

THE IMPACT OF WEATHER AND CLIMATIC CONDITIONS ON THE DENTAL HEALTH OF MILITARY PERSONNEL

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ABSTRACT

The study is devoted to studying the dental status of military doctors while adapting to extreme weather and climatic conditions and strenuous official activities in the Donetsk People's Republic. The dental status of military personnel has been studied. The content of mineral substances in the blood serum of 20 servicemen who arrived on a business trip from the country's central region was determined. They were previously sanitized in their places of residence. The individuals in this group were monitored from the second to the third day of acclimatization during the hottest period of the year - July. Their nature of work was carried out in an open area in conditions of irregular working hours and increased psycho-emotional stress. The repeated examination of the military personnel was carried out after 20 days. Against the background of a violation of the electrolyte balance of the body, the phenomena of demineralization of hard dental tissues increased, the pH and volume of saliva secreted, and its mineralizing potential decreased. According to electroodontodiagnostics, the sensitivity of intact central incisors did not significantly change. The data obtained indicated a decrease in the caries resistance of military personnel.

Key words: Military personnel, Extreme conditions, Adaptation, Dental health.

Introduction

According to the World Health Organization, more than 98% of the adult population is susceptible to dental caries [1, 2]. In military personnel, the prevalence of this pathology has no significant differences and is 94.7% on average [3, 4]. In addition, recently there has been a positive trend in the growth of the prevalence and intensity of the carious process, the dominance of non-sanitized foci of odontogenic infection against the background of poor oral hygiene [5, 6].

Dental caries is one of the most common diseases in the world [7]. Dental caries is a polyetiological disease [8, 9]. The main factors in the development of caries are plaque microorganisms, the nature and diet, the amount and quality of salivation, extreme effects on the body, and the general condition of the body [10-12]. As internal factors contribute to the development of dental caries, it is necessary to consider the state of the oral fluid, the presence of chronic systemic diseases, and the level of resistance of the body [13-15]. External factors are nutrition, socio-economic, and behavioral factors [16-18].

World practice has proven that the introduction of prevention programs leads to a sharp decrease in caries, prevention of the development of foci of odontogenic infection, and early tooth loss [19, 20]. The cost of preventive measures is up to 20 times lower than the cost of

treating existing dental diseases [21]. Over the past three decades, the results of the prevention of dental caries indicate its decline in many regions of the world in all age groups [22].

The effectiveness of methods of population and individual prevention when using fluoride preparations has been proven [23, 24]. Fluoride ions contribute to the formation of fluorapatite in enamel but in the presence of calcium and phosphate ions, which affects the process of enamel demineralization [25]. However, the most important thing is to conduct research on the prevention of caries in the early stages through non-invasive intervention to ensure the remineralization of foci [26]. This may be an important step in the treatment of this disease.

Dental diseases in military personnel of law enforcement agencies and the processes caused by them reduce the combat capability and working capacity of personnel, leading to the appearance and development of diseases of internal organs and systems that affect the general condition of the body [27]. The prevalence and course of pathological processes of the dental system are significantly influenced by the specific living conditions and combat activities of military personnel, which requires appropriate methods of prevention and treatment [28].

At the same time, the conditions of professional activity of military personnel affecting the incidence of dental caries of hard tissues have not been studied in depth enough to date [29, 30]. Of particular interest is also the study of caries prevention measures based on nutrition optimization [15, 20]. The combination of the above mentioned problems has determined the relevance of this study.

The purpose of the study: clinical and laboratory assessment of risk factors for the development of dental caries in military personnel.

Materials and Methods

The object of surveillance was military personnel who arrived on a business trip from the central region of Russia to the Donetsk People's Republic aged 23 to 25 years. They were monitored from the second to the third day of acclimatization during the hottest period of the year (July). It was found that the body is affected by a whole range of adverse factors [31-38]: weather and climatic conditions, insufficient intake of fluoride from drinking water, and factors of professional activity (physical, psycho-emotional stress, irregular working hours, etc.) [39-41]. Among the main reasons for non-compliance with the regulatory requirements of drinking water quality are the increased content of calcium and magnesium salts (total hardness), nitrogen-containing compounds, arsenic, and low content of fluorine, and iodine [42-44].

Significant concentrations of arsenic are detected in the waters of various regions of the Donetsk People's Republic [45, 46]. More than 200 thousand people consume water with a high iron content in the republic [47].

It should be noted that the territory of the Donetsk People's Republic is a biogeochemical province, where a natural area of risk to public health has naturally developed [48-51].

The servicemen carried out their work in an open area in conditions of irregular working hours and increased psycho-emotional tension. They were housed in military camps, and ate in an organized manner in the conditions of a field kitchen; when working outside the territory of permanent deployment, they used an individual diet for food [52, 53].

The work uses hygienic, clinical laboratory, sanitary and chemical, instrumental, radiological, computational, and statistical research methods. The research was conducted

based on organized military collectives in the Donetsk People's Republic. An assessment of the working conditions of military personnel according to the degree of harmfulness and danger was carried out. According to the data obtained from the hydrometeorological center of the republic, the weather and climatic conditions were assessed.

To objectively study the caries resistance of military personnel, an assessment of the content of minerals in the blood serum of persons who arrived at military training (potassium, sodium, chlorine, phosphorus, calcium, magnesium) was carried out. The research was conducted using standard methods;

- measurement of the vital activity of the pulp by an electrodontodiagnostic device [54];
- conducting an enamel resistance test to the action of a standard 0.1% acid solution followed by staining with 1% methylene blue [55];
- determination of the acid-silk balance of saliva (pH) using indicator strips (RochDiagnostics Switzerland);
- determination of salivation rate by saliva collection technique for 10-15 minutes without additional stimulation;
- determination of the mineral-forming composition of saliva using a complex of automated microscopy with a telemedicine function for hematological, cytological, and histological studies "Mekos-C2" with an increase of 4×10 [56].

Statistical data processing was carried out using the Statistica program. Statistical data analysis was performed for dependent (Wilcoxon criterion) samples.

Results and Discussion

The study involved 81 servicemen who arrived in the Donetsk People's Republic in 2023. The average age of men was 28.4 ± 0.55 years.

According to the assessment of climatic conditions, the average daytime temperature in the open area on some days reached 27.4 °C, and the maximum was 30.0 °C. The relative humidity of the air exceeded the limits of the norm ($77.3 \pm 2.6\%$), reaching 80.0-100.0%. The minimum wind speed was 2.0 m/s, the maximum was 7.0 m/s (4.3 ± 0.3 m/s). An assessment of the content of electrolytes and trace elements [57] in the blood serum of persons who arrived on a business trip in a hot, humid climate showed that they were within the reference boundaries (**Table 1**).

Table 1. Comparative indicators characterizing the dynamics of the levels of electrolytes and trace elements in the blood serum of the examined persons, $M \pm m$

№	Mineral substance	Reference limits, mmol/l	Observation period	
			Initial data	After 21 days
1	Potassium	3.5-5.1	4.01 ± 0.14	3.56 ± 0.15 , $p=0.0038$
2	Sodium	136-146	135.2 ± 0.62	128.5 ± 1.33 , $p=0.003$

3	Chlorine	97-107	102.2±0.95	100.0±1.17, p=0.00384
4	Calcium	2.15-2.57	2.13±0.06	2.04±0.06, p=0.106
5	Phosphorus	0.87-1.45	0.93±0.03	1.16±0.08, p=0.0104
6	Magnesium	0.80-1.00	0.92±0.02	0.95±0.05, p=0.22

However, after 20 days of acclimatization, a significant decrease in the content of potassium and sodium was determined: on average - by 11.2% and 5.0%, respectively. At the same time, the sodium level was below the normal limits. Chlorine levels decreased in 80.0% of individuals by an average of 2.2% [58-64]. According to individual indicators, 46.7% of the studied individuals had reduced potassium levels, and 13.3% had chlorine levels. Sodium levels were below normal in all military personnel. This indicated a violation of the body's water-electrolyte balance [65-68]. The calcium level did not significantly change, but

it decreased in the majority of the examined individuals. Initially, it was below the norm at 53.3%, by the end of the follow-up it was at 66.7%. The phosphorus level, on the contrary, increased within the reference boundaries, which was noted in 86.7% of individuals [69-79]. Only the magnesium level remained within the same limits. This is directly related to changes in mineral metabolism in the oral cavity and a decrease in caries resistance of hard dental tissues [80-83], as shown in the studies presented below (**Figure 1**).

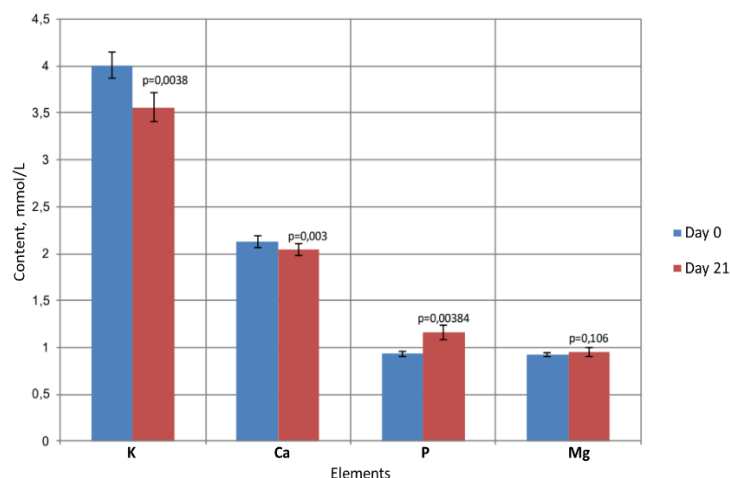


Figure 1. Dynamics of potassium, calcium, phosphorus, and magnesium content during adaptation to extreme conditions

When assessing the dynamics of resistance indicators of oral fluid and enamel, it was determined that at the time of arrival of the subjects in the Donetsk People's Republic, the pH of saliva was slightly alkaline. After 20 days, the acid-base balance shifted to the acidic side (**Table 2**). At the same time, such a saliva reaction was noted in 86.7% of the examined individuals. Of these, 20.0% had a pH below 6.5 units. (average norm): up to 6.2 units. In the initial state, 53.3% had a score of up to 3 points, which indicated a significant resistance of the enamel to caries; The remaining individuals represented a risk group for caries (**Figure 2**) [8, 9, 23, 84]. By the end of the follow-up, all 100.0% of individuals

according to this indicator belonged to the risk group for caries, where the indicator of the enamel resistance test was more than 5 points. According to the average data, the mineralizing potential of saliva in the initial state was assessed as satisfactory (**Figure 3a**). In the dynamics of observation, a significant decrease in the mineralizing function of saliva towards demineralization was noted (**Figure 3b**) [24, 29, 30]. The rate of salivation also significantly decreased – by 5.5%; This was found in 86.7% of individuals. The data of electrodiagnostics and radiography have not changed significantly [85-95].

Table 2. Indicators characterizing the caries resistance of individuals, M ± m

№	Indicators	Reference limits	Observation period	
			Initial data	Initial data
1	Saliva pH	6.8-7.4 units.	7.25±0.08	6.66±0.08, p=0.0022
2	Saliva's mineralizing potential	1-5 points	2.8±0.2	2.6±0.18, p=0.0014
3	Enamel resistance test	1-10 points	3.4±0.22	5.1±0.17, p=0.0017

4	Salivation rate	18-111.0 ml/h	25.32±1.14	23.92±1.36, p=0.0007
5	Electrodontodiagnostics of intact central incisors of the upper jaw	2-6 μ A	4.88±0.14	5.17±0.12, p=0.47

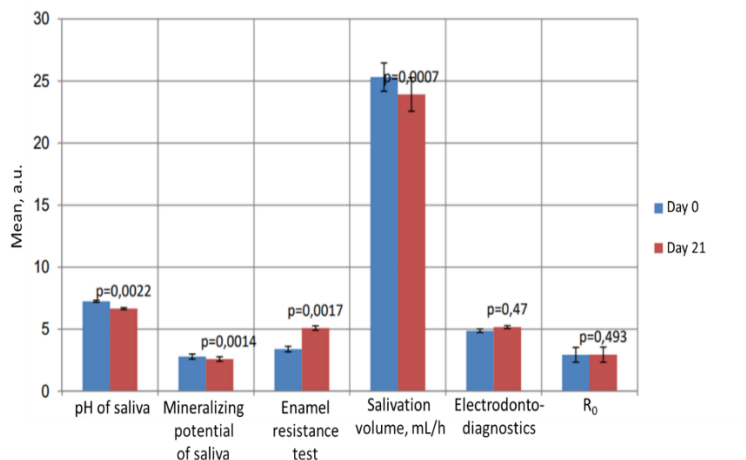


Figure 2. Dynamics of indicators of resistance of oral fluid and enamel

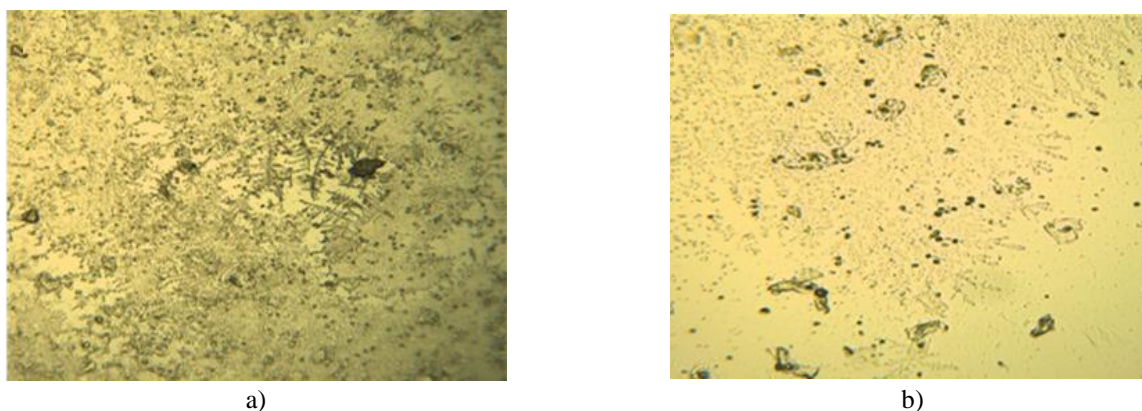


Figure 3. Photo (saliva mineralizing potential) in its initial state before arrival in the Donetsk People's Republic (a) and after 21 days of service (b)

Conclusion

Thus, as the results of the study showed:

1. Weather, climatic, and social factors affect the human body in a fairly short time (20 days after the change of location).
2. The Donetsk People's Republic is a biogeochemical province, which must be taken into account when temporarily residing in this territory.

Staying in this area is accompanied by a violation of the electrolyte balance of the body and a decrease in the mineralizing potential of saliva, which puts this category of employees at risk for the development of dental caries.

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Conflict of interest: None

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Ethics statement: The military personnel under study were explained the goals and objectives of the study, after which they gave written consent. The study was approved by the Ethic Committee of the institution (Protocol #3 Dated by August 3 2023).

References

1. Borg-Bartolo R, Rocuzzo A, Molinero-Mourelle P, Schimmel M, Gambetta-Tessini K, Chaurasia A, et al. Global prevalence of edentulism and dental caries in middle-aged and elderly persons: a systematic review and meta-analysis. *J Dent.* 2022;127:104335. doi:10.1016/j.jdent.2022.104335
2. Bashir NZ. Update on the prevalence of untreated caries in the US adult population, 2017-2020. *J Am Dent Assoc.* 2022;153(4):300-8. doi:10.1016/j.adaj.2021.09.004
3. Batsos C, Boyes R, Mahar A. Community water fluoridation exposure and dental caries experience in newly enrolled members of the Canadian armed forces

- 2006-2017. *Can J Public Health*. 2021;112(3):513-20. doi:10.17269/s41997-020-00463-7
4. Schindler DK, Lopez Mitnik GV, Zarzabal LA, Soliván-Ortiz AM, Irwin SP, Boroumand S, et al. Dental caries risk in the U.S. air force: 2009 to 2017. *Mil Med*. 2020;185(11-12):e2061-70. doi:10.1093/milmed/usaa155
 5. Govindraj V, Nagarajan T, Mechery R, Patil C, Sri S, Vidyadharan, et al. Oral health practices related risk factors and prevalence of dental caries in Armed Forces: a multicentric study. *Med J Armed Forces India*. 2024;80(4):475-81. doi:10.1016/j.mjafi.2024.05.011
 6. Baklanova OA, Baklanov IS, Kolomak AI, Pokhilko AD. Sociality as a social-philosophical problem. *Life Sci J*. 2014;11(11s):5-7.
 7. Shi L, Zhu Z, Tian Q, He L. Association of interdental cleaning and untreated root caries in adults in the United States of America. *Int Dent J*. 2023;73(6):819-27. doi:10.1016/j.identj.2023.04.004
 8. Radhi AA, Jaafar IS. Factors influencing the dissolution behavior of meloxicam dispersions. *J Adv Pharm Educ Res*. 2022;12(3-2022):9-14.
 9. Soboleva MS, Loskutova EE, Kosova IV. Pharmacoepidemiological study of the use of e-pharmacies by the population. *J Adv Pharm Educ Res*. 2022;12:36-43.
 10. Pitts NB, Twetman S, Fisher J, Marsh PD. Understanding dental caries as a non-communicable disease. *Br Dent J*. 2021;231(12):749-53. doi:10.1038/s41415-021-3775-4
 11. A Patenaude S, Papagerakis P, R L Lieffers J. Development of a nutrition questionnaire for dental caries risk factors. *Int J Environ Res Public Health*. 2020;17(5):1793. doi:10.3390/ijerph17051793
 12. Shao Q, Feng D, Yu Z, Chen D, Ji Y, Ye Q, et al. The role of microbial interactions in dental caries: dental plaque microbiota analysis. *Microb Pathog*. 2023;185:106390. doi:10.1016/j.micpath.2023.106390
 13. Duruk G, Laloglu E. Relationship between dental caries and YKL-40 levels in saliva. *J Clin Pediatr Dent*. 2022;46(2):137-42. doi:10.17796/1053-4625-46.2.8
 14. Dzugutova K, Kozyreva Z, Mekhtieva K, Bertaev B, Agkatsev A, Zaseev R, et al. Experimental in vivo evaluation of the activity of hydroxyapatite modified with selenium nanoparticles against caries in laboratory animals. *J Med Pharm Chem Res*. 2024;7(1):89-97. doi:10.48309/jmpcr.2025.457522.1243
 15. Samyuktha PS, Syam S. Periodontal abscess as a clinical oral sign in patients with diabetes mellitus - an original study. *Bull Pioneer Res Med Clin Sci*. 2024;3(2):7-12. doi:10.51847/ZDpdihizWm
 16. Sengupta K, Bihrmann K, Christensen LB, Mortensen LH, Andersen I, Ersbøll AK. Development of geographic inequality in dental caries and its association with socioeconomic factors over an 18-year period in Denmark. *BMC Oral Health*. 2023;23(1):662. doi:10.1186/s12903-023-03373-5
 17. Siddiqui SA, Pahmeyer MJ, Mehdizadeh M, Nagdalian AA, Oboturova NP, Taha A. Consumer behavior and industry implications. In *The age of clean label foods 2022 Jun 7* (pp. 209-247). Cham: Springer International Publishing. doi:10.1007/978-3-030-96698-0_7
 18. Falah Abdulwahab R, Khalaf MS. Comparison of green tea [TWININGS®] and matcha tea [now Real Tea®] effect on re-mineralization of artificially-Induced initial enamel caries of human teeth: study *in vitro*. *J Med Pharm Chem Res*. 2025;7(4):775-85. doi:10.48309/jmpcr.2025.468590.1340
 19. Machiulskiene V, Campus G, Carvalho JC, Dige I, Ekstrand KR, Jablonski-Momeni A, et al. Terminology of dental caries and dental caries management: consensus report of a workshop organized by ORCA and cariology research group of IADR. *Caries Res*. 2020;54(1):7-14. doi:10.1159/000503309
 20. Ansari SH, Qamar Z, Alshammari M, Bazoun R, Alenazi R, Alattar R. Clinical efficacy and longevity of monolithic VS layered zirconia crowns; a systematic review. *Bull Pioneer Res Med Clin Sci*. 2024;3(1):7-18.
 21. Cortellini P, Stalpers G, Mollo A, Tonetti MS. Periodontal regeneration versus extraction and dental implant or prosthetic replacement of teeth severely compromised by attachment loss to the apex: a randomized controlled clinical trial reporting 10-year outcomes, survival analysis and mean cumulative cost of recurrence. *J Clin Periodontol*. 2020;47(6):768-76. doi:10.1111/jcpe.13289
 22. Esiev RK, Samvelyan AA, Kliukina EI, Gazaryants VA, Abdurakhmanova BS, Garibyan VS, et al. Investigation of the effectiveness of nano impregnation of dentine tubules with a molecular complex of copper hydroxyapatite. *J Med Pharm Chem Res*. 2024;7(1):42-50. doi:10.48309/jmpcr.2025.457568.1244
 23. Polevoy GG, Sablin AB. Development of flexibility of children with different types of the nervous system using speed-strength exercises. *Arch Pharm Pract*. 2022;13(2-2022):7-10.
 24. Lampasona M, Pantaleo L. The role of pharmacies in immunization programs and health promotion. *Arch Pharm Pract*. 2022;13(2-2022):62-5.
 25. Schiffner U. Use of fluorides for caries prevention. *Bundesgesundheitsblatt Gesundheitsforschung Gesundheitsschutz*. 2021;64(7):830-7. [German]. doi:10.1007/s00103-021-03347-4
 26. Shah SV, Kibbe LJ, Heaton LJ, Desrosiers C, Wittenborn J, Filipova M, et al. Framework for fiscal impact analysis of managing initial caries lesions with noninvasive therapies. *J Am Dent Assoc*. 2023;154(10):897-909. doi:10.1016/j.adaj.2023.07.007

27. Patinen P, Tanner T, Huttunen M, Muhonen A, Räsänen S, Moilanen P, et al. Caries experience and erosive tooth wear in Finnish men conscripts 2021: a cross-sectional study. *Dent J (Basel)*. 2022;10(7):122. doi:10.3390/dj10070122. Erratum in: *Dent J (Basel)*. 2022 Oct 24;10(11):197. doi:10.3390/dj10110197
28. Lim SN, Tay KJ, Li H, Tan KBC, Tan K. Prevalence and risk factors of erosive tooth wear among young adults in the Singapore military. *Clin Oral Investig*. 2022;26(10):6129-37. doi:10.1007/s00784-022-04562-2
29. Dorontsev AV, Vorobyeva NV, Kumantsova ES, Shulgin AM, Sharagin VI, Eremin MV. Functional changes in the body of young men who started regular physical activity. *J Biochem Technol*. 2022;13(1-2022):65-71.
30. Ranganadhareddy A. Production of polyhydroxyalkanoates from microalgae—a review. *J Biochem Technol*. 2022;13(2-2022):1-6.
31. Tsvetkova D, Kostadinova I, Vezenkov L, Marinov L. Determination of radical scavenging activity of Creatine lysinate against methanol solutions of ABTS. *J Adv Pharm Educ Res*. 2023;13(2):150-5.
32. Triyono T, Amijaya KA. Regular donor characteristics, inter-donation interval and the presence of subclinical anemia—a 3-year observational single-center study. *J Adv Pharm Educ Res*. 2023;13(2):118-23.
33. Akbari M. Topical interferon alpha-2b is a proper alternative for management of adenoviral keratitis: a case report. *J Adv Pharm Educ Res*. 2023;13(2):12-5.
34. Arroyo-Fernández A, Blanco-Fernández MA, Lladó-Jordan G. Psychological therapy in overweight and obesity treatment centers. Do the centers include it on their websites? *J Adv Pharm Educ Res*. 2023;13(1):158-61.
35. Nezhadrahim A, Shahri MM, Akbari NN. Effects of the Roux-en-Y gastric bypass on DM and renal function in obese patients. *J Adv Pharm Educ Res*. 2023;13(1):1-5.
36. Deisy D, Aditama L, Yulia R. Consumers' knowledge, attitude and practice of respiratory symptoms self-medication in community pharmacy during COVID-19 pandemic. *J Adv Pharm Educ Res*. 2023;13(1):66-72.
37. Moses MP. CHATGPT4 (AI) shaping the future of medical laboratory sciences by improving teaching, learning, and assessment. *J Adv Pharm Educ Res*. 2024;14(1):52-5.
38. Nugroho AE, Perwitasari DA, Athiyah U, Tjahjono DH, Diantini A, Syukri Y, et al. Does on-line learning affect to achieve the minimal competencies of entry level pharmacists in Indonesia? *J Adv Pharm Educ Res*. 2024;14(1):21-5.
39. Knapik JJ, Trone DW, Steelman RA, Farina EK, Lieberman HR. Adverse effects associated with multiple categories of dietary supplements: the military dietary supplement use study. *J Acad Nutr Diet*. 2022;122(10):1851-63. doi:10.1016/j.jand.2022.01.014
40. Van Puyvelde M, Van Cutsem J, Lacroix E, Pattyn N. A state-of-the-art review on the use of modafinil as a performance-enhancing drug in the context of military operationality. *Mil Med*. 2022;187(1-2):52-64. doi:10.1093/milmed/usab398
41. McLarnon MJW, Rothstein MG, King GA. Resiliency to adversity in military personnel: the role of self-regulation. *Mil Psychol*. 2021;33(2):104-14. doi:10.1080/08995605.2021.1897492
42. Klitynska OV, Hasiuk NV, Struk VI, Kruchak RY, Gurando VR, Bobelskyi VV. The quality of drinking water as a factor in the formation of dental pathology of the hard tissues of the teeth in children. *Wiad Lek*. 2021;74(5):1120-4.
43. Egbueri JC. A multi-model study for understanding the contamination mechanisms, toxicity and health risks of hardness, sulfate, and nitrate in natural water resources. *Environ Sci Pollut Res Int*. 2023;30(22):61626-58. doi:10.1007/s11356-023-26396-5
44. Bykowska-Derda A, Spychala M, Czlapka-Matysik M, Sojka M, Bykowski J, Ptak M. The relationship between mortality from cardiovascular diseases and total drinking water hardness: systematic review with meta-analysis. *Foods*. 2023;12(17):3255. doi:10.3390/foods12173255
45. Fu Z, Xi S. The effects of heavy metals on human metabolism. *Toxicol Mech Methods*. 2020;30(3):167-76. doi:10.1080/15376516.2019.1701594
46. Rahmani A, Khamutian S, Doosti-Irani A, Saatchi O, Shokoohizadeh MJ. Arsenic level in drinking water, its correlation with water quality parameters, and associated health risks. *Environ Monit Assess*. 2023;195(7):899. doi:10.1007/s10661-023-11486-1
47. Zhou S, Li W, Wan J, Fu Y, Lu H, Li N, et al. Heavy metals in drinking water and periodontitis: evidence from the national oral health survey from China. *BMC Public Health*. 2023;23(1):1706. doi:10.1186/s12889-023-16391-3
48. Elshorbagy RT, Balbaa AE, Ayad KE, Allam NM, Eladl HM, Allah WR. Cognitive task versus focus of attention on dynamic postural control in recurrent ankle sprains. *J Adv Pharm Educ Res*. 2022;12(2):6-10.
49. Abdel-Hadi B, Abdel-Fattah SR. Clinical pharmacist intervention in Appendectomy-Dexametomidine as an adjunct therapy. *J Adv Pharm Educ Res*. 2022;12(2):1-5.
50. Batarseh N, Khalil R, Al-Domi HA. Hypothalamic neuroinflammation induced by obesity and the effect of Liraglutide. *J Adv Pharm Educ Res*. 2022;12(1):46-55.
51. Vasetska O, Zhminko P, Prodanchuk M, Galkin A, Tsygankova V. Perspective for using 2, 6-dimethylpyridine-N-oxide to reduce the toxic effect of

- xenobiotics in mammals. *J Adv Pharm Educ Res.* 2022;12(1):21-9.
52. Sadovoy VV, Selimov MA, Slichedrina TV, Nagdalian AA. Usage of biological active supplements in technology of prophylactic meat products. *Res J Pharm Biol Chem Sci.* 2016;7(5):1861-5.
 53. Alruwaili A, Khorram-Manesh A, Ratnayake A, Robinson Y, Goniewicz K. Supporting the frontlines: a scoping review addressing the health challenges of military personnel and veterans. *Healthcare (Basel).* 2023;11(21):2870. doi:10.3390/healthcare11212870
 54. Tran HT, Kong Y, Talati A, Posada-Quintero H, Chon KH, Chen IP. The use of electrodermal activity in pulp diagnosis and dental pain assessment. *Int Endod J.* 2023;56(3):356-68. doi:10.1111/iej.13868
 55. Kim MJ, Lee MJ, Kim KM, Yang SY, Seo JY, Choi SH, et al. Enamel demineralization resistance and remineralization by various fluoride-releasing dental restorative materials. *Materials (Basel).* 2021;14(16):4554. doi:10.3390/ma14164554
 56. Proctor GB, Shaalan AM. Disease-induced changes in salivary gland function and the composition of saliva. *J Dent Res.* 2021;100(11):1201-9. doi:10.1177/00220345211004842
 57. Joshi A, Kaur S, Taneja SK, Mandal R. Review article on molecular mechanism of regulation of hypertension by macro-elements (Na, K, Ca and Mg), Micro-elements/Trace Metals (Zn and Cu) and Toxic Elements (Pb and As). *Biol Trace Elem Res.* 2024;202(4):1477-502. doi:10.1007/s12011-023-03784-z
 58. Tilahun L, Jenber AJ, Degu A, Tizazu TY. Effects of preservative solutions on shelf life and quality of cut gypsophila flowers, Ethiopia. *World J Environ Biosci.* 2024;13(1):8-14.
 59. Kyire LA, Ackah O, Acheampong EO, Korda MH. Antecedents of green innovation among SMEs in Ghana: the moderating role of organizational green core competence. *World J Environ Biosci.* 2023;12(3):47-57.
 60. Fada SJ, Omotoriogun TC, Tende T, Abidemi K, Awoyemi AG, Folaranmi B, et al. Wildlife conservation in Nigeria: a perception of professionals and practitioners. *World J Environ Biosci.* 2023;12(3):40-6.
 61. Padma KR, Don KR, Dinesh B, Karthikeyan D. Antibiotics are current approaches to improve productivity using soil microbiome. *World J Environ Biosci.* 2023;12(3):33-9.
 62. Malthesh SR, Achar RR, Cathrine AA, Vadiraj KT. Extraction of alcohols from non-edible agricultural weed, lignocellulouic feedstock-alternanthera caracasana. *World J Environ Biosci.* 2023;12(3):27-32.
 63. Omondi EA, Kegode AA. The role of physicochemical pretreatment in lignocellulosic biomass energy valorisation—a review. *World J Environ Biosci.* 2023;12(3):7-19.
 64. Cherif BA. The floods in arid areas case of catchment of the Valley Béchar, South-West, Algeria. *World J Environ Biosci.* 2023;12(3):1-6.
 65. Kwiatkowski MJ, Fryc J, Brzóska S, Naumnik B. Water-sodium homeostasis in hemodialysis - the eternal problem in nephrology practice. *Pol Merkur Lekarski.* 2021;49(292):311-5. [Polish].
 66. Bernal A, Zafra MA, Simón MJ, Mahía J. Sodium homeostasis, a balance necessary for life. *Nutrients.* 2023;15(2):395. doi:10.3390/nu15020395
 67. Gil-Bona A, Bidlack FB. Tooth enamel and its dynamic protein matrix. *Int J Mol Sci.* 2020;21(12):4458. doi:10.3390/ijms21124458
 68. Ciosek Ż, Kot K, Kosik-Bogacka D, Łanocha-Arendarczyk N, Rotter I. The effects of calcium, magnesium, phosphorus, fluoride, and lead on bone tissue. *Biomolecules.* 2021;11(4):506. doi:10.3390/biom11040506
 69. Tovar NE, Méndez EJ, Cruz WX, Rodríguez DC, Ramos NS, Gómez BJ, et al. Mango peel as a substrate for the production of citric acid. *World J Environ Biosci.* 2023;12(2):43-7.
 70. Meena DS, Akash A, Bijalwan K, Bhandari BS, Sharma P. Efficacy of oleoresin obtained from bore-hole method in chir-pine for potential antimicrobial activity. *World J Environ Biosci.* 2023;12(2):7-12.
 71. AlTurkistani MA, Albarqi HH, Alderaan MY. Medical errors in pediatric emergency to improve safety and quality, a systematic review. *World J Environ Biosci.* 2023;12(1):41-6.
 72. Mulu E, Jenber AJ, Tesfaye A, Belay B. Integrated management of onion thrips on onion, Mecha District, Ethiopia. *World J Environ Biosci.* 2023;12(1):32-40.
 73. Gowda B, Gurusiddappa LH, Kalikeri S. Study on occupational health hazards of municipal solid waste workers-a review. *World J Environ Biosci.* 2023;12(1):24-31.
 74. Mortazavizadeh SM, Rafatmagham S, Tabatabaie F, Hakimizad R, Hashemipour SM. Frequency distribution and ten-year survival rate of patients with different malignant liver lesions in Iran. *J Adv Pharm Educ Res.* 2022;12(2):71-5.
 75. Alarfaj SJ, Ibrahim A, Alshahrani J, Alnuwaysir M, Almutairi A, Alwahhabi B. Effectiveness, tolerability, and pattern of liraglutide treatment use for weight loss: a mixed-methods cohort study. *J Adv Pharm Educ Res.* 2022;12(2):63-70.
 76. Van Nguyen T, Le HT, Nguyen HT. Evaluating the curriculum of vocational schools in Vietnam. *J Adv Pharm Educ Res.* 2022;12(2):57-62.
 77. Xuan EY, Razak NF, Ali AM, Said MM. Evaluation of knowledge, attitudes, and perceptions on halal pharmaceuticals among pharmacy students from Malaysian private universities. *J Adv Pharm Educ Res.* 2022;12(1):84-90.
 78. Van TP. Relationship between well-being and social interaction of disabled people in Ho Chi Minh City, Vietnam. *J Adv Pharm Educ Res.* 2022;12(2):23-9.

79. Salama NM, El-Rokh ES, Hashem G, Mowafy HH, Elsisy MH, Labib DA. Clopidogrel versus ticagrelor in elective percutaneous coronary intervention. *J Adv Pharm Educ Res.* 2022;12(2):30-7.
80. Zhou Y, Liu Z. Saliva biomarkers in oral disease. *Clin Chim Acta.* 2023;548:117503. doi:10.1016/j.cca.2023.117503
81. Song M, Bai H, Zhang P, Zhou X, Ying B. Promising applications of human-derived saliva biomarker testing in clinical diagnostics. *Int J Oral Sci.* 2023;15(1):2. doi:10.1038/s41368-022-00209-w
82. Melguizo-Rodríguez L, Costela-Ruiz VJ, Manzano-Moreno FJ, Ruiz C, Illescas-Montes R. Salivary biomarkers and their application in the diagnosis and monitoring of the most common oral pathologies. *Int J Mol Sci.* 2020;21(14):5173. doi:10.3390/ijms21145173
83. Logan D, Wallace SM, Woodside JV, McKenna G. The potential of salivary biomarkers of nutritional status and dietary intake: a systematic review. *J Dent.* 2021;115:103840. doi:10.1016/j.jdent.2021.103840
84. Yellepeddi VK, Race JA, McFarland MM, Constance JE, Fanaeian E, Murphy NA. Effectiveness of atropine in managing sialorrhea: a systematic review and meta-analysis. *Int J Clin Pharmacol Ther.* 2024;62(6):267-77. doi:10.5414/CP204538
85. Obisesan OO, Egbetokun OA. Climate change impacts, food security, intra-africa trade and sustainable land governance on food systems in Africa. *World J Environ Biosci.* 2024;13(3):39-50.
86. Nagdalian A, Askerova A, Blinov A, Shariati MA. Evaluation of the toxicity of copper oxide nanoparticles toward pea seeds. *World J Environ Biosci.* 2024;13(3):23-30.
87. Kumbhar S, Patil N, Patil B, You HW, Bhatia M. Unleashing the power of rutin-loaded nanophytosomes: enhancing antioxidant potential for improved health outcomes. *World J Environ Biosci.* 2024;13(3):8-15.
88. da Silva J, Rosa GB, Sganzerla WG, Ferrareze JP, Simioni FJ, Campos ML. Studying the effectiveness of phytoremediation in the purification of soils contaminated with heavy metals. *World J Environ Biosci.* 2024;13(3):1-7.
89. Jaafar NH, Jalani SM, Mohamed R, Mutalip SS. *Nigella sativa* on the improvement of ovarian dysfunctions in polycystic ovary syndrome (PCOS): a short review. *World J Environ Biosci.* 2024;13(2):36-40.
90. Singar FA. Characterization of defatted cake prepared from egyptian olive's fruit (Wateeken Cultivar) and its biological activity. *World J Environ Biosci.* 2024;13(2):31-5.
91. Shaji S, Gowda B, Gurusiddappa LH, Veeresh SJ, Kalikeri S, Bellari K, et al. Navigating the hazards: a review of pesticides and their effects on human well-being. *World J Environ Biosci.* 2024;13(2):21-30.
92. Doddapanen N, Lakshmegowda YK, Aardhya S, Rajashekar R, Doolgindachbaporn T, Nagaraju P. Environmental education, awareness and environmental ethics among pre-university students of Mysuru city, Karnataka, India. *World J Environ Biosci.* 2024;13(2):13-20.
93. Bergeron S, Boopathy R, Nathaniel R, Corbin A, LaFleur G. A review of the reasons for increasing the antibiotic-resistant bacteria presence in drinking water. *World J Environ Biosci.* 2024;13(2):6-12.
94. Enwa S, Ogisi OD, Ewuzie PO. Gender role and effects on climate change adaptation practices among vegetable farmers in delta central zone. *World J Environ Biosci.* 2024;13(1):22-9.
95. López-García JA, Madrigal-López M, De Gyves-Cordova MG, Albores-Flores V, Grajales-Conesa J. Evaluation of in vivo encapsulated biopolymers of moringa leaves (*Moringa oleifera*) in ruminal overrun. *World J Environ Biosci.* 2024;13(1):15-21.