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## CEREBROVASCULAR DISORDERS IN PATIENTS WITH COVID-19 CONSEQUENCES PATHOGENETICALLY DETERMINED DIAGNOSIS AND METHODS OF CORRECTION

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The purpose of the study was to investigate and to correct the state of the autonomic system, cognitive functions, vestibular apparatus and cerebral blood circulation autoregulation in patients with cerebrovascular pathology formed as the result of COVID-19 consequences. Patients with chronic cerebral ischemia in the compensated and subcompensated stages together with 46 patients with ischemic stroke were examined. The Mini-Mental State Examination and Frontal Assessment Batter criteria were used together with 10-word recall test. Vegetative characteristics were investigated in patients: tone, reactivity and vegetative activity ensuring, together with brain arteries reactivity in triplex mode using an ultrasound scanner. Cognitive, psychoemotional, vestibular, and autonomic disorders have been found to be key and comorbidities of cerebrovascular insufficiency in people who have experienced COVID-19 and are correlated with the degree of brain damage. Their progression is facilitated by the transferred coronavirus infection with subsequent decompensation of ischemia, especially as a result of direct damage to the CNS vascular system. The use of  $\beta$ -phenyl-GABA restores cognitive functions, affects vestibular structures, improves their vascularization, has a harmonizing vegetotropic, antidepressant effect, and also normalizes cerebrovascular reactivity.

**Key words:** cerebrovascular pathology, coronavirus infection, vegetative system, cognitive and vestibular disorders, nervous system damage,  $\beta$ -phenyl-GABA

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## ПАТОГЕНЕТИЧНО ДЕТЕРМІНОВАНА ДІАГНОСТИКА ТА МЕТОДИ КОРЕКЦІЇ ЦЕРЕБРОВАСКУЛЯРНИХ ПОРУШЕНЬ У ХВОРИХ З НАСЛІДКАМИ COVID-19

Метою дослідження було з'ясування та корекція стану вегетативної системи, когнітивних функцій, вестибулярного апарату та ауторегуляції мозкового кровообігу у пацієнтів із цереброваскулярною патологією, сформованою внаслідок наслідків COVID-19. Обстежено хворих з хронічною ішемією мозку у компенсованій та субкомпенсованій стадіях, а також пацієнтів з ішемічним інсультом. Були використані критерії Mini-Mental State Examination та Frontal Assessment Batter, тест на запам'ятовування 10 слів. У хворих були досліджені вегетативні характеристики: тонуус, реактивність та забезпечення вегетативної діяльності, реактивності артерій мозку в триплексному режимі на ультразвуковому сканері. Виявлено, що когнітивні, психоемоційні, вестибулярні та вегетативні розлади є ключовими та супутніми захворюванням недостатності мозкового кровообігу у людей, які перенесли COVID-19, і корелюють зі ступенем ураження мозку. Їх прогресуванню сприяє перенесена коронавірусна інфекція з подальшою декомпенсацією ішемії, особливо внаслідок прямого ураження судинної системи ЦНС. Застосування  $\beta$ -феніл-ГАМК відновлює когнітивні функції, впливає на вестибулярні структури, покращує їх васкуляризацію, має гармонізуючу вегетотропну, антидепресивну дію, а також нормалізує цереброваскулярну реактивність.

**Ключові слова:** цереброваскулярна патологія, коронавірусна інфекція, вегетативна система, когнітивні та вестибулярні порушення, ураження нервової системи,  $\beta$ -феніл-ГАМК

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Cerebrovascular diseases (CVD) remain leading in cardiovascular pathology structure [3]. One could see the increasing data of both acute and chronic cerebrovascular accidents incidence and prevalence on Ukraine [1, 3]. The problem of CVD is worsening as a result of the coronavirus disease (COVID-19) pandemy. The statistical data indicated acute cerebral stroke (ACS) high probability development throughout the first days of acute respiratory syndrome clinical manifestation as a result of SARS-CoV-2 virus. Such a risk persists after the end of the acute period of the disease which is significantly highly greater pertaining the same index after the influenza virus infection [7].

The ACS clinical manifestation characterizes by cognitive disorders domination [15] which persist and progress during the recovery period [7] making it significantly complicated to perform out the pathogenetically based pharmacological correction of all periods of stroke including rehabilitation [10].

Important that chronic cerebral ischemia (CCI) is the main clinical forms of ACS "supplier" [7]. Therefore, it is obligatory to pay special attention to the most prevalent chronic disorders of cerebral hemorrhage to avoid the culprit of the central nervous system gross organic judicial changes such as ACS,

which is the critical problem of clinical medicine and neurology [6, 7]. Additionally, to mnemonic disorders and cephalgic syndrome, conductive and vestibular dysfunction (VD) which development are evident in the vascular dysgemia clinical manifestation, the central nervous system lesion correlates with these stages damage to the brain [4].

Although the question of including VD among the main symptoms of COVID-19 in the acute period remains open, its significance in people who have had COVID-19 is beyond doubt, where the most common neurological symptom in such patients is dizziness. A strong correlation between SARS-CoV-2 infection and dizziness has been reported, but the mutual mechanisms are not fully understood and require further study [4].

Hence, the CCI progression is facilitated by coronavirus infection development with the frequent appearance of non-motor symptoms in the form of cognitive, psychoemotional and other neural disorders leading patients' clinical condition worsening with a high probability of CNS severe vascular lesions including CCI development [7, 10].

**The purpose** of the study was to investigate and correct the state of the autonomic system, cognitive functions, vestibular apparatus and cerebral blood circulation autoregulation in patients with cerebrovascular pathology formed as the result of COVID-19 consequences.

**Materials and methods.** This study included data from a medical examination of persons who gave written agreement. The complex laboratory studies and clinical observations were painless, non-invasive and taking into account the individual condition of each patient. Violations of the norms of bioethics were not observed.

We examined 108 patients (49 men and 59 women) aged from 32 to 60 years (mean age equal to  $43.6 \pm 1.6$  years) who had COVID-19 in the neurological departments of the Center for Reconstructive and Restorative Medicine (University Clinic of Odesa National Medical University) and Odesa Regional Clinical Hospital during 2022–2023 years. These patients were randomized into those with compensated CCI (group I,  $n=24$ ) and subcompensated stage (group II,  $n=38$ ). The third one group (group III) consisted of 46 patients suffered with an ischemic stroke in the post-COVID period confirmed using neuroimaging methods. Twenty relatively healthy people who underwent professional selection consisted the control group.

The stroke duration varied within the early recovery period. Speech and writing were preserved in all patients. We provided the patients' clinical and neurological examination with the additional investigation of their somatic sphere with the help of the highly specialized specialists.

The study of cognitive functions was carried out using a short scale of mental state – Mini-Mental State Examination (MMSE) [13], a battery of tests for studying frontal dysfunction – Frontal Assessment Batter (FAB) [5] and a test for 10 words memorizing for both short-term and long-term memory investigation [2]. All patients were tested twice – at the beginning of the study and three months later.

The patients' autonomic nervous system (ANS) state was studied using a questionnaire [2]. The necessary autonomic characteristics were studied using a table of vegetative tone (VT), vegetative reactivity test (VR) and vegetative support of activity (VSA) express diagnostics.

The Hospital Anxiety and Depression Scale (HADS) were used to identify the presence and severity of anxiety and depressive disorders in patients.

The cerebrovascular reactivity indexes investigation was performed with the help of triplex mode on an Ultima-PA ultrasound scanner (RADMIR, Ukraine) using the following criteria: hypercapnic ( $KrCO_2$ ), hyperventilation ( $KrO_2$ ), orthostatic ( $KrOL$ ), anti-orthostatic ( $KrAOL$ ) and functional metabolic tests ( $KrFMT$ ) [12].

Phenibut ( $\beta$ -phenyl-GABA) for three months [one tablet (250 mg) per 3 times a day] was prescribed for all patients with post-stroke cognitive deficits.

The data obtained were presented as mean (M) and the standard error of the mean (m) and were calculated statistically using parametric Bonferroni multiple t-test. Nonparametric Kruskal-Wallis test was used in case of the absolute indexes statistical calculation. The minimum statistical probability was determined at  $p < 0.05$ .

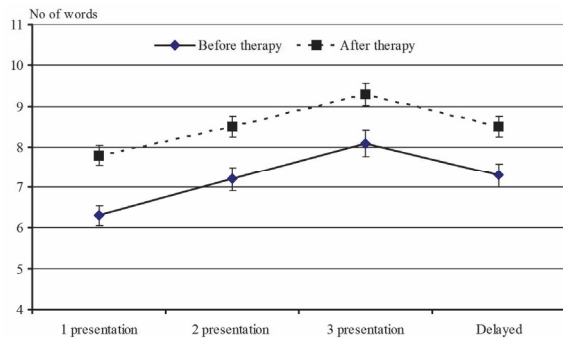
**Results of the study and their discussion.** The majority of patients noted positive dynamics in terms of subjective experiences, a significant improvement in well-being after complex therapy using  $\beta$ -Phenyl-GABA.

Dizziness after a coronavirus infection and brain ischemic changes was more often manifested by an increase in organic ischemic symptoms with a maximum in group III, while the non-systemic symptoms with psychoneurasthenic syndrome manifestations prevailed in patients with CCI compensated stage (group I).

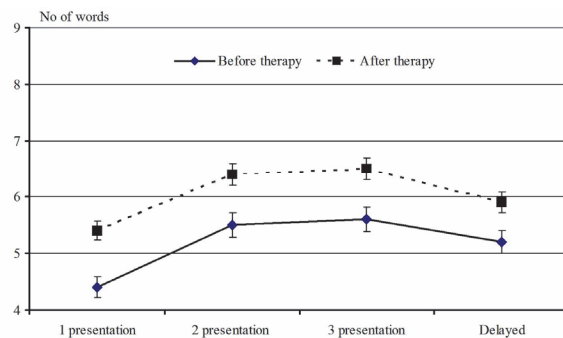
The complaints of unsteadiness when walking and instability were decreased by 49.1 % in the CCI groups after complex treatment with  $\beta$ -Phenyl-GABA. The dizziness episodes decreased by 1.5 times ( $p<0.05$ ), including systemic dizziness – by 40.0 %.

We found the main vegetative signs to be pathological during examination of the majority of patients. Vegetative tone sympathicotonic direction predominates in patients with compensated cerebral ischemia ( $p<0.05$ ) with a tendency to decrease with subcompensation (group II) and an acute shift in polarity (6 times) towards vagotonia (86.9 %,  $p<0.05$ ) in cases of pathological process decompensation (group III).

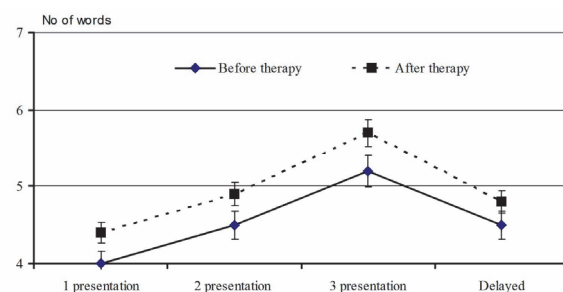
Vegetative tone pathological variants changes were similar: from a predominance of excessive ones in patients with compensated cerebral ischemia ( $p<0.05$ ) towards to VR insufficient indexes in cases of ANS compensatory activities decrease ( $p<0.05$ ).



A



B



C

Fig. 1. Dynamics of the number of 10 words memorization in three (short-term) and in delayed (long-term memory) presentations in patients of all examined groups (correspondently, A, B and C fragments).

The proposed nootropic therapy resulted in all groups patient's memorization improvement ( $p<0.05$ ) confirmed in case of MMSE and FAB scales use (Table 1).

According to MMSE scale data, the average score is on the border of the range of "mild cognitive impairment" and the normal value ( $27.9\pm 0.5$  points – group I), group II moved into the range of "mild cognitive impairment" ( $25.4\pm 0.8$  points), the investigated index improved in group III patients but "mild dementia" level still remained.

The group I cognitive functions increased by  $1.4\pm 0.3$  points and returned to normal value, according to FAB data. The same check in the group II revealed cognitive functions increase by  $2.1\pm 0.6$  points and moved from the range of "severe cognitive impairment" to "moderate". The treatment prescribed to group III patients allowed to increase cognitive functions by  $1.3\pm 0.5$  points which correspond to "severe cognitive impairment".

We registered cerebral arteries reactivity for both the prognosis treatment efficacy check. We found the positive influence of treatment on CVR indexes. The greatest effect was determined in groups II and III patients in terms of  $KrCO_2$  indexes (group II – increase from  $1.14\pm 0.03$  to  $1.22\pm 0.06$ , group III – increase from  $1.10\pm 0.03$  to  $1.19\pm 0.05$ ).

We registered a similar direction of VSA activity in all three groups of examined patients ( $p<0.05$ ).

The "vegetotropic" nature of the prescribed therapy is confirmed by autonomic dysfunctions both paroxysmal and permanent manifestations normalization with emotional instability and metotropia. Additionally, one could see the increase of number of patients with eutonia increased as the result of the treatment proposed (from 10.2 % to 37.9 %,  $p<0.05$ ). The distribution within groups was the following – 45.8 %, 26.3 %, 13.0 % of observations, respectively. Vegetative reactivity index normalized by 27.2 % ( $p<0.05$ ) and fell within the normal distribution. The analogous changes – normalization by 25.8 % ( $p<0.05$ ) – occurred with VSA index.

Clinically significant depression was most often detected in the first CCI stages and less often in persons with ACS in anamnesis which can be regarded as vascular encephalopathy earlier clinical marker. The depressive-like symptoms in all patients of the examined groups were eliminated in 40.5 % after the prescribed treatment ( $p<0.05$ ). We noted the psycho-emotional reactions maximal normalization in CCI groups (43.7 % and 40.0 %, correspondently), the minimal – in group III (in 33.3 % of observations).

We received the precise data after the complex treatment using  $\beta$ -Phenyl-GABA which outlined the expressed short-term and long-term memory improvement in all the patients together with stability of attention (fig. 1).

Table 1

**The effect of the applied treatment on the structure of neurocognitive disorders according to the indicators of the FAB and MMSE scales in the examined groups**

Groups of patients	Treatment efficacy criteria (M±m), points	
	MMSE	FAB
Group I		
Before treatment	25.5±0.6	15.8±0.5
After treatment	33.2±0.4#	20.6±0.7#
Group II		
Before treatment	23.6±0.2	13.2±0.4
After treatment	30.6±1.1#	17.3±0.9#
Group III		
Before treatment	20.9±0.4	10.9±0.7
After treatment	27.2±1.1#	14.6±0.8#

Notes: # –  $p < 0.05$  – probable differences of the studied indexes compared to analogous control indexes (Bonferroni multiple t-test)

The dynamic of  $KrO_2$  indexes growth was slightly lower, but it should be taken into account that changes in reactivity to  $O_2$  sample were initially not as significant as to  $CO_2$  sample (group II – increase from  $0.26 \pm 0.02$  to  $0.31 \pm 0.03$ , group III – increase from  $0.24 \pm 0.02$  to  $0.30 \pm 0.04$ ). We found the  $KrO_2$  indices to be relevant to normal ones.

The most significant impact of treatment used on CVR we believe to be an IVMR index stabilization which is the cerebral autoregulation integral index and stroke development the most significant predictor. Its value increased from  $51.2 \pm 4.6$  to  $59.5 \pm 5.4$  in group II patients and from  $42.1 \pm 3.9$  to  $55.1 \pm 4.7$  in group III patients.

Therefore, the data obtained indicate the of short-term and long-term memory together with stability of attention improvement in patients of all groups with CCI after using of  $\beta$ -Phenyl-GABA which affects the cognitive functions reproduction in examined patients. According to the MMSE scale, the mean score of neurocognitive impairments after treatment improved in all examined groups: on the border of “mild cognitive impairment” and normal (group I), the indicators of group II moved into the range of “mild cognitive impairment”, in group III they improved, but remained at the level of “mild dementia”.

After treatment, the number of cases of dizziness, both systemic and non-systemic, decreased by half. Taking into account the above-mentioned effects of  $\beta$ -Phenyl-GABA, it can be assumed that the nootropic drug had a direct effect on the state of the central mechanisms of the vestibular structures with an improvement in their vascularization. This indicates the prospects for using the drug in a comprehensive scheme for the prevention of ischemic stroke in patients with CCI.

Trying to analyze all the results received in these clinical and instrumental observations we suppose it necessary to start discussion from the point of the patients choice explanation. We found the expressed “rejuvenation” of patients with ACS episodes after the SARS-CoV-2 infection [8]. The ACS development was recorded previously throughout the SARS-CoV-2 postponed period [10]. Everybody knows ACS is an age-dependent disease with a gradual “accumulation” of mainly several risk factors for vascular accident clinical manifestation. We interested in the problem of such kind of disease “prehistory” absence and young age of patients which no doubts to complicate significantly the therapy and rehabilitation received [8].

The second idea we suppose it important to attract attention is the following. Important is to pay attention to the possible routes of SARS-CoV-2 virus penetration into the central nervous system: olfactory nerves and pathways, cellular invasion (monocytes, macrophages) like a “Trojan horse”, endothelial cells, blood-brain barrier. Transsynaptic transmission through peripheral nerves with the possible use of kinesin axonal transport and paracellular migration has also been suggested [11]. We believe it is highly important from the point of view of disease clinical manifestation. Because all of the above routes of infection penetration inside brain affects the vestibular system functional stability. Vestibular system is the first realizes changes in the ANS and brain stem functioning, where the vestibular nuclei and their pathways are located. Our understanding of vestibular system principal pathophysiological importance in cases of intracerebral infections penetration allows to make several clinical efforts to influence on some central nervous system degenerative diseases with anosmia, motor, cognitive, psycho-vegetative disorders, systemic and non-systemic dizziness, disorders of statolocomotor, balance. One os the possible was of principal influence – the intranasal way of pharmacological drugs administration [9].

We are still sure that treatment prescribed has to be pathogenetically proved. That’s why nobody has to forget another important mechanism of nervous system infectious damage in the form of

hypercoagulation due to systemic inflammation, cytokine storm leading to endothelial dysfunctions and other related factors of CNS vascular damage [8]. All mentioned events are fully consistent with nervous system virus-induced lesions pathophysiological mechanisms that we convinced and confirmed through our own diagnostic and treatment efforts. In fact, vestibular apparatus damage is accompanied by bloodflow decrease within the vestibular structures, which are very sensitive to ischemia. Additionally, hemodynamic changes easily occur as a result of vasospasm, endothelial damage and thrombosis which are constant vascular problems in patients with coronavirus infection [8, 14].

And the final one – we have to attract attention to a very modest and even sometimes forgotten drug with the GABA receptor complex stabilization as key mechanism of its action. When using  $\beta$ -Phenyl-GABA with a known vegetotropic effect, it can be assumed that the harmonizing and sympatholytic effects, as well as the improvement in cerebral blood flow reactivity, are associated with the functioning of the central nervous system and cardiovascular system, which influence the pathophysiological mechanisms of the development and course of ischemic processes in post-COVID period.

Considering the high influence of the emotional state on memory functions, the antidepressant effect of nootropic drugs was assessed. Favorable changes in the psychoemotional state of patients of all examined groups after treatment with  $\beta$ -Phenyl-GABA were established.

### Conclusions

1. Cognitive, psychoemotional, vestibular and autonomic disorders are key and comorbid in cerebrovascular insufficiency in patients who have had COVID-19, and largely correlate with the degree of brain damage.
2. Previous coronavirus infection contributes to the progression of the above-described syndromes and further decompensation of ischemia due to direct damage to the vascular system of the central nervous system.
3. The  $\beta$ -Phenyl-GABA prescription to persons with SARS-CoV-2 infection in anamnesis improves memory and concentration with restoration of cognitive functions.
4. Additionally to nootropic influence in persons with SARS-CoV-2 infection the investigated drug affects the central vestibular structures, including their vascularization improvement, has a harmonizing vegetotropic, antidepressant effect, and also stabilizes or normalizes the cerebrovascular reactivity pathological indexes, especially the vasomotor reactivity index which can be considered as a stroke predictor.

*Prospects for further research aimed the abovementioned pathological changes elimination during cerebral chronic ischemia or stroke throughout the post-COVID period include a subsequent comprehensive clinical observation to evaluate the clinical efficacy of combined  $\beta$ -Phenyl-GABA use with different rehabilitative measures to identify possible potential and synergistic effects.*

### References

1. Vinichuk SM, Fartushna OE. Epidemiolohiya tranzytornykh ishemichnykh atak u strukturi hostrykh porushen mozkovoho krovoobihu v Ukraini ta inshykh krayinakh. Mizhnarodnyy nevrolohichnyy zhurnal. 2017; 5(91): 105–111. doi: 10.22141/2224-0713.5.91.2017.110863 [In Ukrainian].
2. Lesiv MI. Kohnityvni funktsiyi u khvorykh na hipertonichnu khvorobu ta hipotyreozy z retrospektyvnoyu otsinkoyu kontrolyu kompensatsiyi zakhvoryuvannya. Ukrayins'kyy nevrolohichnyy zhurnal. 2019; (2-3), 40–44. doi: 10.30978/UNJ2019-2-40 [In Ukrainian].
3. Svyrydova NK, Cherednichenko TV. Diahnostyka ta likuvannya kohnityvnykh rozladiv u komorbidnykh patsiyentiv iz khronichnoyu ishemiyeyu holovnoho mozku. Liky Ukrayiny. 2020; 8(244): 50–53. doi: 10.37987/1997-9894.2020.8(244).215487 [In Ukrainian].
4. Trinus KF, Claussen KF. Mizhnarodnyy klinichnyy protokol z prysinkovykh porushen (zapamorochen) Skhidno-yevropeyskyy nevrolohichnyy zhurnal. 2015;4: 4–47 [In Ukrainian].
5. Aiello EN, Esposito A, Gramegna C, Gazzaniga V, Zago S, Difonzo T et al. The Frontal Assessment Battery (FAB) and its subscales: validation and updated normative data in an Italian population sample. *Neurol Sci.* 2022; 43(2): 979–984. doi: 10.1007/s10072-021-05392-y.
6. Barpanda S. Pathophysiology and Epidemiology of Cerebrovascular Disease *International Journal of Collaborative Research on Internal Medicine & Public Health.* 2021; 13(7): 1–2.
7. Ellul MA, Benjamin L, Singh B, Lant S, Michael BD, Easton A. et al. Neurological associations of COVID-19. *Lancet Neurol.* 2020; 19(9): 767–783. doi: 10.1016/S1474-4422(20)30221-0
8. Fifi JT, Mocco J. COVID-19 related stroke in young individuals. *Lancet Neurol.* 2020; 19(9): 713–715. doi: 10.1016/S1474-4422(20)30272-6
9. Kellar D, Lockhart SN, Aisen P, Raman R, Rissman RA, Brewer J, Craft S. Intranasal Insulin Reduces White Matter Hyperintensity Progression in Association with Improvements in Cognition and CSF Biomarker Profiles in Mild Cognitive Impairment and Alzheimer's Disease. *J Prev Alz Dis.* 2021; 8(3): 240–248. doi: 10.14283/jpad.2021.14
10. Obaid M, Flach C, Marshall I, Wolfe CDA, Douiri A. Long-Term Outcomes in Stroke Patients with Cognitive Impairment: A Population-Based Study. *Geriatrics (Basel).* 2020; 5(2): 32. doi: 10.3390/geriatrics5020032.
11. Rajeev V, Fann DY, Dinh QN, Kim HA, De Silva TM, Lai MKP. et al. Pathophysiology of blood brain barrier dysfunction during chronic cerebral hypoperfusion in vascular cognitive impairment. *Theranostics.* 2022; 12(4): 1639–1658. doi: 10.7150/thno.68304

12. Stoyanov AN, Kalashnikov VI, Vastyanov RS, Pulyk AR, Son AS, Kolesnik OO. State of autonomic regulation and cerebrovascular reactivity in patients with headache with arterial hypertension. *Wiadomości Lekarskie*. 2022; 75(9 p2): 2233–2237. doi: 10.36740/WLek202209210
13. Su Y, Dong J, Sun J, Zhang Y, Ma S, Li M. et al. Cognitive function assessed by Mini-mental state examination and risk of all-cause mortality: a community-based prospective cohort study. *BMC Geriatr*. 2021; 21: 524. doi: 10.1186/s12877-021-02471-9
14. Varga Z, Flammer AJ, Steiger P, Haberecker M, Andermatt R, Zinkernagel AS. et al. Endothelial cell infection and endotheliitis in COVID-19. *Lancet*. 2020; 395(10234): 1417–1418. doi: 10.1016/S0140-6736(20)30937-5
15. Zhitao Li, Zhen Z, Zhuoya Z, Zhiyong W, Hao Li. Cognitive impairment after long COVID-19: current evidence and perspectives. *Front Neurol*. 2023; 14: 1239182. doi: 10.3389/fneur.2023.1239182

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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 сановані. 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.

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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,