Cross-Sectional Study

THE MULTIFACETED IMPACT OF EARLY CHILDHOOD CARIES: A STUDY ON PHYSICAL, PSYCHOLOGICAL, AND SOCIAL DEVELOPMENT

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ABSTRACT

Early childhood caries remains a global public health challenge with implications extending beyond oral health. This cross-sectional study aimed to assess the multifaceted impact of different dental statuses on the physical development, psychological well-being, and social adaptation of preschool and early school-aged children. A total of 300 children (aged 4-7) were divided into three groups: treated caries (n=120), caries-free controls (n=100), and active untreated caries (n=80). All participants underwent a comprehensive evaluation, including dental examination (dmft, OHI-S), anthropometric measurements, and psycho-pedagogical assessment using validated questionnaires (SDQ, COHIP). Results demonstrated a clear gradient of adverse outcomes. Children with active caries showed significantly higher dmft (7.8 ± 2.3) and OHI-S (3.2 ± 0.7) indices. This group had a fivefold higher prevalence of underweight (42.5% vs. 8.0% in controls), increased ARVI incidence (5.8 ± 1.7 episodes/year), and substantially impaired psycho-social metrics, including a total SDQ difficulties score of 18.4 ± 4.2 points and a low COHIP score of 41.6 ± 9.8 points. 48.8% of them performed poorly academically. Dmft and SDQ scores showed strong positive associations (r=0.68), while anthropometric and academic markers showed negative correlations. Children with treated dental caries showed persistent effects by occupying an intermediate position. The study concludes that untreated early childhood caries acts as a systemic stressor, detrimentally affecting a child's physical growth, immune competence, mental health, and social integration. The findings advocate for a paradigm shift, positioning pediatric dental care as a crucial, interdisciplinary intervention essential for safeguarding holistic child development and preventing long-term socio-educational disadvantages.

Key words: Early childhood caries, Pediatric dentistry, Psychosocial impact, Physical development, Quality of life, Academic performance.

Introduction

Dental caries, recognized by the World Health Organization as a major global public health challenge, remains the most common chronic disease of childhood worldwide [1]. Its prevalence has reached pandemic proportions, showing significant variation across different countries and regions due to a complex interplay of socioeconomic, hygiene, and dietary factors **(Table 1)** [2, 3]. Despite declared progress in preventive dentistry, the global epidemiological situation continues to be a cause for concern, particularly in high-risk groups, necessitating continuous monitoring and analysis.

Table 1. Prevalence of Early Childhood Caries in Preschool Children Across Various Countries (based on the latest available reports)

Country	Age Group	Prevalence (%)	Notes
Russian Federation	3 years	73%	Data from the Russian Ministry of Health
Russian Federation	6 years	85%	High intensity (dmft index >5)
United States	2-5 years	28%	CDC, National Health and Nutrition Examination Survey
Eastern European Countries (e.g., Poland, Romania)	3-6 years	70-83%	Significant disparities between urban and rural areas
Scandinavian Countries (Sweden, Norway)	3-6 years	40-50%	Result of decades-long targeted preventive programs
China	5 years	66%	Notable variation between provinces

The issue of childhood caries has long outgrown the confines of dentistry. Modern medical science is increasingly focusing on its role as a multisystemic pathological process that triggers a cascade of negative

consequences for the entire growing organism [4-6]. While the traditional focus on local complications like pulpitis, periodontitis, and dental abscesses remains clinically relevant, it fails to capture the full pathophysiological picture [7, 8]. The forefront is now occupied by the distant and systemic effects that profoundly impact a child's physical, intellectual, and psychosocial development, creating a vicious cycle that is nearly impossible to break without an interdisciplinary approach [9-11].

The pathogenic chain begins with the disruption of a fundamental physiological function: chewing [12, 13]. A youngster will naturally steer clear of hard, fibrous meals that need to be thoroughly chewed due to pain, hypersensitivity, and the mechanical deterioration of teeth [14]. Soft, cariogenic foods abundant in easily fermentable carbs take over the diet [15]. This not only worsens the caries itself but also creates a state of chronic nutritional deficiency [16, 17]. An organism in a phase of active growth and development is deprived of essential vitamins, trace elements (particularly calcium, phosphorus, and iron), and proteins, inevitably affecting metabolic processes and growth [18, 19]. The consequence is a negative trend in anthropometric indicators [20, 21]. Numerous studies convincingly demonstrate that children with multiple untreated carious lesions are statistically significantly more likely to have below-average height and weight, falling into lower percentile ranges, compared to their peers with healthy oral cavities [22-24].

Alongside somatic ailments, another equally significant pathological pathway develops. A chronic odontogenic source of infection provides constant antigenic stimulation, leading to the strain and subsequent depletion of the immune system's reserves [25-27]. This manifests as increased susceptibility to respiratory and other infectious diseases, and a higher frequency of lymphadenitis and allergic reactions [28-30]. Thus, the body's resources, which should be directed toward growth and development, are diverted to fighting a persistent infection, further exacerbating physical developmental delays [31].

The most complex and socially significant consequence is the impact of dental status on a child's neuropsychological sphere and social adaptation **(Figure 1)**. Persistent or frequently recurring toothache acts as a powerful chronic stressor [32, 33]. It provokes sleep disturbances, increases general anxiety, contributes to emotional lability, and impairs cognitive functions, particularly concentration and memory [34]. In school-age children, this directly translates into reduced academic performance. A child experiencing discomfort cannot focus on learning material, while school absences related to dental visits or pain create gaps in knowledge.

The aesthetic aspect of the problem must not be underestimated. Decayed front teeth create a persistent cosmetic defect that becomes a source of psychological complexes [35, 36]. The fear of ridicule and negative peer evaluation causes the child to consciously limit social contacts. They smile less, avoid verbal communication and group play, leading to isolation, difficulties in forming communication skills, and, as a result, impaired social adaptation [37]. In the long term, this can contribute to the development of anxiety and depressive disorders, laying the groundwork for psychological issues in adulthood [38].

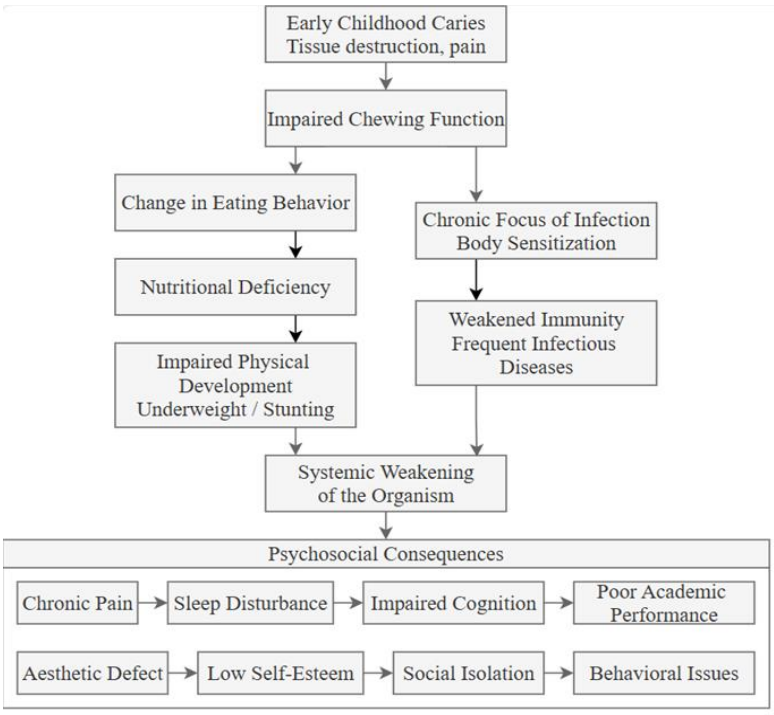

Figure 1. Cause-and-effect relationships between early childhood caries and its systemic consequences.

Despite the obvious and logical nature of these pathogenic pathways, there is a notable lack of comprehensive studies in the contemporary scientific literature that objectively assess the difference in the quality of life and development among children with different dental statuses using valid psychological and pedagogical methodologies. Existing research typically limits itself to reporting dental and anthropometric parameters, overlooking the socio-psychological component, which is key to understanding the full impact of the disease on a child's life. A comparative analysis not only between caries-free children and those with caries, but also *within* the caries group – between those who received timely and comprehensive treatment and those with active, untreated pathology – is of particular scientific and practical interest. This approach will allow for a quantitative assessment of the real-world effect of dental care, extending far beyond the oral cavity, and determine to what extent medical intervention can mitigate not only somatic but also psychosocial risks.

This interdisciplinary study aims to comprehensively assess the influence of different dental statuses (healthy, treated caries, active untreated caries) on the physical development, academic performance, behavioral characteristics, and psycho-emotional state of preschool and early school-age children. The findings are intended not only to verify existing hypotheses about the systemic impact of dental pathology but also to provide a scientific basis for developing specific collaboration algorithms between pediatricians, dentists, psychologists, and educators [39-47].

Materials and Methods

This prospective cross-sectional comparative study was conducted at the clinical facilities of the Department of Dentistry at Saratov State Medical University between September 2023 and May 2025. The study enrolled 300 children aged 4 to 7 years, divided into three groups according to their dental status. Group 1 (treated) included 120 children with a confirmed diagnosis of early childhood caries who had undergone comprehensive oral rehabilitation no more than three months before study enrollment. Group 2 (control) consisted of 100 children with either intact dentition or a compensated form of caries, presenting no more than two fillings. Group 3 (active caries) comprised 80 children with multiple untreated carious lesions and a DMFT index exceeding 5. Exclusion criteria for all groups included severe somatic pathologies, congenital syndromes, neurological disorders, or established psychiatric conditions that could independently affect physical development, cognitive functions, or child behavior.

The study was conducted in accordance with the ethical principles of the Declaration of Helsinki and approved by the Local Ethics Committee of Saratov State Medical University (protocol No. 512-03-2023, dated March 12, 2023). Written informed consent was obtained from all parents or legal guardians of each participating child, covering both study participation and personal data processing.

Dental examinations were performed under standard conditions using conventional dental instruments and visual inspection. The DMFT index was calculated to assess caries intensity in primary dentition, while the DMFT index was used for permanent teeth. Oral hygiene status was evaluated using the simplified Oral Hygiene Index (OHI-S) by Green and Vermillion, which quantifies soft dental plaque accumulation on six key teeth. All dental assessments were conducted by the same certified dentist to ensure consistency and minimize inter-examiner variability.

Anthropometric measures and a thorough medical history were part of the paediatric assessment. Height and weight were measured using standardized equipment, with subsequent calculation of Body Mass Index (BMI). The obtained measurements were plotted on age- and gender-specific percentile charts. Children falling below the 25th percentile were categorized as at risk for growth or weight deficits. Additional data were collected regarding the frequency of medical consultations for acute respiratory infections and gastrointestinal disorders during the preceding year, based on parental reports and medical records.

Psycho-educational assessment utilized validated questionnaires completed by parents or legal guardians. The Strengths and Difficulties Questionnaire (SDQ) was employed to screen for emotional and behavioral issues. This instrument evaluates five domains: emotional symptoms, conduct problems, hyperactivity/inattention, peer relationships, and prosocial behavior. The total difficulty score, derived from the first four subscales, helps identify children at risk for psychological disorders. The Russian version of the Child Oral Health Impact Profile (COHIP) questionnaire was used to assess oral health-related quality of life, examining how dental health affects physical and psychosocial well-being, including pain experience, self-esteem, and social interactions. Academic performance of school-aged children was evaluated through current grades in core subjects, while preschool children's progress was assessed through parental reports regarding their adaptation to educational programs, attention span, and learning engagement.

Statistical analysis was performed using SPSS Statistics version 26.0. Quantitative data were presented as means with standard deviations, while qualitative data were expressed as absolute frequencies and percentages. Intergroup comparisons of quantitative parameters were conducted using one-way ANOVA with post-hoc Tukey testing for multiple comparisons. Qualitative characteristics were compared using the chi-square test. Correlation analysis between dental indices and psycho-educational parameters utilized Spearman's rank correlation coefficient. The significance level was set at $p < 0.05$ for all statistical

tests [48-55].

Results and Discussion

The study yielded data characterizing the three observation groups across dental, somatometric, and psycho-pedagogical parameters. The distribution of children by group according to dental status was 120 children in the treated caries group, 100 children in the control group, and 80 children in the active untreated caries group. The average age of participants was 5.8 ± 1.2 years with no statistically significant differences between groups, ensuring the representativeness of the comparative analysis [56, 57].

Analysis of dental status revealed the expected statistically significant differences between groups **(Table 2)**. The highest values for the dmft index (7.8 ± 2.3) and the OHI-S hygiene index (3.2 ± 0.7 points) were recorded in the active caries group. In the control group, the indicators corresponded to physiological norms: the dmft index was 0.4 ± 0.3, and the hygiene index was 0.9 ± 0.3 points. Bleeding gums were noted in 62.5% of children with active caries, while in the control group, this indicator did not exceed 5%.

Table 2. Dental Status of Children in the Study Groups

Parameter	Group 1 (Treated Caries)	Group 2 (Control)	Group 3 (Active Caries)	p-value
dmft index, units	3.2 ± 1.1	0.4 ± 0.3	7.8 ± 2.3	<0.001
OHI-S Hygiene Index, points	1.8 ± 0.5	0.9 ± 0.3	3.2 ± 0.7	<0.001
Proportion of children with bleeding gums, %	18.3	5.0	62.5	<0.001

Assessment of physical development showed **(Table 3)** that children with underweight (42.5% vs. 8.0% in controls) and growth retardation (average height 105.7 ± 7.1 cm vs. 112.5 ± 5.8 cm in controls) were significantly more common in the active caries group. The incidence of ARVI was also statistically significantly higher in the untreated caries group - 5.8 ± 1.7 episodes per year compared to 3.1 ± 1.0 in the control group.

Table 3. Anthropometric Indicators and Morbidity

Parameter	Group 1 (Treated Caries)	Group 2 (Control)	Group 3 (Active Caries)	p-value
Proportion of children with underweight (<25th percentile), %	25.8	8.0	42.5	<0.001
Average height, cm	108.3 ± 6.2	112.5 ± 5.8	105.7 ± 7.1	<0.01
Average number of ARVI per year, episodes	4.2 ± 1.3	3.1 ± 1.0	5.8 ± 1.7	<0.001

Psychological testing results revealed a clear gradation of indicators across groups **(Table 4)**. The best values on all SDQ scales were noted in the control group (total difficulties score 7.9 ± 2.4 points), intermediate values in the treated caries group (12.3 ± 3.1 points), and the worst values in the active caries group (18.4 ± 4.2 points). Children with untreated caries demonstrated statistically significantly higher levels of emotional problems (4.9 ± 1.5 points), behavioral difficulties (4.2 ± 1.3 points), and social adaptation disorders (4.5 ± 1.2 points).

Table 4. Indicators of Psychological Well-being According to the SDQ Questionnaire

SDQ Scale	Group 1 (Treated Caries)	Group 2 (Control)	Group 3 (Active Caries)	p-value
Emotional symptoms, points	3.1 ± 1.2	1.8 ± 0.9	4.9 ± 1.5	<0.001
Conduct problems, points	2.8 ± 1.1	1.9 ± 0.8	4.2 ± 1.3	<0.001
Hyperactivity, points	3.5 ± 1.3	2.7 ± 1.0	4.8 ± 1.4	<0.001
Peer problems, points	2.9 ± 1.0	1.5 ± 0.7	4.5 ± 1.2	<0.001
Total difficulties score, points	12.3 ± 3.1	7.9 ± 2.4	18.4 ± 4.2	<0.001

Assessment of oral health-related quality of life showed statistically significant differences between groups **(Table 5)**. The highest COHIP scores were recorded in the control group (72.5 ± 6.2 points), indicating minimal impact of dental status on quality of life. In the active caries group, significant limitations in physical and psychosocial functioning were noted (41.6 ± 9.8 points). Academic markers and dental state were found to be directly correlated: 48.8% of children with active caries had unsatisfactory performance, compared to 9.0% in the

control group.

Table 5. Quality of Life and Academic Performance

Parameter	Group 1 (Treated Caries)	Group 2 (Control)	Group 3 (Active Caries)	p-value
Total COHIP score, points	58.3 ± 8.7	72.5 ± 6.2	41.6 ± 9.8	<0.001
Proportion of children with low academic performance, %	22.5	9.0	48.8	<0.001
Average grade in core subjects, points	3.8 ± 0.7	4.3 ± 0.5	3.2 ± 0.9	<0.001

Correlation analysis revealed statistically significant relationships between the DMFT index and physical development indicators ($r = -0.42$; $p < 0.01$), total SDQ difficulties score ($r = 0.68$; $p < 0.001$), and academic performance indicators ($r = -0.51$; $p < 0.01$). The obtained data indicate the presence of stable interrelationships between oral health status and various aspects of child health and development.

The findings of this study provide comprehensive evidence that early childhood caries is not merely a localized dental issue, but a multisystemic condition with profound implications for a child's physical, psycho-emotional, and social development. The data convincingly demonstrate a gradient of adverse outcomes depending on clinical dental status: the most severe impairments were observed in children with active, untreated caries, intermediate ones in the treated caries group, and the mildest in the control group [58-63].

The strong correlation we identified between caries intensity and anthropometric indicators aligns with the consensus in contemporary scientific literature. Other researchers have similarly noted that chronic pain and impaired chewing function in children with multiple carious lesions lead to the development of avoidant eating behaviors [64-66]. The diet of such children shifts towards soft, high-carbohydrate foods, which not only exacerbates the caries process but also provokes nutritional deficiency [67-69]. This is corroborated by our data: nearly half of the children with active caries were underweight, and their average height was significantly lower than that of the control group. These results support the hypothesis that an unsanitized oral cavity is a risk factor for impaired physical development during this critical growth period.

The significant increase in the frequency of ARVI episodes among children in the active caries group (an average of 5.8 episodes per year) can be explained from the perspective of immunological load. A persistent odontogenic source of infection, such as rampant caries, serves as a constant source of antigenic stimulation and microbial sensitization of the body [70, 71]. This leads to functional strain on the immune system and a reduction in its reserves for adequately responding to respiratory pathogens [72]. A similar mechanism is described in studies exploring the link between chronic focal infection and overall body resistance, which emphasizes the role of oral rehabilitation in reducing general morbidity [73, 74].

The most dramatic and socially significant differences between groups were found in the realm of psychological well-being and social adaptation. The clearly traceable dependence between the DMFT index and the total difficulties score on the SDQ scale ($r = 0.68$) indicates a direct link between the severity of dental disease and the level of emotional and behavioral problems. Children with active caries demonstrated significantly higher scores on all SDQ subscales, particularly in emotional symptoms and peer relationship problems. These data are reflected in research exploring the psychosocial consequences of chronic childhood pain and the stigma associated with visible defects [75, 76]. Persistent pain creates chronic stress, a known risk factor for the development of anxiety and affective disorders [77]. Simultaneously, embarrassment due to the appearance of decayed teeth, confirmed by low COHIP scores in this group, directly leads to social isolation and difficulties in building relationships with peers [78].

An important aspect of our results is the intermediate position of the treated caries group on most psycho-pedagogical parameters. This indicates that even after eliminating the anatomical defect and the source of pain, the negative psychological experience associated with the disease can have a prolonged effect [79]. Previous negative experiences, missed classes, established patterns of avoidant behavior, and low self-esteem do not disappear immediately after dental treatment. This fact underscores the need not only for timely oral rehabilitation but also for the introduction of psychological and pedagogical support for such children to help them fully regain social confidence and academic engagement.

The identified link between dental status and academic performance has a multifactorial nature. A direct influence is exerted by cognitive impairments due to chronic pain and sleep disturbances. Indirect influence is associated with school absences due to dental visits or illness, as well as the child's reduced motivation and self-esteem. Our data, showing that nearly half of the children with active caries had low academic performance, is an alarming signal for the education and healthcare systems. They confirm the conclusions of research viewing oral health as one of the social determinants of educational outcomes.

Thus, this study clearly demonstrates that the boundary between dentistry and pediatrics is artificial in the context of child health. Caries acts as a starting point for a cascade of interconnected problems affecting all aspects of a child's life. The clinical significance of this work lies in its justification for transitioning from a reactive model of caries treatment to a preventive and comprehensive one. Pediatricians should consider oral examination a mandatory component of assessing children with underweight, frequent illnesses, reduced academic performance, or behavioral problems. Dental treatment should be positioned not as a cosmetic or highly specialized procedure, but as a crucial intervention for safeguarding a child's overall health and well-being, requiring an interdisciplinary approach involving psychologists and educators.

Conclusion

This study provides compelling evidence for the systemic nature of early childhood caries. A direct correlation has been established between the severity of dental pathology and comprehensive impairments in child development. The most vulnerable group was children with active, untreated caries, whose DMFT index reached 7.8. In this category of patients, underweight was registered in 42.5% of cases, a figure five times higher than the control group, while the frequency of respiratory infections was 5.8 episodes per year.

There are even more severe psychosocial repercussions. Children with progressing caries had significantly lower oral health-related quality of life (41.6 points on the COHIP) and more than twice as many behavioural and emotional problems (18.4 points on the SDQ). Nearly half of such children (48.8%) demonstrated persistent academic underachievement, forming a group at educational risk. The intermediate indicators of the treated caries group confirm the prolonged nature of the consequences that persist even after the primary pathology is eliminated.

The clinical significance of this work lies in the necessity for a fundamental revision of the role of dental health in pediatric practice. Dental status must be recognized as a significant marker of a child's overall well-being. The obtained data dictate the mandatory integration of dental screening into the management algorithms for children with delays in physical development, school maladjustment, and behavioral problems. Caries treatment needs to be positioned as a comprehensive medical-social intervention, requiring an interdisciplinary approach involving pediatricians, dentists, psychologists, and educators to prevent long-term consequences affecting all spheres of a child's life.

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