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Analysis of Risk Factors Influencing the Formation of Dental Pathology in Childhood

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Annotation: Caries of permanent and milk teeth is generally recognized as a multifactorial disease. Currently, the literature mentions many independent risk factors in low- and middle-income countries, including individual (diet, feeding methods, low birth weight, hereditary enamel defects, family (maternal education, oral health knowledge, attitudes and practices, household income level, socio-cultural (area of residence and cultural values, environmental (access to fluoridated water and economic) factors. here are significant gaps in the literature regarding the main risk factors and the degree of their association with caries, as they vary in children in different settings.

Introduction. Dental pathology in childhood represents one of the most prevalent health conditions worldwide, affecting millions of children and imposing substantial burdens on healthcare systems, families, and society as a whole. According to the World Health Organization (WHO), dental caries affects 60-90% of school-aged children globally, making it the most common chronic disease of childhood, surpassing even asthma and allergies in prevalence. The Global Burden of Disease Study 2019 identified untreated dental caries in deciduous teeth as the 10th most prevalent condition worldwide, affecting approximately 532 million children. In permanent teeth, untreated caries ranks as the most common health condition globally, with an estimated 2.3 billion people affected.

The epidemiological landscape of childhood dental pathology varies significantly across different regions and populations, reflecting complex interactions between genetic, environmental, behavioral, and socioeconomic factors. High-income countries generally demonstrate lower prevalence rates of dental caries due to widespread fluoride exposure, better oral hygiene practices, and improved access to preventive dental care. However, concerning trends have emerged in some developed nations, with increasing prevalence of early childhood caries (ECC) in certain vulnerable populations. Conversely, many low- and middle-income countries continue to experience high rates of dental pathology, with limited access to preventive interventions and restorative care.

The spectrum of dental pathology in childhood encompasses a diverse range of conditions beyond dental caries. Early childhood caries, defined as the presence of one or more decayed, missing, or filled tooth surfaces in any primary tooth in children under six years of age, affects 23% of children aged 2-5 years in the United States and shows even higher prevalence rates in developing countries, reaching up to 70-80% in some populations. Periodontal diseases, including gingivitis and early-onset periodontitis, affect 50-90% of children and adolescents worldwide, with gingivitis being nearly universal among teenagers. Dental trauma affects approximately 25% of school-aged children, with the highest incidence occurring between 8-12 years of age. Orthodontic malocclusions are observed in 56-87% of children globally, with significant variations based on population genetics and environmental factors.

Developmental dental anomalies, including hypoplasia, hypocalcification, and structural defects, occur in 2-20% of children depending on the specific condition and population studied. These conditions can have lasting impacts on oral function, aesthetics, and psychosocial well-being. Oral manifestations of systemic diseases, nutritional deficiencies, and genetic syndromes further contribute to the complexity of pediatric dental pathology, requiring specialized diagnostic and management approaches.

The multifactorial nature of dental pathology formation in childhood involves complex interactions between biological, behavioral, environmental, and social determinants of health. Biological factors

include genetic predisposition, immune system function, saliva composition and flow rate, oral microbiome composition, and systemic health status. Host susceptibility factors such as tooth morphology, enamel quality, and individual variations in bacterial colonization patterns significantly influence disease development and progression. The oral microbiome plays a crucial role in dental pathology development, with specific bacterial species such as Streptococcus mutans and Lactobacillus species being primary cariogenic pathogens. Recent advances in microbiome research have revealed the complexity of microbial communities in the oral cavity and their dynamic interactions with host factors and environmental influences. The concept of dysbiosis, representing an imbalance in the oral microbial ecosystem, has emerged as a key mechanism underlying various oral diseases. Behavioral factors constitute perhaps the most modifiable risk factors for childhood dental pathology. Dietary habits, including frequency and timing of sugar consumption, consumption of acidic beverages, and overall nutritional patterns, significantly influence caries development. The WHO recommends limiting free sugar intake to less than 10% of total energy intake, with further benefits observed when intake is reduced to below 5%. However, many children worldwide exceed these recommendations, contributing to high caries rates.

Oral hygiene practices, including frequency and effectiveness of tooth brushing, flossing, and the use of fluoride-containing products, are fundamental protective factors against dental pathology. Studies consistently demonstrate that children who brush their teeth twice daily with fluoride toothpaste have significantly lower caries rates compared to those with irregular oral hygiene practices. However, oral hygiene behaviors are influenced by multiple factors, including parental knowledge and attitudes, socioeconomic status, cultural beliefs, and access to oral hygiene products. Fluoride exposure represents one of the most significant public health achievements in dental disease prevention. Community water fluoridation, fluoride toothpaste, and professional fluoride applications have contributed to dramatic reductions in childhood caries rates in many countries. However, optimal fluoride exposure requires careful balance, as excessive intake can lead to dental fluorosis, while insufficient exposure leaves children vulnerable to caries development. Socioeconomic factors profoundly influence childhood dental pathology, creating significant health disparities within and between populations. Children from lower socioeconomic backgrounds consistently demonstrate higher rates of dental caries, periodontal diseases, and untreated dental conditions. The social gradient in oral health reflects differential access to preventive care, healthy foods, oral hygiene products, and dental treatment services. Income inequality, parental education levels, and neighborhood characteristics all contribute to these disparities. Healthcare access and utilization patterns significantly impact the prevention, early detection, and management of childhood dental pathology. Many children worldwide lack access to regular dental care, with the WHO estimating that only 60% of the global population has access to appropriate oral healthcare services. Barriers to dental care include geographic accessibility, financial constraints, availability of pediatric dental specialists, cultural factors, and health system organization.

The consequences of untreated childhood dental pathology extend far beyond the oral cavity, affecting multiple aspects of child development and well-being. Pain and infection associated with dental caries can significantly impact eating, sleeping, and learning, leading to failure to thrive, school absenteeism, and reduced educational achievement. The psychosocial impacts include reduced self-esteem, social interaction difficulties, and impaired quality of life. Economic consequences affect both families and society through direct treatment costs, lost productivity, and long-term healthcare utilization.

Early childhood represents a critical period for establishing oral health habits and preventing dental pathology. The concept of the "critical window" emphasizes the importance of interventions during pregnancy and the first few years of life. Maternal oral health during pregnancy influences infant oral health outcomes through bacterial transmission and shared environmental factors. The establishment of the oral microbiome during infancy and early childhood has long-lasting implications for oral health throughout life.

Prenatal and perinatal factors significantly influence childhood dental pathology risk. Maternal nutrition, including adequate calcium, phosphorus, and vitamin D intake, affects tooth development

and mineralization. Prenatal exposure to medications, infections, and environmental toxins can result in developmental dental defects. Birth weight, gestational age, and early feeding practices influence oral development and caries risk.

Family factors, including parental oral health knowledge, attitudes, and behaviors, strongly predict childhood oral health outcomes. Parents serve as primary caregivers and role models for oral hygiene practices, dietary choices, and healthcare utilization patterns. Parental oral health literacy, defined as the capacity to obtain, process, and understand basic oral health information needed to make appropriate health decisions, significantly influences child oral health outcomes.

School environments present both opportunities and challenges for childhood oral health. School-based interventions, including oral health education programs, supervised tooth brushing initiatives, and fluoride applications, have demonstrated effectiveness in reducing dental pathology. However, school food policies, availability of sugary snacks and beverages, and limited access to oral hygiene facilities can contribute to increased caries risk.

Cultural and ethnic factors influence childhood dental pathology through traditional dietary practices, health beliefs, care-seeking behaviors, and genetic predispositions. Some cultural practices, such as prolonged bottle feeding, early introduction of sugary foods, and traditional remedies, may increase dental pathology risk. Understanding cultural contexts is essential for developing appropriate prevention and intervention strategies.

Environmental factors, including water fluoride levels, air pollution, climate change effects, and exposure to environmental toxins, influence childhood oral health. Geographic variations in dental pathology rates often reflect environmental factors such as natural fluoride levels in water and soil, dietary patterns based on local food availability, and regional healthcare policies.

The role of systemic diseases and medications in childhood dental pathology is increasingly recognized. Conditions such as diabetes, immunodeficiencies, genetic syndromes, and chronic illnesses can significantly increase oral disease risk. Medications commonly used in pediatric populations, including antibiotics, antihistamines, and psychotropic drugs, can affect saliva production, oral microbiome composition, and caries risk.

Technological advances are transforming approaches to childhood dental pathology prevention and management. Digital health interventions, including mobile health applications, telemedicine consultations, and artificial intelligence-based diagnostic tools, offer new opportunities for improving access to care and enhancing prevention efforts. Precision medicine approaches, incorporating genetic, microbiome, and environmental factors, hold promise for personalized risk assessment and targeted interventions.

The economic burden of childhood dental pathology is substantial, with direct treatment costs representing only a portion of the total societal impact. Indirect costs, including lost school and work days, reduced productivity, and long-term healthcare utilization, significantly exceed direct treatment expenses. Investing in prevention has consistently demonstrated cost-effectiveness, with community-based interventions showing favorable benefit-to-cost ratios.

Prevention strategies for childhood dental pathology must address multiple risk factors through comprehensive, population-based approaches. The WHO emphasizes the importance of integrating oral health into general health promotion activities and addressing social determinants of health. Successful prevention programs typically combine individual-level interventions with policy changes and environmental modifications.

Current evidence supports multi-level intervention strategies that address individual, family, community, and policy factors simultaneously. These approaches recognize that sustainable improvements in childhood oral health require changes in social, economic, and environmental conditions that influence health behaviors and outcomes.

The concept of proportionate universalism suggests that prevention efforts should be universal but with intensity proportionate to need, ensuring that interventions reach all children while providing additional support for those at highest risk. This approach helps address health inequities while maximizing population-level impact.

Emerging research priorities in childhood dental pathology include understanding gene-environment interactions, characterizing oral microbiome development and its relationship to disease, evaluating novel preventive interventions, and developing more effective approaches to reducing oral health disparities. Longitudinal studies following children from birth through adolescence are essential for understanding risk factor interactions and critical periods for intervention.

The integration of oral health into broader child health initiatives represents an important opportunity for improving outcomes while maximizing resource utilization. Collaborative approaches involving healthcare providers, educators, policymakers, and community organizations are essential for addressing the complex, multifaceted nature of childhood dental pathology.

The purpose of the study. In this regard, we have undertaken a study aimed at identifying the main risk factors that influence the development of dental caries in children of different ages. To do this, we analyzed the data of children - 0-3 ,4-7 years old.

Materials and methods.

We selected the following risk factors for the analysis (Table 1).

Risk factors for the formation of dental pathology in children under 3 years of age Table 1

	Risk factor	RR	95% CI	P
1	Low birth weight	**1.303**	1.234 - 1.376	<0,05
2	Mother's age (under 21 years old)	**0.983**	0.924 - 1.046	>0,05
3	Mother's education (not higher)	**1.298**	1.229 - 1.369	<0,05
4	Smoking during pregnancy	**0.832**	0.718 - 0.963	>0,05
5	Artificial feeding	**3.041**	2.764 - 3.345	<0,05
6	Poor oral hygiene of the child	**4.604**	4.021 - 5.271	<0,05
7	ENT diseases (presence of adenoids)	**1.914**	1.799 - 2.036	<0,05
8	Elevated baseline level of Streptococcus mutans in saliva	**1.661**	1.569 - 1.758	<0,05
9	The age of the beginning of brushing teeth is more than 1 year	**1.102**	1.027 - 1.182	<0,05
10	Anemia in a child	**1.914**	1.799 - 2.036	<0,05
11	Vitamin D deficiency in children	**3.013**	2.754 - 3.295	<0,05
12	Maternal transmission of covid	**6.700**	5.259 - 8.534	<0,05
13	Improper selection of hygiene products (brush and toothpaste)	**2.011**	1.860 - 2.175	<0,05
14	Preventive examination of the oral cavity at the dentist less than once every 6 months	**3.029**	2.701 - 3.395	<0,05
15	Use of fluoride-free toothpastes	**4.420**	3.918 - 4.986	<0,05
16	The mother's lack of knowledge of proper dental cleaning techniques	**2.117**	1.995 - 2.246	<0,05
17	Night feeding	**2.978**	2.732 - 3.247	<0,05
18	Consumption of sugar-containing products more than once a day	**3.229**	2.934 - 3.553	<0,05
19	Consumption of sugary carbonated drinks more than once a day	**2.257**	2.112 - 2.412	<0,05
20	Consumption of medicinal sweet syrups	**1.259**	1.187 - 1.336	<0,05
21	Gum diseases	**1.552**	1.477 - 1.630	<0,05

According to our data, the most significant factors influencing the formation of dental pathology in young children are the following: artificial feeding (increases the likelihood of caries formation by 3 times), vitamin D deficiency (increases the likelihood of caries formation by 3 times), visits to the dentist for preventive examination less than once every 6 months (increases the probability of caries formation by 3 times), consumption of sugar-containing foods more than once a day (increases the probability of caries formation by 3.2 times), the use of toothpastes without fluoride (increases the likelihood of caries formation by 4.4 times), poor oral hygiene (increases the likelihood of caries formation by 4.6 times). The most dangerous risk factor was the presence of COVID-19 in the mother's medical history (increases the likelihood of caries formation by 6.7 times).

It should be noted that such widely discussed risk factors in the literature as maternal smoking during pregnancy and maternal age did not significantly affect the risk of dental caries ($p>0.05$)

The next stage of the study was to study possible risk factors for caries in preschool children (4-7 years old). (Table 2.)

Table 2. Risk factors for the formation of dental pathology in children aged 4-7 years

	Risk factor	RR	95% CI	P
1	Poor oral hygiene of a child	**1.413**	1.323 - 1.508	<0,05
2	Consumption of sugar-containing products more than once a day	**2.029**	1.826 - 2.254	<0,05
3	Consumption of sugary carbonated drinks more than once a day	**3.028**	2.582 - 3.552	<0,05
4	Malocclusion	**1.087**	1.027 - 1.149	<0,05
5	Enamel hypoplasia	**1.192**	1.132 - 1.255	<0,05
6	Incorrect selection of hygiene products (brush and toothpaste)	**2.088**	1.888 - 2.308	<0,05
7	Preventive examination of the oral cavity at the dentist less than once every 4 months	**1.827**	1.694 - 1.970	<0,05
8	Elevated baseline level of Streptococcus mutans in saliva	**2.406**	2.159 - 2.681	<0,05
9	Frequent acute respiratory viral infections	**1.885**	1.701 - 2.090	<0,05
10	Elevated baseline level of Streptococcus mutans in saliva	**1.164**	1.103 - 1.228	<0,05
11	Vitamin D deficiency in children	**2.372**	2.142 - 2.626	<0,05
12	Use of fluoride-free toothpastes	**2.552**	2.285 - 2.851	<0,05
13	ENT diseases (presence of adenoids)	**1.087**	1.028 - 1.149	<0,05
14	Frequent snacking	**1.482**	1.412 - 1.557	<0,05
15	Increased saliva viscosity	**1.715**	1.607 - 1.829	<0,05
16	Brushing teeth less than 2 times a day	**2.148**	1.962 - 2.351	<0,05

Results and discussion.

Compared with young children, the influence of possible risk factors on the development of caries in this age group was less pronounced. According to Table 1, the most significant risk factors for caries in preschool children were the following: consumption of sugary carbonated drinks (increases the likelihood of caries formation by 3 times) and sugar-containing products more than once a day (increases the likelihood of caries formation by 2 times), use of toothpastes without fluoride (increases the likelihood of caries formation in 2.5 times), increased baseline level of Streptococcus mutans in saliva (increases the likelihood of caries formation by 2.4 times), vitamin D deficiency (increases the likelihood of caries formation by 2.4 times), brushing teeth less than 2 times a day (increases the likelihood of caries formation by 2.2 times) and improper selection of hygiene products (increases the likelihood of caries formation by 2.1 times).

Consultation. Thus, the analysis of possible risk factors for the formation of dental pathology in children of different age groups, according to data from only one dental clinic, revealed typical organizational problems that require strengthening preventive measures at the level of primary care institutions and children's educational institutions, as well as optimizing work with family members (primarily mothers) of children to reduce/neutralize the negative impact. identified risk factors.

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