambodia	Longitudinal study	1703		1-4 years

Table 2. Summary of included studies and extracted data.

Authors	Assessment of dental status	Registration of episodes of respiratory infections	Result
Kaskova L.F.,	Clinical examination	Medical records and	In children with recurrent

Pavlenkova O.S., 2015	according to WHO methodology. Study of the properties of the oral fluid: salivation rate, pH of saliva, viscosity with Oswald's viscosimeter, mineralizing potential for microcrystallization by the Posdeeva method, 1994.	parental questionnaire	respiratory infections, a cariogenic situation in the oral cavity has been detected, which is due to reduce salivation rate, decreased mineralization potential, viscosity, pH of the oral fluid.
Kaskova L.F., Pavlenkova O.S., 2015	Clinical examination according to WHO methodology. Determination of the caries index – DMF+dmf, the Fedorov-Volodkina and Green-Vermillion hygiene indices.	Medical records and parental questionnaire	Children with recurrent respiratory infections were found to have high rates of dental caries and poor oral hygiene compared to healthy people.
Rantala A.K. et al., 2016	Questionnaire on the number of teeth with fillings	Data from the National Hospital Discharge Register from birth to age 7	Childhood respiratory infections increase the frequency of dental caries in permanent teeth in young adults
Zhou Y. et al., 2018	Clinical examination by trained dentist-epidemiologist	Questionnaire filled out by parents about episodes of acute respiratory infections within 12 months after basic dental examination.	The presence of caries in children has been linked to a decrease in the frequency of episodes of respiratory infections of the upper respiratory tract.
Samarina T.I., 2019	Clinical dental examination with registration of prevalence, intensity, activity of caries.	Medical records: "Child's record", the registration form № 112-u, adopted in the country.	The epidemiological rates of dental caries in children with recurrent respiratory infections are significantly higher than in comparison group.
Albelali A. et al, 2021	Data from electronic dental records on early caries activity (dft and dfs indices) at the age of 1-3 years.	Data from electronic medical records on the frequency and severity of ARVI in children aged 4-6 years.	High risk of relapse of recurrent respiratory infections of the upper respiratory tract in children with early caries.
Matsumoto N. et al., 2021	A basic and control questionnaire with information on caries, treated in clinics during the last year.	A basic and control questionnaire with information on visits of children to a pediatrician for the treatment of flu.	The presence of dental caries increases influenza morbidity in all age groups.
Chowdhury N.et al., 2022	Clinical examination by a team of dentists. Caries status assessed using the three-stage ECC classification index and the Pulpally involved Ulcerated Fistula Abscess index.	Personal interview (full questionnaire) and telephone interview (morbidity questionnaire) of parents	Increased risk of developing prolonged cough in children with high activity of early caries.

Analysis of the data tables shows that questions of the relationship of dental health with recurrent respiratory infections in children attracted the attention of researches from different countries of the world: United States of America, China, Japan, Finland, Cambodia, Ukraine. Age of the studied populations corresponded to Toddler, Early childhood and

Late childhood.

To assess the dental status of children, five studies used clinical examination, three of which used the WHO methodology, two used questionnaires and on used data from electronic dental records. Kaskova L.F. and Pavlenkova O.S[30] studied the properties of oral fluid in the study population: pH, viscosity, mineralizing potential and salivary flow rate. It should be noted that the authors assessed only the condition of hard tooth tissues by various caries indices, and in two studies, oral hygiene was also assessed using the Silness-Loe, Fedorov-Vodkina and Green-Vermillion indices. However, the condition of periodontal tissues and the oral mucosa was not recorded. Information on the incidence of acute respiratory infections was obtained from children's medical records in five studies, and only from questionnaires filled out by parents in three studies.

Four articles were devoted to studying the influence of frequent respiratory infections on the predisposition of temporary and permanent teeth to caries. All studies devoted to this issue showed deterioration of dental health by caries and oral hygiene. Thus, according to Kaskova L.F. and Pavlenkova O.S[30]. the intensity of caries in 6–7-year-old children often suffering from acute respiratory virus infection (ARVI) was 1.5 times higher than in children who suffer episodically. This category of children also had an unsatisfactory level of oral hygiene (the Fedorova-Volodkina index was 2,29±0,18 points, the Green-Vermillion index was 1,79±0,17 points). Subsequent studies by the authors allowed them to established the presence of a cariogenic situation in the oral cavity in children with recurrent respiratory infections. It was caused by a significant decrease in the rate of salivation to 0,48± 0,02 ml/min, the mineralizing potential of the oral fluid to 2,21±0,08 points, a decrease in pH to a slightly acidic value and a slight increase in viscosity. Samarina T.I[31]. found that the prevalence of early caries in children 3-4 years old was 2.2 times higher and the intensity of caries was 2.7 times higher than in healthy peers. These children had type III (the most severe according to Wyne A.H., 1999) of early childhood dental caries was 58.3 %, while in healthy children this type of caries was not defined. Rantala A.K. et al.[32] in 20-year prospective cohort study by Espoo found that early respiratory tract infections predicted a higher incidence of caries in permanent teeth in young adults. For example, the average number of teeth filled in young subjects who had lower respiratory tract infections before the age of 2 years (SD 4,8) was 1,4 times higher than those who did not have such infections (SD 3,4).

Four articles examined the relationship between early dental caries and the frequency of respiratory infections in children. The results published in three articles show a positive association between early dental caries and the frequency of respiratory infections of the upper respiratory tract. According to Albelali A. et al.,[33] the likelihood of developing acute respiratory viral infections in children with early childhood caries was 1.6 times higher than in children without caries, even taking into account other respiratory diseases risk factors. This allowed the authors to conclude that the presence of early childhood caries can be used as a predictor of the development of upper respiratory tract infections in preschool age. Chowdhury N. et al.[34] found that active early childhood caries increases by 23% the risk of developing a prolonged cough, which parents say lasts more than 14 days. Studies by Matsumoto N. et al.[35] showed that the presence of dental caries led to an increased incidence of influenza in all age group studied, with calculated risk factors -1.15 (95% CI: 1.05-1.25) for ages 1.5-2.5 years, 1.06 (95% CI: 1.01-1.11) for ages 4.5-5.5 years and 1.22 (95% CI: 1.17-1.28) for ages 9-10 years. These data are important for clinical practice. The prevention and treatment of caries, which the authors consider to be a modifiable risk factor, contributes to the prevention of respiratory diseases in children.

In one study, scientist got the opposite result. Zhou et al.[36] found that the degree of caries activity determined by the dmft index in children was inversely proportional to the number of episodes of respiratory infections of the upper respiratory tract in one year. The researches did not find a significant association between the dental plaque index and the number of ARVI episodes (IRR = 1.066; CI: 0.37-3.073; P = 0.906). The authors explain the observed feedback by the activation of innate and adaptive immune responses caused by dental caries. For example, s-IgA induced by dental caries can be a protective factor against ARVI. The authors also suggest that cariogenic microorganisms can change the pH of the saliva to the acidic side, which inhibits, proliferation or virus production. However, this study had limitations that could have influenced the results. Firstly, the observation period was one year, which was less than in other studies. Secondly, the diagnosis of ARVI was based on reports from parents, not doctors.

DISSCUSION

The literature review showed that in the last 10 years a small number of scientific papers have been published on dental problems of children with recurrent respiratory tract infection.

However, acute respiratory infections are widespread in childhood, reducing the quality of life not only of the child but also of the family, and have serious medical, social and economic consequences. Recurrent respiratory infections are diagnosed in 25 % of children under 1 year of age and in 6% of children during the first 6 years of life[37]. The predisposition of young children to acute respiratory infections is the result of physiological immaturity of systematic and local immunity, as well as suboptimal interactions between the microbiome and effectors of the immune system[38]. Clinical studies have shown that there is a strong correlation between reduced body resistance, immune dysfunction and recurrent respiratory infections in children[39]. In children who are frequently and chronically ill, who repeatedly suffer from respiratory tract diseases throughout the year, the immune system is suppressed due to the immaturity of the protective mechanisms of the mucous membranes of the mouth and respiratory tract[40].

Frequent viral infections can aggravate the composition of naso-pharyngeal microbiota and affect the severity of the disease and phenotype. In children with increased susceptibility to repeated respiratory infections, dysbiosis of the microbiome of the oral cavity and upper respiratory tract is evident [41,23]. In particular, in children with recurrent respiratory tract diseases at the age of 1-3 years, a significant increase in the adhesion index of C. albicans on one buccal epithelial cell was determined to 21.24 ± 1,21 ($p < 0,01$). In addition, a correlation was observed between the composition of the microbiota and the activity of the inflammatory process in the mucous membrane of the oral cavity and digestive tract, as well as with the severity of their damage[42].

These factors can adversely affect the state of organs and tissues of the oral cavity in children with recurrent respiratory pathology.

It was established that in children with frequent episodes of upper respiratory tract infections, a cariogenic situation is created in the oral cavity, which leads to an increase in the prevalence and intensity of caries of temporary and permanent teeth. However, there is no information about the condition of the periodontal tissues and the oral mucosa of this contingent. Research in this area would make enable to develop effective preventive and curative measures that contribute to improving the quality of oral and respiratory health in children. In this context, we would like to mention the publication by Tropina A.A. et al.,[43] which was not included in the review due to the inconsistency of our research. It has been proven that the cleaning of the oral cavity and the rational use of immunoprophylaxis improve dental health indicators (OHI-S, PMA, reduction of tooth decay) and some respiratory health indicators (infectious index, recurrence index) in children 12-15 years.

Most published scientific studies indicate that tooth decay is a modifiable risk factor for predisposition to respiratory infections in children. Only one publication describes feedback. The study of Mehtonen IT[38], not included in the review due to age of the study population (20-27 years), which showed that the risk of respiratory diseases of the lower respiratory tract increased proportionally increase in the number of filling teeth, reaching the highest value in patients with 10 or more filled teeth. All studies on the links between periodontal diseases and upper and lower respiratory tract infections have been carried out in a cohort of adults and elderly people. We have not found publications that highlight this relationship in children. This suggests that further study of this problem is required

CONCLUSION

In the last 10 years, a small number of articles have been published on dental problems of children with recurrent respiratory infections. There is no information on the condition of periodontal tissue and mucosa of the mouth in this category of children. The association between tooth decay and children's susceptibility to respiratory infections remains unclear.

Limitations. We limited the search not only Russian, Ukrainian and English language publications, not being sure of the accuracy of computer translation and, accordingly, our understanding of texts presented in other languages.

Author Contributions

All authors contributed substantially to the work presented and gave final approval of the version for publication. Conceptualization, KKA and RIG; methodology, KKA and RIG; software, DLI; validation, KKA and RIG; data curation, DLI, KAA, YVA; formal analysis, DLA, KAA, YVA; writing—original draft preparation, KKA; writing—review and editing, RIG; supervision KKA.

DECLARATIONS

Conflict of Interest

The authors declared no conflict of interest.

FundingThis research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors. All costs associated with this study were fully borne by the author.

Acknowledgements

The author would like to express sincere gratitude to the scholars and researchers whose work formed the foundation of this bibliometric analysis. Special appreciation is extended to academic colleagues and institutions for their intellectual support and constructive

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