ORIGINAL ARTICLE

CONTENTS

Comprehensive assessment of caries resistance in 6 -7 year-old children residing in Poltava and internally displaced children

Olha Sheshukova, Anna S. Mosiienko, Tetiana V. Polishchuk, Alina I. Maksymenko, Alla V. Marchenko, Sofia S. Bauman, Nataliia M. Lokhmatova
POLTAVA STATE MEDICAL UNIVERSITY, POLTAVA, UKRAINE

ABSTRACT

Aim: The aim of this study is to assess caries resistance in children from Poltava and internally displaced children from frontline regions by analyzing caries indicators and oral fluid properties. This will help evaluate the impact of war and displacement on their dental health.

Materials and Methods: This study was conducted at the City Children Dental Clinic in Poltava and included 330 children aged 6-7 years, of whom 56.7% were boys and 43.3% were girls. Among them, 230 children were internally displaced persons (Group I), and 100 were permanent residents of Poltava (Group II).

Results: The analysis of caries prevalence and intensity showed a significant difference between the groups. In Group I, the prevalence of caries was 77.8%, and the intensity of the dmft+DMFT index was 3.31±0.2, which is significantly higher than in Group II (66% and 1.91±0.2; $p<0.05$). Indicators of oral fluid homeostasis were also worse in internally displaced children; pH was 13% lower, and the salivary flow rate was 1.3 times lower than in Group II children ($p<0.05$).

Conclusions: The study revealed a higher prevalence of caries among internally displaced children (77.8%) compared to children from Poltava (66%). Internally displaced children showed higher caries rates and lower caries resistance. These findings highlight the urgent need for preventive programs to improve the dental health of internally displaced children.

KEY WORDS: children, dental caries, oral fluid, enamel resistance, microcrystallization, war time

Wiad Lek. 2024;77(12):2487-2492. doi: 10.36740/WLek/197114 DOI

INTRODUCTION

In the context of the ongoing armed conflict in Ukraine, which began in 2014, the number of internally displaced persons (IDPs), including children, has significantly increased. According to the Ministry of Social Policy, as of 2024, there are over 4.9 million IDPs in Ukraine. Of these, nearly 21% (approximately 997,000) are children under the age of 18. This poses an urgent need for society to thoroughly study the dental health of this vulnerable group [1, 2, 3].

The conflict in Ukraine also has serious global environmental consequences, which negatively impact health and food security. The chaos and fear resulting from hostilities are accompanied by intimidation, leading to increased violence and depression among the civilian population. These actions of the aggressor country aim at weakening the will of the people and diminishing their resistance, particularly among vulnerable groups such as women, children, and the elderly people, who endure both physical and psychological suffering [4, 5].

War and forced displacement significantly affect children's health, particularly due to limited access to healthcare and worsening living conditions. Concerns are growing regarding the dental health of children from frontline regions and those who are internally displaced [6]. Epidemiological studies have shown an increased prevalence of dental caries among children who have experienced stressful situations, including those related to warfare [7].

Oral fluid is known to play a crucial role in preserving the integrity of dental hard tissues, maintaining enamel homeostasis and microcrystallization processes under the influence of external factors [8]. Preliminary studies suggest a deterioration in the properties of oral fluid among these children, potentially leading to impaired tooth mineralization due to constant stress and environmental changes. Investigating the properties of oral fluid and its mineralizing potential remains an important tool for assessing the dental health of children in crisis situations.

AIM

The aim of this study was to assess dental enamel resistance to caries through a comprehensive analysis of

caries indicators and oral fluid properties in children from Poltava, including both local children and internally displaced children (IDC) from frontline regions.

The study hypothesizes that internally displaced children (IDC) from frontline zones demonstrate poorer dental health indicators compared to local children residing in Poltava.

MATERIALS AND METHODS

This cohort study was conducted at the City Children Dental Clinic in Poltava. The study included 330 children aged 6–7 years who visited the clinic for dental care or preventive examinations. Inclusion criteria were: age 6–7 years, absence of chronic somatic pathologies, and specified place of residence. Two groups were formed: Group I (IDC) consisted of 230 internally displaced children who had been residing in Poltava for six months at the time of examination (from February 2022 to August 2022), and Group II included 100 children who were permanent residents of Poltava. Among the participants, 56.7% were boys and 43.3% were girls.

Dental status was assessed by evaluating the intensity of caries using the dmft, dmft+DMFT, and DMFT indices; the prevalence of caries was determined by the percentage of children having at least one decayed, missing or filled tooth; oral hygiene was assessed using the Fedorov-Volodkina Index (1971); the degree of gingivitis was evaluated with the papillary-marginal index (PMI) in Parma modification (1960). Enamel resistance was assessed using the TER test (V.R. Okushko, L.I. Kosareva, 1983); the crystal-forming function of mixed saliva was measured using P.A. Leus's method (1977). The rate of unstimulated saliva flow was calculated using the formula Rs = V/T (ml/min), where V represents the volume of saliva (ml), and T is the collection time (min). The hydrogen ion concentration (pH) of the oral fluid was determined using standard test strips (SPOFA, Czech Republic).

The normality of the data distribution was assessed using the Shapiro Wilkinson test. Statistical analysis of the findings obtained was performed using SPSS software, applying parametric methods. The arithmetic mean (M) and standard error of the mean (m) were calculated, and Student's t-test was used to compare the variables.

The study adhered to the key provisions of GSP (1996), the Council of Europe Convention on Human Rights and Biomedicine (04.04.1997), the World Medical Association Declaration of Helsinki on Ethical Principles for Medical Research Involving Human Subjects (2013-2014), and the Ethical Code of Scientists of Ukraine (2009). These ethical standards were confirmed by the protocol of the Bioethics Committee of Poltava State Medical University (No. 231) for data collection and processing of information about children.

RESULTS

The survey was conducted on a sample of children divided into two groups based on their place of residence: Group I involved 230 internally displaced children who previously lived in frontline areas, with an average age of 6.47±0.03 years; Group II included 100 children permanently residing in Poltava, with an average age of 6.53±0.05 years (Table 1). According to the analysis, the majority of children were previously residents of the Kharkiv (59.6%), Donetsk (30%), Luhansk (7.4%), and Zaporizhzhia (3%) regions.

The analysis of caries prevalence and intensity revealed a significant difference between the groups (Table 2). In children of Group I, the average caries prevalence was 77.8%, representing 179 children with carious lesions. In Group II, the prevalence was slightly lower and approached to 66%. Correspondingly, a higher caries intensity, measured by the dmft+DMFT index, was observed in Group I, with a value of 3.31±0.2, which is more than 1.5 times higher than in Group II (1.91±0.2; $p<0.05$). A similar trend was noted for the intensity of caries in primary teeth: in Group I, the value was 3.12±0.19, while in Group II, it was 1.72±0.18 ($p<0.05$).

Regarding permanent teeth, the prevalence and intensity of caries were similar in both groups. The prevalence of caries according to the DMFT index was 10% in Group I and 11% in Group II. The intensity of caries in permanent teeth did not show significant differences between the two groups ($p>0.05$).

The state of oral hygiene in internally displaced children (Group I) was 1.52±0.03, while in children living in Poltava (Group II), this indicator was 1.42±0.02, and both were assessed as good.

We observed reduced enamel resistance in internally displaced children, with the enamel resistance test in Group I exceeding that of Group II by 1.6 times (4.23±0.18 and 2.64±0.12, $p<0.05$) (Table 3).

When analyzing the indicators of oral fluid homeostasis, a decline was found in the IDP children (Table IV). The hydrogen index (pH) of oral fluid was lower than normal in both groups, but Group I children had the lowest value, at 5.6±0.04. The salivary flow rate in Group I was 0.29±0.004 ml/min, which is 1.3 times lower than in Group II (0.4±0.01 ml/min, $p<0.05$).

The analysis of crystal-forming characteristics of oral fluid showed that the mean value of microcrystallisation types in the Group I was higher and amounted to 2.5±0.04 compared to 2.02±0.07 in children of Group II ($p<0.05$).

In the distribution of oral fluid microcrystallization (MCS) types, it was found that type I MCS was most prevalent among children in Group II, observed in 25% of the subjects, while in Group I, this type was less frequent, at 12.2% (Fig. 1). Type II MCS was detected in 51%

Table I. Age characteristics of the examined children (age, M±m)

Groups	N	Age	Sex			
			Boys		Girls	
			N	%	n	%
I	230	6,47±0,03	137	59,6	93	40,4
II	100	6,53±0,05	50	50	50	50

Table II. Caries indicators in the examined children

Groups	Prevalence, absolute number/(%)			Intensity, (M±m)		
	dmft	dmft+DMFT	DMFT	dmft	dmft+DMFT	DMFT
I	179/77,8	179/77,8	23/10	3,12±0,19	3,31±0,21	0,19±0,04
II	66/66	66/66	11/11	1,72±0,18	1,91±0,21	0,19±0,06
				p<0,05	p<0,05	p>0,05

Table III. State of oral hygiene (points), periodontal inflammation (%), and enamel resistance (points), M±m

Groups	Gingival index, points	PMA,%	Enamel resistance test, points
I	1,52±0,03	0,17±0,08	4,23±0,18
II	1,42±0,02	0,45±0,33	2,64±0,12
	p<0,05	p<0,05	p<0,05

Table IV. Indices of oral fluid, M±m

Groups	Ph, (units)	Microcrystallization of oral fluid (points)	Rate of oral fluid unstimulated secretion (ml/min.)
I	5,6±0,04	2,5±0,04	0,29±0,004
II	6,45±0,07	2,02±0,07	0,4±0,01
	p<0,005	p<0,05	p<0,00

of children in Group II, almost double the occurrence in Group I, where it was 23.5%. The worst MCS index, type III, which indicates low caries resistance and serves as a marker of stress, was recorded in 64.3% of children in Group I. This is significantly higher than in Group II, where this index was found in only 24% of the subjects.

DISCUSSION

The war in Ukraine, one of the largest humanitarian crises of this century, has caused millions of Ukrainians to become internally displaced [9]. The conflict has severely impacted life in towns and villages on the frontline, forcing people to seek refuge in remote locations. With constant fighting, local residents cannot lead normal lives, facing daily threats to their safety. The destruction of infrastructure, social services, and the healthcare system, along with economic hardships caused by the war, has left many without access to essential psychological and medical care, including dental care. Many children have suffered from both physical and emotional trauma and require support to recover and adapt to their new circumstances.

Our study aimed to evaluate caries resistance of the teeth by conducting a comprehensive analysis of caries prevalence and assessing oral fluid parameters in two groups: children from Poltava and internally displaced children from frontline regions. The study sought to examine the impact of the armed conflict and displacement on the dental health of this group of children compared to those living in a city farther from the frontline, who had not been displaced.

Most districts in Poltava Oblast, an agricultural region, have normal or elevated fluoride concentration in drinking water, and the regional dental disease prevention program considers this factor. According to the literature, the regions from which children were primarily resettled to Poltava—namely Kharkiv, Donetsk, Luhansk, and Zaporizhzhia—are industrially polluted and have higher than normal fluoride levels in drinking water, which influences caries rates [10]. To evaluate the impact of resettlement on caries rates in children, we compared literature data on caries prevalence in children from these regions [11, 12] with our survey data from children in Poltava. This comparison indicates that children from Poltava [13, 14] have a lower

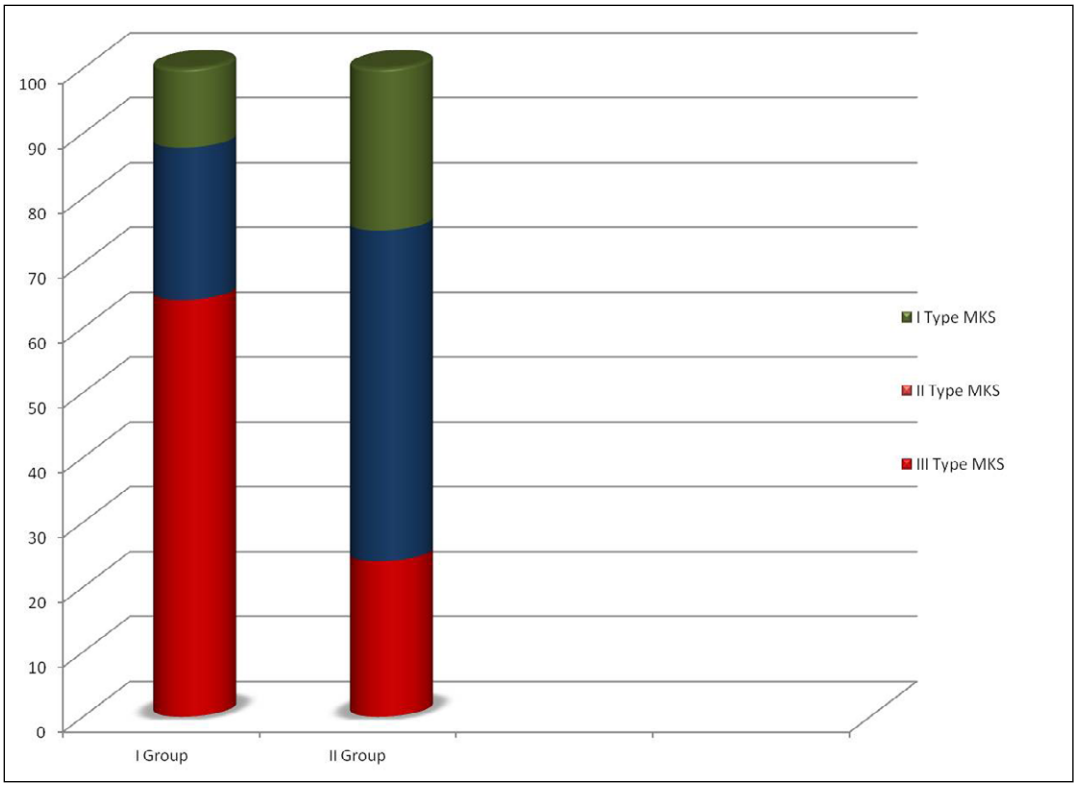

Fig. 1. Characteristics of microcrystallisation of mixed saliva in the examined children depending on the distribution by groups, (%).

prevalence and intensity of caries, as reflected by the dmft and DMFT indices.

When assessing the level of oral hygiene in children from both groups, it was found that the indicators did not differ significantly: the average oral hygiene index for internally displaced children was 1.52±0.025, and for children living in Poltava, it was 1.42±0.02. Both values are considered to indicate good oral hygiene status. This suggests that, despite the different living conditions and stressful situations faced by the internally displaced children, their level of oral hygiene remains acceptable.

In contrast to the findings on oral hygiene, the analysis of caries prevalence showed significant differences between the two groups. The average prevalence of caries among internally displaced children was 77.8%, an alarming indicator of the high level of caries in this vulnerable population. In comparison, the prevalence of caries among children living in Poltava was 66%, which, although lower, still represents a significant dental health concern for these children. Given the acceptable oral hygiene levels, it can be assumed that other factors—such as nutrition, access to healthcare services, and psycho-emotional stress—may have a significant impact on the oral health of the studied children [15].

The negative impact of armed conflicts on the psychological state of the population has been widely discussed in numerous scientific studies. The link between the dental health of internally displaced children and the consequences of living under constant stress has also been explored. A study conducted in Syria by Wail Habal et al. examined the effects of the Syrian crisis, assessing the mental and oral health of 99 Syrian internally displaced adolescents. The results demonstrated a significant relationship between mental health and oral health: participants diagnosed with psychological changes were more likely to rate the condition of their teeth and gums as average or poor [16].

According to our data, internally displaced children were found out to have decreased oral fluid parameters, such as lower pH levels, reduced salivary flow rates, and diminished mineralizing potential, all indicating low caries resistance. This may be attributed to stress factors and limited access to dental care, which contribute to higher rates of caries. It is well known that saliva maintains oral homeostasis through various functions, including lubrication, buffering, enamel mineralization, and antimicrobial activity. Salivary gland innervation and secretion are regulated by the central nervous system, and chronic stress can influence the concentration of salivary proteins and reduce salivary flow rates. This increases the risk of caries affects the concentration of salivary proteins and salivary flow rate [17, 18, 19, 20, 21].

Numerous studies have reported changes in the saliva composition and properties under the influence of stress caused by traumatic events [22, 23, 24, 25]. Research conducted by N. Yu. Yemelyanov in 2023 confirms that prolonged chronic stress significantly affects both the qualitative and quantitative parameters of oral fluid, highlighting the importance of non-invasive diagnostic methods, such as saliva microcrystallization analysis, for detecting stress [26].

In our study, the microcrystallization properties of oral fluid in internally displaced children showed significant changes that negatively impacted their dental health. The differences identified in the prevalence of microcrystallization (MCS) types suggest varying levels of stress and, consequently, potential health risks. In children who were exposed to considerable stress, Type I MCS, the most favorable for caries resistance, was observed twice as rarely as in children from Poltava (12.2% versus 25%). Similarly, Type II MCS was detected in 51% of children in Group II, nearly double the occurrence compared to Group I (23.5%).

The most alarming finding is the high rate of Type III MCT, recorded in 64.3% of children in Group I. This value is significantly higher than in Group II (24%), further confirming that stress factors related to the living conditions of internally displaced children have a substantial impact on their health.

CONCLUSIONS

This study revealed an increased susceptibility to caries in internally displaced children. The prevalence of caries among them was 77.8%, significantly higher than the 66% observed in children from Poltava. Although the level of oral hygiene in both groups was good (1.52 in internally displaced children and 1.42 in Poltava children), the morphological characteristics of the oral fluid indicated a high cariesogenic potential reflected in the lower pH (5.6 ± 0.04), reduced salivary flow rate (0.29 ml/min), low mineralizing potential (2.5 ± 0.04), and enamel resistance in internally displaced children, which was 1.6 times lower than in children from Poltava. These findings highlight the urgent need for targeted preventive programs to protect the dental health of this vulnerable group of children. These findings underscore the need for targeted prevention programs to support the dental health of this group of children and to adapt the regional prevention program accordingly.

REFERENCES

1. Kulu H., Christison S., Liu C. Mikolai J. The war, refugees, and the future of Ukraine's population. Population, Space and Place. 2023 ; 29 (4) : e2656. https://doi.org/10.1002/psp.2656 DOI
2. Niss.gov.ua. Internal forced displacement: volumes, problems and ways to solve them. https://niss.gov.ua/en/node/5096 Accessed September 21, 2024.
3. Jankowski M., Gujski M. Editorial: The Public Health Implications for the Refugee Population, Particularly in Poland, Due to the War in Ukraine. Med Sci Monit. 2022 Apr 1; 28: e936808. https://doi: 10.12659/MSM.936808 DOI
4. Boiko D.I., Skrypnikov A.M., Shkodina A.D., Hasan M.M., Ashraf G.M., Rahman M.H. Circadian rhythm disorder and anxiety as mental health complications in post-COVID-19. Environ Sci Pollut Res Int. 2022 Apr; 29 (19): 28062-28069. https://doi: 10.1007/s11356-021-18384-4. DOI
5. Salo A. K. SØR-VARANGER MUNICIPALITY: Security and trust in limbo following the Ukraine war. 2024. 90 p. (Master's thesis, UiT Norges arktiske universitet). https://hdl.handle.net/10037/34112
6. Udod O.A., Yefimova O.O. Retrospective analysis of the indicators of dental care for the population of the dontsk region. Sci Pract J Stomatol Bull. 2023; 122 (1): 94-99. https://doi: 10.31718/2409-0255.1.2023.12 DOI
7. Sheshukova O.V., Mosiienko A.S., Polishchuk T.V., Trufanova V.P., Bauman S.S., Kazakova K.S., Dodatko V.I. Epidemiology of dental caries in internally displaced children during wartime in Ukraine. Wiad Lek. 2024; 77(6):1155-1160. https://doi: 10.36740/WLek202406107 DOI
8. Humphrey S.P., Williamson R.T. A review of saliva: normal composition, flow, and function. J Prosthet Dent. 200;85(2):162-9. https://doi: 10.1067/mpr.2001.113778 DOI
9. UNHCR. Ukraine Emergency. [Online]. Available: https://www.unrefugees.org/emergencies/ukraine/. Accessed January 21, 2024.
10. Khomenko L.O., Ostapko O.I., Duda O.V. Ecological aspects of stomatological deseases in children. CLINICAL DENTISTRY. 2014; 1-2:53-63. https://doi: 10.11603/2311-9624.2011.1_2.2474 DOI
11. Yakubova I.I., Kuzmina V.A. Early childhood caries. State of the problem in Ukraine. Modern dentistry. 2017;1: 48-55. – Access mode: http://nbuv.gov.ua/UJRN/ss_2017_1_13.
12. Zadorozhna I., Povoroznyuk V. Prevalence and Intensity of Dental Caries in Children in Ukraine: Results of Clinical and Epidemiological Survey. PAIN, JOINTS, SPINE. 2022; 1-2(13-14); 26–29. https://doi.org/10.22141/2224-1507.1-2.13-14.2014.80058 DOI
13. Kaskova L.F., Popik K.M., Ulasevych L.P. et al. Age differences in permanent tooth caries index in children aged 6 to 16. Bull Probl Biol Med.2019; 1 (2), 353-357. https://doi: 10.29254/2077-4214-2019-1-2-149-353-357 DOI
14. Sheshukova O.V., Mosienko A.S., Trufanova V.P. et al. Prevalence and intensity of dental caries and fluorosis in children of Poltava city and its residential neighborhoods. Bull Probl Biol Med. 2020;156(2):369-373. https://doi: 10.29254/2077-4214-2020-2-156-369-373. DOI
15. Barma M.D., Bhadauria U.S., Purohit B. et al. Impact of war on oral health: a systematic review. Evid Based Dent. 2024; 25: 167–168. https://doi.org/10.1038/s41432-024-01006-6 DOI
16. Habal W., Alkattan R., Hajeer M.Y., Alkhouli M., Al-Nerabieah Z., Habal T., Awawdeh M. Impact of Syrian Conflict on the Oral Health of Adolescents: A Cross-Sectional Study. Cureus. 2024 Feb 21; 16(2):54613. https://doi: 10.7759/cureus.54613. DOI
17. Tikhonova, S., Booij, L., D'Souza, V. et al. Investigating the association between stress, saliva and dental caries: a scoping review. BMC Oral Health 2018; 18, 41 (. https://doi.org/10.1186/s12903-018-0500-z DOI

18. Dian Yosi Arinawati, Nurwulan Sari, Christina Mahardika; Relationship of stress level on salivary flow rate and salivary calcium. AIP Conf. Proc. 23 May 2024; 3127 (1): 020043. https://doi.org/10.1063/5.0216315 DOI
19. Bosch J.A., Brand H.S., Ligtenberg T.J., Bermond B., Hoogstraten J., Amerongen A.V.N. Psychological stress as a determinant of protein levels and salivary-induced aggregation of Streptococcus gordonii in human whole saliva. Psychosom Med. 1996; 58(4):374–82. https://doi: 10.1097/00006842-199607000-00010 DOI
20. Lupien S., McEwen B., Gunnar M. et al. Effects of stress throughout the lifespan on the brain, behaviour and cognition. Nat Rev Neurosci 10, 434–445 (2009). https://doi.org/10.1038/nrn2639 DOI
21. Tsuber V., Kadamov Y., Tarasenko L. Activation of antioxidant defenses in whole saliva by psychosocial stress is more manifested in young women than in young men. PLoS One. 2014 Dec 19;9(12):e115048. Salivary Research Unit, King's College London Dental Institute, Floor 17 Guy's Tower, London SE1 9RT, UK https://doi: 10.1371/journal.pone.0115048 DOI
22. Hugo F.N., Hilgert J.B., Corso S., Padilha D.M., Bozzetti M.C., Bandeira D.R., Pawlowski J., Gonçalves T.R. Association of chronic stress, depression symptoms and cortisol with low saliva flow in a sample of south-Brazilians aged 50 years and older. Gerodontology. 2008 Mar;25(1):18-25. https://doi: 10.1111/j.1741-2358.2007.00188.x DOI
23. Bosch Jos A., Turkenburg Marjolein, Nazmi Kamran, Veerman Enno C. I., de Geus Eco J. C., Amerongen Arie V. Nieuw. Stress as a Determinant of Saliva-Mediated Adherence and Coadherence of Oral and Nonoral Microorganisms. Psychosomatic Medicine. 2003; 65(4): p 604-612. https://doi.org/10.1097/01.PSY.0000074759.71084.AB DOI
24. Naumova E.A., Sandulescu T., Al Khatib P., Thie M., Lee W-K., Zimmer S., Arnold W.H. Acute short-term mental stress does not influence salivary flow rate dynamics. PLoS One. 2012;7(12):e51323. https://doi.org/10.1371/journal.pone.0051323 DOI
25. Naumova E.A., Sandulescu T., Bochnig C., Al Khatib P., Lee W.K., Zimmer S., Arnold W.H. Dynamic changes in saliva after acute mental stress. Sci Rep. 2014 May 8; 4: 4884. https://doi: 10.1038/srep04884 DOI
26. Emelyanova N. Y. The condition of the oral fluid in patients under conditions of long-term chronic stress. Ukrainian Therapeutical Journal. 2023. No. 2. P. 40–46. https://doi.org/10.30978/utj2023-2-40 DOI

CONFLICT OF INTEREST

The Authors declare no conflict of interest

CORRESPONDING AUTHOR

Olha Sheshukova
Poltava State Medical University
23 Shevchenka St., 36000 Poltava, Ukraine
email: oldista@gmail.com

ORCID AND CONTRIBUTIONSHIP

Olha Sheshukova: 0000-0002-4739-4890 A B F
Anna S. Mosiienko: 0000-0003-2129-8304 A B D
Tetiana V. Polishchuk: 0000-0003-1114-5830 A D
Alina I. Maksymenko: 0000-0002-9791-0873 C
Alla V. Marchenko: 0000-0003-2178-6383 B
Sofia S. Bauman: 0000-0002-9029-8968 E
Nataliia M. Lokhmatova: 0000-0002-7800-0516 E

A – Work concept and design, B – Data collection and analysis, C – Responsibility for statistical analysis, D – Writing the article, E – Critical review, F – Final approval of the article

RECEIVED: 23.08.2024
ACCEPTED: 22.11.2024