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DENTAL MORBIDITY IN CHILDREN AND ITS ASSOCIATION WITH BONE TISSUE METABOLISM MARKERS AND MINERAL METABOLISM LEVELS

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The work was devoted to the clinical assessment of the state of hard tissues of teeth and periodontium in children who first visited a dentist and the establishment of a relationship with the level of markers of bone metabolism and mineral metabolism. Clinical trials were conducted with 109 children aged 2–5 years and 60 12–15-year-old adolescents who had not been previously sanitized. We studied the prevalence and intensity of caries in temporary and permanent teeth and an indicator of periodontal status. Laboratory tests involved determination of serum levels of total vitamin D (25-OH) (D2+D3), calcium, magnesium, and phosphorus. The results of the study indicate that there is a direct correlation between the indicators of children's dental health, vitamin D metabolism and calcium-phosphorus metabolism. Establishing of the correlation between the level of essential micro- and macronutrients, as well as vitamin D in the organism of a child, in particular magnesium, and the prevalence of dental pathology in children allows to determine the directions of treatment and prevention measures aimed at improving the level of dental health.
Key words: children, teeth, caries, periodontal disease, bone metabolism, mineral metabolism.

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СТОМАТОЛОГІЧНА ЗАХВОРЮВАНІСТЬ У ДІТЕЙ ТА ВЗАЄМОЗВ'ЯЗОК З РІВНЕМ МАРКЕРІВ МЕТАБОЛІЗМУ КІСТКОВОЇ ТКАНИНИ ТА МІНЕРАЛЬНОГО ОБМІНУ

Робота була присвячена клінічній оцінці стану твердих тканин зубів і пародонту у дітей, що вперше звернулися до стоматолога та встановлення взаємозв'язку з рівнем маркерів кісткового метаболізму та мінерального обміну. Клінічні дослідження проведені за участю 109 дітей 2–5 років та 60 12–15 річних підлітків, які раніше не були санованні. Вивчали показники розповсюдженості та інтенсивності карієсу тимчасових та постійних зубів та показник стану пародонту. Лабораторні дослідження включали визначення в сироватці крові вмісту загального вітаміну D (25-OH) (D2+D3) та кальцію, магнію, фосфору. Отримані результати дослідження вказують на те, що існує безпосередній взаємозв'язок між показниками стоматологічного здоров'я дітей, метаболізмом вітаміну D та кальцій-фосфорним обміном. Встановлення залежності рівня есенціальних мікро- та макроелементів, а також вітаміну D в організмі дитини, зокрема магнію від поширеності стоматологічної патології у дітей дозволяє визначити напрямки проведення лікувально-профілактичних заходів, спрямованих на покращення рівня стоматологічного здоров'я.
Ключові слова*:* діти, зуби, карієс, пародонт, кістковий метаболізм, мінеральний обмін.

The work is a fragment of the research project "Development and introduction into clinical practice of methods of diagnosis, prevention and treatment of osteogenesis disorders during dental intervention in patients in wartime", state registration No. 0123U103247.

High dental morbidity among children in Ukraine has been a significant medical issue for many years, with rising incidences of caries, periodontal disease, and tooth development disorders across different age groups [1]. According to the WHO Global Oral Health Report, nearly 3.5 billion people worldwide suffer from oral diseases, with 2 billion experiencing caries in permanent teeth and 514 million children affected by caries in temporary teeth [12].

Dental caries, one of the most prevalent human diseases, causes substantial social and economic harm. It is extensively studied globally, with research focusing on its epidemiology, etiology, pathogenesis,

treatment, and prevention. A child's overall health and systemic diseases impact the development of caries and gingivitis by altering mineral metabolism and disrupting defense mechanisms [6]. Early childhood dental caries is recognized as an epidemic in most countries, leading to pain, impaired chewing and speech functions, social maladjustment, and reduced quality of life [7]. Effective measures to combat this disease, from prevention to rehabilitation, must be rooted in a comprehensive understanding of its pathogenesis, interrelationships, manifestations, and prevalence at both individual and population levels [11].

Vitamin D has garnered special attention for two main reasons. First, there is a high prevalence of vitamin D deficiency, affecting up to 50% of the global population [15]. Second, new evidence highlights vitamin D's role in various physiological processes throughout life. Active metabolites of vitamin D are crucial for calcium absorption, bone mineralization, and the metabolism of phosphate and magnesium [5]. Vitamin D's regulation of phosphorus-calcium metabolism, along with its anti-inflammatory and immunomodulatory effects, significantly influences oral health [9].

A critical factor in the pathogenesis of bone diseases, such as osteoporosis, is insufficient calcium intake or inadequate intestinal absorption, leading to a negative calcium balance [8]. Vitamin D is essential for calcium utilization, and its deficiency disrupts calcium absorption, resulting in calcium insufficiency despite adequate mineral intake [10]. Magnesium, which constitutes about 70% of all magnesium in bone tissue, is vital for numerous metabolic processes, including the functioning of the cardiovascular, nervous, hematopoietic, musculoskeletal, and digestive systems. It is necessary for calcium and vitamin C metabolism, sodium and potassium regulation, protein synthesis, and protecting capillary vessels in muscles. Magnesium's role as a cofactor in calcium metabolism is critical for enamel formation, and its deficiency increases the risk of carious lesions, although direct evidence linking these factors is limited [2].

The study of dental disease epidemiology and risk factors among children is fundamental for planning and organizing dental care, identifying prevention and treatment needs, and assessing the quality of these measures.

The purpose of the study was to clinically evaluate the condition of hard tissues of teeth and periodontium in children who had not been previously sanitized and to establish the relationship with the level of markers of bone metabolism and mineral metabolism.

Materials and methods. To study the intensity of caries in children, dental examinations were conducted in 109 children aged 2–5 years and 60 children aged 12–15 years, who were born and permanently reside in the southern region of Ukraine (Odesa, Mykolaiv and Kherson regions). Children with multiple dental lesions and those not previously sanitized were selected. Children aged 2–5 years were sanitized under general anesthesia for medical reasons and taking into account age and behavioral characteristics. The children visited the dentist for the first time or their parents had previously refused dental treatment due to the absence of complaints from the child. Thus, the prevalence of caries was 100 %.

Dental examination according to the method recommended by WHO [1] was performed in the dental office of the Department of Pediatric Dentistry and Orthodontics of SE “The Institute of stomatology and maxilla-facial surgery National academy of medical sciences of Ukraine” (SE “ISMFS NAMS”, Odesa) all year round, regardless of the season, using a dental mirror, probe, tweezers, and a button probe to assess the periodontal condition. All children were sanitized after the examination. Dental examination and subsequent oral cavity sanitation of children aged 2–5 years were performed exclusively under general anesthesia.

We studied the prevalence and intensity of caries in permanent teeth using the DFMS and DFMT indices, and temporary teeth using the dft index. WHO criteria were used to assess the prevalence and intensity of caries [13].

The periodontal condition in children aged 12–15 years was assessed based on the determination of the papillary-marginal-alveolar index (PMA, %) in the modification of Parma (1960). [3]. The data obtained were entered into the map of examination of the state of the oral cavity of the child, developed at the State Institution SE “ISMFS NAMS”.

All children were relatively healthy somatically (according to parents and pediatricians, which was confirmed by the relevant health certificates of 2–5-year-olds who underwent appropriate examinations before dental treatment under general anesthesia). Additional examinations, especially for children aged 12–15 years, included serum tests for total vitamin D (25-OH)(D2+D3) (bone metabolism) and calcium, magnesium, phosphorus (mineral metabolism).

In the statistical processing of the collected data, the computer program STATISTICA 6.1 was used to assess their reliability and measurement errors [4].

Results of the study and their discussion. Of the 109 children aged 2–5 years, 27.5 % were 5 years old, 31.2 % were 4 years old, 26.6 % were 3 years old, and 14.7 % were 2 years old.

Table 1 shows the data on the state of hard tissues of temporary teeth in children aged 2–5 years. The intensity of caries in temporary teeth in children of the study group did not change significantly with age. In the structure of the dft index, the dominance of the proportion of "d" (61.13 %), i.e. untreated carious lesions, can be traced, but high rates of complicated caries in all age groups (34.42 %) were found, which is mainly represented by chronic forms of pulpitis (61.7 %) and periodontitis (38.3 %).

Table 1

Condition of hard tissues of temporary teeth in children 2–5 years old

Age and number of children examined (n)	Intensity	d	f	Complications of caries in the "dft" structure	The share of pulpitis and periodontitis in the structure of complicated caries	
	DFT	abs.	abs.	abs.	pulpitis, %	periodontitis, %
2 years (n=16)	11.06±0.62	8.18±0.84	0	2.87±0.78	14.12	11.86
3 years (n=29)	10.3±0.59	7.10±0.59	0	3.21±0.38	21.74	8.69
4 years (n=34)	11.38±0.48	6.82±0.59	0	4.65±0.53	27.4	13.44
5 years (n=30)	10.8±0.67	7.1±0.78	0	3.83±0.44	17.9	17.9
Total (n=109)	10.86±0.34	7.17±0.34	0	3.76±0.26	61.7	38.3

After complete oral cavity sanitation of children of all age groups of 2–5 years, the proportion of extracted teeth amounted to 6.55 %, including 50 % in children aged 2–4 years, which leads to disruption of the normal functioning of the dentoalveolar apparatus and the formation of the bite.

The findings indicate a lack of sanitary and educational work, the absence of a system of preventive examinations that would allow for early diagnosis and treatment of the initial stages of the disease; low parental awareness, as well as an insufficient level of dental care for children or its ineffectiveness, which leads to a sharp increase in morbidity with age and has significant consequences for the formation of a child's dental health.

The analysis of the location of carious cavities in the jaws and groups of teeth showed that in children aged 2–3 years, lesions are mainly localized on the anterior upper teeth. The second most common lesions are the first temporary molars of the lower jaw, followed by the upper ones.

In the current realities (COVID pandemic, war), children are in a state of social disorientation, chronic stress, the usual regimen of nutrition, rest, school attendance, preschools, sports clubs, etc. has been disrupted. Children began to eat chaotically. Moreover, a survey of parents showed that only a small number of families pay attention to a healthy, balanced diet for children of this "tender" age group. The priority is caloric content, and therefore, the predominant consumption of carbohydrates.

12 years of age is the time of eruption of all permanent teeth, except for the third molars. This age is global for monitoring dental caries and determining trends in its dynamics in different countries; the age of 15 is important for assessing the condition of periodontal tissues and determining the need for treatment of periodontal diseases at the population level.

The problem of caries is relevant for all ages. But adolescents have additional risks. They strive for maximum independence and freedom. As a result, they eat what they want, and home hygiene often fades into the background. The following factors increase the chances of dental morbidity: poor hygiene (they do not follow the recommendations either in terms of the number of cleanings or the duration), excessive sugar in the diet (sweet drinks and junk food are popular with teenagers, and it is more difficult for parents to monitor nutrition at school and during the day than in early childhood); visiting the dentist more often with severe complaints of pain.

It was established that the intensity of caries in the examined children according to the DFMT index was 9.78±0.83. As shown in Table 2, the proportion of D in the structure of DFMT is 85.3 %, the proportion of F is 0.32 %, and the proportion of B is 0.68 %. Caries complications in the structure of DFMS is 12.6 %.

Table 2

Condition of hard tissues of permanent teeth and periodontium in children at the age of 12–15 years

Number of children examined	DFMT	DFMS	D	F	Complications of caries in the "DMFS" structure	Number of extracted permanent teeth
			abs.	abs.	abs.	abs.
60	9.78±0.83	10.47±0.88	8.93±0.82	0.03±0.02	1.32±0.21	0.07±0.04

The results of the study of the PMA index showed that the prevalence of periodontal inflammation in children aged 12–15 years was 20.1±2.28. Mild gingivitis was diagnosed in 40 % of the subjects, moderate gingivitis in 31.7 %, and severe gingivitis in 5 %. Only 23.3 % of adolescents had no manifestations of periodontal inflammation.

Analysis of bone metabolism in children aged 2–5 years revealed the following. In 13 subjects (12 %), the content of total vitamin D (25-OH) (D2+D3) in the blood serum corresponds to the norm in the range of 30.7–65.0 ng/ml; in 8 children (7.3 %), a clear vitamin D deficiency was detected – from 5.7 to 9.9 ng/ml; 88 children have insufficient content in the range of 10.4–28.7 ng/ml, and in 50 % of them the indicator does not exceed 20 ng/ml. As for the intensity of caries, the average caries index in children with normal vitamin D levels is 8.7; in case of deficiency – 9.54, in case of deficiency – 14.0.

In all children of the above-mentioned group, the calcium and for phosphorus content corresponds to the reference values, namely: 2.2–2.65 mmol/L for calcium and 0.87–1.86 mmol/L for phosphorus. The mean calcium content in children aged 2–5 years is 2.4±0.03, and phosphorus is 1.66±0.01.

Regarding the magnesium content in the blood serum of children aged 2–5 years, we found that out of 109 examined children, 71 (65.12 %) had values below normal and ranged from 0.4–0.81 mmol/l. The average value in the group was 0.78±0.01.

None of the children had previously been tested for vitamin D, calcium, magnesium, phosphorus or other trace elements. Some of the children, without measurement, have signs of overweight; all children have visible signs of dental damage. All the examined children are from well-off families.

The average content of total vitamin D (25-OH)(D2+D3) in the blood serum of 12–15 year old children was 21.49±1.42 ng/ml. In 15 % of adolescents, the level was 43.65±2.25 ng/ml (normal), in 11.7 % of them D-deficiency was observed – 9.19±0.37 ng/ml, and in 73.3 % of children, the level of vitamin D in the blood serum was insufficient – 18.88±0.73 ng/ml. In 60 % of the examined children, vitamin D levels were below 20 ng/ml, and in 8 % – below 10 ng/ml.

Regarding mineral metabolism: the level of calcium and phosphorus corresponds to the norm in all subjects and is 2.46±0.01 mmol/l and 1.52±0.03 mmol/l, respectively. The magnesium content in blood serum of 70 % of children indicates a lack of this trace element and amounts to 0.69±0.02 mmol/l.

When parents are interviewed, complaints of poor health, depression, lethargy, weakness, mood disturbance, and nighttime sleep disturbance, especially in children aged 12–15 years, draw attention to themselves. All this provides a clinical picture of magnesium deficiency, characterized by a variety of nonspecific manifestations and indicates the need to examine children for possible magnesium deficiency.

Parents of almost all children in both groups indicate that during the COVID-19 pandemic, their children took vitamin D at a dose of 500 IU from 3 to 6 months. No laboratory tests were performed.

Blood calcium levels are strictly controlled by parathyroid hormone (PTH). This is why blood calcium levels do not usually rise with increased calcium intake and absorption and do not fall with decreased calcium intake. PTH, which raises calcium levels, requires sufficient magnesium to function.

The main participants in calcium metabolism are calcium, magnesium, vitamin D, vitamin K2, and phosphorus. Without vitamin D, there is no calcium absorption. Not enough calcium – the body will "disassemble" the bones to get it. No vitamin K2 – calcium will not go to the bone tissue.

Thus, the results of the study indicate that there is a direct correlation between children's dental health, vitamin D metabolism, and calcium-phosphorus metabolism. In case of vitamin D deficiency, the calcium level is compensated by its mobilization from bone tissue, which can lead to osteomalacia and rickets in children.

Since the main reason for the current epidemic of vitamin D deficiency is the lack of exposure of children to sunlight due to reduced time spent outdoors, the use of sunscreen, and skin pigmentation, it is necessary to emphasize the importance of the dietary route of vitamin D intake. The method of choice is the administration of cholecalciferol, known as vitamin D3. Its use results in a much higher level of 25(OH)-D than when taking ergocalciferol or vitamin D2, which is explained by its greater affinity for vitamin D-binding protein.

The results of our study reveal a direct correlation between the oral health of children and their levels of bone and mineral metabolism markers, notably calcium, magnesium, and vitamin D. The substantial prevalence of dental caries and periodontal disease among the children in our study aligns with the escalating global figures reported by the World Health Organization, estimating that almost 3.5 billion people are affected by oral diseases, with a significant number being children [12]. Our findings underscore the crucial role of vitamin D in the regulation of mineral metabolism and its broader implications for oral health. A substantial proportion of our pediatric cohort exhibited suboptimal levels of vitamin D, which is consistent with global concerns about widespread vitamin D deficiency, affecting up to 50 % of the population [15]. This deficiency was strongly associated with increased caries activity, particularly in permanent teeth, as also evidenced by the elevated DFMT scores in our older age group. The relationship between vitamin D and oral health is multifaceted. Vitamin D not only enhances calcium absorption and bone mineralization but also exerts anti-inflammatory and immunomodulatory effects [9]. These properties

are essential for maintaining periodontal health and preventing the progression of periodontal diseases. Our study adds to the body of evidence suggesting that insufficient vitamin D levels may compromise the oral health status of children, thus supporting the findings of Botelho et al., who highlighted the critical role of vitamin D in oral health maintenance [9]. Furthermore, our data indicate a noteworthy pattern in magnesium levels, with a significant portion of our sample displaying levels below the normative range. This finding is pivotal considering magnesium's role in calcium metabolism and bone structure integrity, which are vital for tooth enamel formation and overall dental health [2]. The deficiencies observed could contribute to the susceptibility to dental caries seen in our population, an aspect that is less explored in the current literature but is crucial for understanding the full scope of mineral interactions in oral health. Calcium and phosphorus, while within normal limits across our study population, did not preclude the high prevalence of dental issues, suggesting that adequate serum levels of these minerals alone are insufficient to deter oral diseases if other factors, like vitamin D and magnesium, are unbalanced. This is in line with research indicating that the interplay of these minerals, regulated by vitamin D, is essential for optimal dental and bone health [10]. The implications of these findings are profound, given the increasing rate of early childhood caries, identified as an epidemic in several regions [7]. Our results reinforce the need for comprehensive public health strategies that encompass not only direct dental interventions but also systemic nutritional assessments and adjustments to combat the high burden of dental diseases from an early age.

In conclusion, our study highlights the complex interdependencies between mineral metabolism and dental health in children. It emphasizes the necessity of monitoring and correcting vitamin D and magnesium deficiencies as part of integrated public health approaches to oral health. Future research should focus on longitudinal studies to further elucidate these relationships and to refine preventive and therapeutic strategies aimed at reducing the prevalence and severity of dental diseases in children.

Conclusions

1. Dental preventive measures should take into account the general condition of the body and be aimed, in particular, at normalizing the general indicators of mineral metabolism, bone metabolism and the child's immune defense system.

2. Timely detection of vitamin D deficiency and its correction in children, especially in risk groups, minimizes the risk of developing many chronic diseases, including dental diseases. We believe that childhood age is in itself an indication for controlling the content of total vitamin D, regardless of the place where the child lives.

3. The situation with early childhood caries nationwide can only be resolved by a comprehensive program of prevention and treatment of this disease at the state level with the participation of dentists, pediatricians, parents and public organizations.

4. Establishing the dependence of the level of essential micro- and macronutrients, as well as vitamin D in the child's body, in particular magnesium, on the prevalence of dental pathology in children and the level of stress in modern conditions allows us to determine the directions of treatment and prevention measures aimed at improving dental health.

Prospects for further research are to develop an effective method for the prevention of major dental diseases in children, depending on the level of vitamin D in the blood serum, using an appropriate treatment and prevention complex.

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DYNAMICS OF THE LEVEL OF INFLAMMATION MARKERS IN PATIENTS WITH FRACTURES OF LONG BONES AGAINST THE BACKGROUND OF COVID-19

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The purpose of the study was to determine the response dynamics of inflammatory markers C-reactive protein and procalcitonin in patients with long bone fractures against the background of COVID-19. The main group included 157 cases of skeletal fractures against the background of COVID-19, and the control group included 132 cases of skeletal fractures in which there was no COVID-19 infection. The dynamics of the C-reactive protein level in patients with fractures against the background of COVID-19 indicated that this inflammatory marker is not informative at the initial stage, however, starting from the 3rd day, a significant increase in the C-reactive protein level was noted with a subsequent drop in the level in the postoperative period on the 10th day of treatment. The dynamics of the procalcitonin level was approximately the same during all observation periods and did not reflect the changes that occurred in patients with long bone fractures against the background of COVID-19, which does not allow the use of this inflammatory marker in the clinical diagnosis of the course of COVID-19 in patients with long bone fractures

Key words: trauma, COVID-19, C-reactive protein, procalcitonin

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ДИНАМІКА РІВНЯ МАРКЕРІВ ЗАПАЛЕННЯ У ХВОРИХ З ПЕРЕЛОМАМИ ДОВГИХ КІСТОК НА ТЛІ COVID-19

Метою дослідження було визначити динаміку відповіді маркерів запалення С-реактивний білок та прокальцитонін у пацієнтів з переломами довгих кісток на тлі COVID-19. До основної групи були віднесені 157 випадки переломів скелета на тлі COVID-19, у контрольну групу увійшло 132 випадки переломів скелета, в яких була відсутня COVID-19 інфекція. Динаміка рівня С-реактивний білку у пацієнтів з переломами на тлі COVID-19 вказала, що на початковому етапі цей маркер запалення не є інформативним, однак починаючи з 3 дня відмічалось значне підвищення рівня С-реактивний білок з послідуючим падінням рівня у післяопераційному періоді на 10 добу лікування. Динаміка рівня прокальцитоніну була приблизно однаковою в усі терміни спостереження і не відображала зміни, що відбувались у пацієнтів з переломами довгих кісток на тлі COVID-19, що не дозволяє використовувати даний маркер запалення у клінічній діагностиці протікання COVID-19 у пацієнтів з переломами довгих кісток

Ключові слова: травма, COVID-19, С-реактивний білок, прокальцитонін

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In the first months of the COVID-19 pandemic, humanity faced the problem of high-quality and accurate diagnosis of the virus in patients. Not all known methods of diagnosing viral diseases were adequate in the early diagnosis of COVID-19. Knowledge of diagnostic tests for severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) is still evolving, and a clear understanding of the nature of the tests and the interpretation of their results is important.

Today, it is clear that the COVID-19 pandemic has become a challenge for the healthcare system in all countries. Vast financial and human resources are involved in providing care to infected patients. Many multidisciplinary hospitals have been repurposed into infectious diseases hospitals. In the conditions when the pandemic is in full swing, it is also necessary to solve the issue of specialized trauma care [1].