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НАУЧНЫЙ МЕДИЦИНСКИЙ ЖУРНАЛ ВОРОНЕЖСКОГО ГОСУДАРСТВЕННОГО МЕДИЦИНСКОГО УНИВЕРСИТЕТА ИМ. Н. Н. БУРДЕНКО И РОССИЙСКОГО НАЦИОНАЛЬНОГО ИССЛЕДОВАТЕЛЬСКОГО МЕДИЦИНСКОГО УНИВЕРСИТЕТА ИМ. Н. И. ПИРОГОВА

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HYGIENIC ASSESSMENT OF RISK FACTORS AND HEALTH OF FORENSIC SCIENTISTS

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The objective of the study was to develop and implement the system of hygienic measures eliminating (mitigating) the impact of risk factors in the work of forensic scientists and to estimate effectiveness of these measures and the program aimed at improvement of employment terms for forensic scientists [1, 2]. Forensic scientists were compared to a control group of other doctors. The following researches were carried out: survey of 303 forensic scientists, analysis of their employment terms based on employment terms special evaluation (2,736 materials of employment terms special evaluation), examination of forensic scientists' health compared to other doctors by analyzing medical examination results (309 health records). Protection and promotion of working population's health is the state priority. Its purpose is to preserve labor potential and create conditions for economic development of the country. Medical workers are exposed to a combined, complex, and associated effect of working environment conditions and parameters [3, 4]. Industrial and social factors can result in a rising incidence, reduction in life expectancy, ill health and medical staff performance increment, and require preventive measures. Those working for forensic expert organizations constitute a special population due to a large number of professional, medical and organizational, and social risk factors [5].

Keywords: forensic scientist, risk factors, occupational hazard

Author contributions: Timerzyanov MI, Milushkina OY — academic advising, writing an article; Ilyina OA, Dubrovina EA, Vasilyev DE — data collection, statistical analysis, literature analysis

Compliance with ethical standards: This trial was approved by the National Office of the Chief Medical Examiner of the Republic of Tatarstan (Protocol No. 4 dated 14.03.2019). Consent shall be given voluntarily by every participant. Adults were surveyed on a voluntary basis using questionnaires. The conducted trial doesn't expose participants to danger and corresponds to the requirements of biomedical ethics.

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ГИГИЕНИЧЕСКАЯ ОЦЕНКА ФАКТОРОВ РИСКА И СОСТОЯНИЕ ЗДОРОВЬЯ СУДЕБНО-МЕДИЦИНСКИХ ЭКСПЕРТОВ

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Целью исследования являлась разработка и внедрение системы санитарно-гигиенических мероприятий по устранению (снижению) воздействия факторов риска в работе судебно-медицинского эксперта и оценка их эффективности, а также программы, направленной на совершенствование условий труда специалистов судебно-медицинской экспертизы [1, 2]. Сравнительный анализ проводился с контрольной группой врачей других специальностей. Выполнены исследования: анкетирование 303 судебно-медицинских экспертов, анализ условий труда по данным специальной оценки условий труда (2736 материалов специальной оценки условий труда), изучение состояния здоровья судебно-медицинских экспертов по сравнению с врачами других специальностей путем анализа результатов медицинского осмотра (309 медицинских карт). Приоритетным направлением государственной политики является охрана и укрепление здоровья работающего населения с целью сохранения трудового потенциала и создания условий для экономического развития страны. Медицинские работники подвергаются сочетанному, комплексному, комбинированному воздействию условий и параметров производственной среды [3, 4]. Воздействие производственных, социальных факторов могут привести к росту заболеваемости, сокращению продолжительности жизни, ухудшению состояния здоровья и снижению работоспособности медицинского персонала и требует проведения профилактических мероприятий. Работники судебно-медицинских экспертных учреждений являются особой группой в связи с большим количеством профессиональных, медико-организационных, социальных факторов риска [5].

Ключевые слова: судмедэксперт, факторы риска, профессиональная вредность

Вклад авторов: Тимерзянов М. И., Милушкина О. Ю., — научное руководство, написание статьи; Ильина О. А., Дубровина Е. А., Васильев Д. Е. — сбор материала, статистическая обработка, анализ литературы.

Соблюдение этических стандартов: Данное исследование было одобрено ЛЭК ГАУЗ «Республиканское бюро судебно-медицинской экспертизы Министерства здравоохранения Республики Татарстан (Протокол № 4 от 14.03.2019). Добровольное информированное согласие было получено для каждого участника. Проведение опроса для взрослого населения проводилось на добровольной основе с использованием анкет. Поведенное исследование не подвергает опасности участников и соответствует требованиям биомедицинской этики.

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Currently, we almost lack legal framework for material and technical equipment of buildings and premises which are parts of forensic medical expert institutions. According to par. 11 of Order of the Ministry of Health of the Russian Federation dated 06.06.2013 No. 354н Concerning the Procedure for Post-Mortem Examinations (hereinafter referred to as Order No. 354н), if signs of especially dangerous infectious diseases are found in the dead, stillborn child or fetus, post-mortem examinations are performed in isolated premises of the office (department) of post-mortem examinations, where such postmortem examinations need to be carried out. Based on the requirements of state sanitary and epidemiological rules and hygienic norms, a detailed analysis, search for decisions and measures of adequate and safe activity are required.

Some researches draw our attention to hard work of forensic scientists and non-compliance of their salary to the actually performed volume of work. This is accompanied by low mood, low self-esteem, and emotional lability as important parts of human life quality. According to researchers, forensic scientists reported that they cared of their health, had an active way of life, went in for sports and ate healthy 3.2 and 2.9 times less frequently than therapists and surgeons, respectively.

As cadavers may pose infection hazards to those who handle them, the issues of hygiene, labor protection and sanitary and epidemiological safety of forensic scientists are still the issues of interest.

The measures protecting forensic scientists from a harmful effect of biological hazards associated with cadavers are underdeveloped. This makes the research relevant. Regulatory documents on design of post-mortem examination departments are either not developed or old.

Upgrade of hygienic approaches during production environment assessment would take control of many factors that constitute a risk for the health of forensic scientists to a new level.

The factors associated with a way of life and influencing one's health include as follows: leisure organization, emotional microclimate in the family, nutrition, sleep, general state of mind, physical activity, smoking and alcohol consumption. It is established that 47.5% and 32.7% of those responded reported such harmful habits as smoking and alcohol consumption, respectively. Assessment of alcohol consumption frequency has shown that 89.17% drink alcohol on official days off, and 10.83% have it every weekend. 37.1% take strong alcoholic beverages (spirit, vodka, cognac, whiskey, rum), 45.7% have other beverages (beer, wine), 17.1% take energy drinks. According to smoking intensity, all smokers were divided into the following groups: 23% of those smoking up to 5 cigarettes a day, 22% of those with 5–10 cigarettes, 50% of those with 10–20 cigarettes, and 5% of those with high smoking intensity (over 20 cigarettes a day). Thus, high prevalence of tobacco dependence and alcohol consumption can be noted [6].

Working environmental factors (temperature of air, noise, etc.) also produce an unfavorable effect on labor process conditions. Intensity of work with frequent attendance on weekends and holidays is the factor of the labor process, which influences a worker's health.

Hygienic measures that must be used to weaken unfavorable factors of the industrial process and preserve health include as follows: installation of mobile devices (pneumatic tubes) at the Chief Medical Examiner department to transport the sample taken there to the laboratory (the devices prevent transition of the infection into other structural subdivisions of the office); installation of the laminar flow system in the room where especially dangerous infections are handled. The system inactivates any microorganisms present in the treated air; develops and applies cadaveric special markings (the marking denotes possible cadaveric contamination, including contamination with especially dangerous infections, which require sanitary protection measures for the area); develops and applies on-site special bags containing hygienic means (when mobile teams are engaged).

Medical and organizational measures must embrace as follows: preliminary and periodic medical examinations to reveal people with contraindications to work for health reasons and to detect initial signs of diseases in employees, educative activity intended to eliminate bad habits and use personal protective equipment.

The objective of the study was to develop and implement the system of hygienic measures eliminating (mitigating) the impact of risk factors in the work of forensic scientists and to estimate effectiveness of these measures and the program aimed at improvement of employment conditions for forensic scientists.

MATERIALS AND METHODS

Social and hygienic assessment of a way of life and working conditions for forensic scientists from offices of the Chief Medical Examiner was done by analyzing survey data. A questionary specially developed by the author was used. The tool took into account the specific scope of work at offices of the Chief Medical Examiner. Work of forensic scientists underwent a special assessment in accordance with the legislation in place.

The specific weight was 49% for the surveyed men (and 51% for women). After distribution of those surveyed into age groups it was found out that the preferential age of doctors was 50–59 years (23%) for the National Office of the Chief Medical Examiner of the Republic of Tatarstan, and 25–30 years (20.9%) for the Voronezh Regional Office of the Chief Medical Examiner. 37 doctors (17.1%) have less than 5 years of service, 24 (11.1%) have 5 to 10 years of service, 36 (16.6%) have 10 to 15 years of service, 21 (9.7%) have 15 to 20 years of service, 41 (18.9%) have 20 to 25 years of service, 29 (13.4%) have 25 to 30 years of service, 22 (10.1%) have 30 to 35 years of service. The years of service underwent a comparative analysis. During the analysis, it was found out that the preferential length of doctors' service was 20 to 25 years (18.9%) for the National Office of the Chief Medical Examiner of the Republic of Tatarstan, and 5 to 10 years (20.9%) for the Voronezh Regional Office of the Chief Medical Examiner.

The results of regular medical check-ups were used when assessing health of forensic scientists. They were comparatively compared with the control group of other doctors. Statistical analysis was done using the R computing environment (v. 3.5.2).

This trial was approved by the National Office of the Chief Medical Examiner of the Republic of Tatarstan (Protocol No. 4 dated 14.03.2019). Voluntary informed consent was provided by every participant. The conducted study doesn't expose participants to danger and corresponds to the requirements of biomedical ethics.

TRIAL RESULTS

The trial results were implemented into organizational and practical work of the National Office of the Chief Medical Examiner of the Republic of Tatarstan. The trial results are used to educate students from the department of general hygiene

of the Kazan State Medical University and students from the pediatric hygiene department of Pirogov Russian National Research Medical University (students specializing in Hygiene and surgery residents specializing in Hygiene and Epidemiology in Emergencies).

Study records were obtained during a sociological study using a developed questionnaire, which considers the specifics of work in the Office of the Chief Medical Examiner.

Factors related to the way of life and influencing health have been assessed. They include as follows: organization of leisure time, emotional microclimate in the family, nutrition, sleep, general state of mind, physical activity, smoking and alcohol consumption.

A very insignificant number of people who regularly go in for sports has been established. According to the analysis of physical activity, 21% of those requested don't go in for sports at all.

65.3% of those responded reported chronic diseases; 34.7% had no chronic diseases at all. Diseases of the digestive system, respiratory diseases and allergic disorders prevail among chronic diseases. No significant differences were found during a comparative analysis of chronic morbidity in doctors from the National Office of the Chief Medical Examiner of the Republic of Tatarstan, and the Voronezh Regional Office of the Chief Medical Examiner (Pearson χ^2 criterion = 2.64, p level 0.104).

Those surveyed were asked about the working environmental factors (air temperature, noise, etc.), emergency situations, availability of first-aid kits (anti-AIDS, antishock), availability of personal protective equipment, occupational health and safety compliance/non-compliance. Based on questionnaire screening, 58.9% are satisfied with on-site air temperature, whereas 41.1% don't like it. 38.7% of those requested reported occupational noise. 81.9% liked the light environment, whereas 18.1% didn't. 50% of all surveyed employees weren't satisfied with ventilation quality. Thus, we need to develop a plan of measures to improve the ventilation regimen in the office. 57.9% of those surveyed mentioned enough available first aid kits, 35.3% said that the kits were not enough and unavailable, 6.8% reported enough but unavailable kits. 82.3% of employees pointed at a sufficient number of individual protective devices, whereas 17.7% reported the opposite. Intensity of work was one of labor process factors influencing a worker's health. When answering the question 'Do you feel tired when processing information (while working with the documents)?' 65.7% gave a positive answer, and 34.3% provided a negative response.

Other questions were used to examine the emotional microclimate in the office. The employees estimated the level of their comfort as rather high ('good' for 34.1% and 'excellent' for 56.2%). The level of comfort during business communication with direct supervisors was lower: 'good' for 22.7% and 'excellent' for 66.2%. During communication with the senior management of the office the level of comfort is also lower as compared to communication with colleagues ('good' for 28.4% and 'excellent' for 54.8%). There were single cases of 'bad' and 'very bad' responses. Half of the employees provided a positive answer to the following question: 'Do you feel the symptoms of emotional burn-out (fatigue, unwillingness to communicate, apathy, physical distress, insomnia, anxiety, inability to restore strength after weekends)?' [7]. Moreover, 26.3% of the employees stated that they needed professional psychological aid in case of negative emotions during communication with colleagues, severe circumstances, accumulation of stress leading to psychological breakdown, depression, and acute conflict with others.

Labor conditions of forensic scientists were analyzed based on labor condition special assessment data.

Parameters of biological, chemical and physical working environmental factors were examined on-site, and the workload and intensity parameters were determined [8].

Labor conditions assessed by harmful factors are presented in the table.

DISCUSSION OF RESULTS

The trials conducted showed that forensic scientists' labor conditions can be characterized as follows: the category of occupational risk relates to the average (significant) risk with the index of occupational diseases (IOD) being equal to 0.12–0.24 (according to P 2.2.1766–03 Guideline Assessing the Professional Risk for Worker's Health. Organizational and Methodological Basis, Principles and Criteria of Estimation). The parameter is determined according to the following formula: IOD=1/(RC*SC), where RC is a risk category and SC is a severity category. Measures to decrease the risk are required under the given conditions.

A forensic scientist must carry out labor functions associated with a biological danger such as forensic examinations of cadavers and other types of expert work; attendance as part of crime scene investigation team comprising necroscopy protocols; visits to examine cadavers in case of emergencies associated with mass fatality incidence.

The total specific gravity of forensic scientists operating under harmful conditions was 100%.

CONCLUSION

On-site labor conditions for forensic scientists can be characterized as harmful according to the biological factor, chemical factor and labor process severity parameters (class 3.1–3.2). Indoor climate (average air temperature in the working area) (41.0%), noise (38.7%), high risk of infection while working with the sources of especially dangerous infections are subjectively considered by employees as the most unfavorable ones. A high percentage of people with cuts by medical

Table. Characteristics of labor conditions for forensic scientists

Working environmental and labor process factors	Class (subclass) of labor conditions
Chemical	3.1 (substance-formaldehyde)
Biological	3.2
Light environment parameters	2
Labor process workload	3.1
Labor process intensity	1
Final class (subclass) of labor conditions	3.2

instruments during forensic examinations (37.7%) is associated with not enough and/or unavailable first-aid kits (anti-AIDS, antishock) (42.0%). 17.7% lack individual protection means. The majority of forensic experts have II and III health groups (94.8%) with 2.8 diseases per one medical worker in average. Eye disorders are ranked first and followed by respiratory diseases, circulatory diseases, locomotor disorders, diseases of the digestive system, and infectious disorders. Female forensic scientists (over 70% of workers) often suffer from the diseases of the genitourinary system due to the contact with formaldehyde. The experts' blood chemical values show an increased level of GGT, cholesterol, and high and low levels of glucose (valid differences, $p \leq 0.001$). High level of professional burnout is typical of 50.3% of forensic scientists. Social risk factors influencing health of forensic scientists such as high prevalence of tobacco dependence and alcohol consumption are found out.

A program aimed at improvement of forensic scientists' employment conditions, educative activities decreasing the spread of bad habits and preventing professional burnout, initiating promotion events to strengthen responsibility for employees' health (encouraging those who lead a healthy way of life, stopped smoking, underwent profound medical exams) has been suggested.

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ANALYSIS OF HEALTH DYNAMICS IN CHILDREN AND ADOLESCENTS BASED ON THE RESULTS OF REGULAR MEDICAL CHECK-UPS

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The article deals with the issues of health in children and adolescents aged 7–17 years. The objective of this study is to analyze health experience in school-age children and adolescents based on regular medical check-up results. According to regular medical check-up results, 15,192 schoolchildren were examined in 2015, including 12,649 children aged 7–14 years and 2,543 children aged 15–17 years. In 2020, health of 18,708 schoolchildren was assessed, including 14,861 children aged 7 to14 years and 3,847 children aged 15 to 17 years. The authors analyze dynamics of distribution of children into health groups, and age-related incidence of school-related diseases. In children and adolescents of different age, eye disorders occupy first place in the rank of prevalent school-related diseases; the events are followed by musculoskeletal diseases, nervous and GIT diseases, progressing with age, including scoliosis. Percentage of healthy children without the signs of a school-related abnormality at school is reducing. In the majority of cases, pathological abnormalities are found in 15–17-year-old adolescents.

Key words: health of children and adolescents, school-related diseases, age dynamics.

Author contributions: Ganuzin VM — academic advising, writing an article, literature analysis; Maskova GS — literature analysis, statistical analysis; Storozheva IV — collection of material, statistical processing; Sukhova NS– data collection, statistical analysis.

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АНАЛИЗ ДИНАМИКИ СОСТОЯНИЯ ЗДОРОВЬЯ ДЕТЕЙ И ПОДРОСТКОВ ПО РЕЗУЛЬТАТАМ ДИСПАНСЕРНЫХ ОСМОТРОВ

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В статье рассматриваются вопросы состояния здоровья детей и подростков 7–17 летнего возраста. Цель исследования это анализ состояния здоровья у детей и подростков школьного возраста по данным диспансерных осмотров. По данным диспансерных осмотров, в 2015 году было обследовано 15192 школьников, в том числе 12649 человек в возрасте от 7 до 14 лет и 2543 человек от 15 до 17 лет. В 2020 году проанализировано состояние здоровья 18708 школьников, в том числе 14861 человек с 7 до 14 и 3847 человек с 15 до 17 лет. Авторы анализируют динамику распределения детей на группы здоровья, возрастные особенности распространенности школьно-обусловленных заболеваний. У детей всех возрастных групп среди школьно-обусловленных заболеваний на первом месте по распространенности находятся болезни глаза и его придаточного аппарата, далее — болезни костно-мышечной системы, нервной системы и желудочно-кишечного тракта, которые с возрастом имеют тенденцию к увеличению, в том числе и сколиотические нарушения. Процент здоровых детей, не имеющих проявлений рассматриваемой школьно-обусловленной патологии в процессе обучения в школе сокращается. При этом в большей степени патологические отклонения выявляются у подростков 15–17-летнего возраста.

Ключевые слова: здоровье детей и подростков, школьно-обусловленные заболевания, возрастная динамика.

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RELEVANCE

Monitoring of health in children and adolescents, prevention of chronic diseases and functional deviations at the stage of school education is a high-priority task faced by any country [1–3]. At present, various social-hygienic, psychological and technical environmental factors produce an unfavorable effect on many children and adolescents [4–7]. A number of children and adolescents with health deviations and need in rehabilitation is constantly increased due to the intensive education process [8–12].

Analysis of regular medical check-up results enables to reveal certain age groups of children and adolescents requiring intensive prophylaxis and clinical care to prevent and decrease the risk of school-related diseases [13–15].

OBJECTIVE OF THE STUDY

To examine the health of children and adolescents of school age based on the regular medical check-up results.

PATIENTS AND METHODS

We compared distribution of children and adolescents into health groups and incidence of school-related diseases among them in 2015 and 2020. Distribution of schoolchildren aged

7–14 years and 15–17 years into groups is associated with the requirement of the regional healthcare department to regular medical check-ups of schoolchildren.

According to regular medical check-up results, 15,192 schoolchildren were examined in 2015, including 12,649 children aged 7–14 years and 2,543 children aged 15–17 years. In 2020, health of 18,708 schoolchildren was assessed, including 14,861 children aged 7 to 14 years and 3,847 children aged 15 to 17 years.

The obtained data were subjected to statistical analysis using StatSoft Statistica 7.0. The groups were compared using Fisher's test, with statistical significance p value of 0.05 or less.

RESULTS

Distribution of schoolchildren into health groups depending on their age and the year of observation is presented in table 1.

Table 1 shows that specific gravity of children with health groups 1 and 2 is decreased with age, whereas a number of schoolchildren with health groups 3 and 4 is increased.

In 2020, a number of schoolchildren with health group 1 aged 7 to 14 years increased, and a number of children and adolescents with health group 3 decreased by a percentage as compared with 2015. Moreover, 2020 is a year of children and adolescents with health group 5.

Incidence of school-related diseases is presented in table 2.

School-related diseases are health problems in children aged 7 to 17 years resulting from academic overload, learning process and diet violation, and stress.

Table 2 shows that eye disorders occupy first place in the rank of prevalent school-related diseases in children and adolescents of the analyzed age groups both in 2015, and in 2020; the events are followed by musculoskeletal diseases, nervous and GIT diseases, progressing with age, including scoliosis. Trials of other authors confirm the data [6,14]. In schoolchildren aged 15 to 17 years, speech abnormalities were reduced as compared with 7- to 14-year-olds.

According to the results of regular medical check-ups held in 2020, 3,847 adolescents aged 15 to 17 years underwent medical and preventive care. The care-related data are presented in table 3.

Table 3 shows that based on the results of regular medical check-ups held in 2020, among 3,847 15–17-year-old adolescents with visual organ pathology, 28.13% needed to wear corrective glasses (including 17.03% of young women and 11.1% of young men). Some of the adolescents were hospitalized to achieve the objectives of an examination, therapeutic and surgical treatment, whereas 4.26% of them were referred for health resort treatment.

According to the results of a regular medical check-up, all schoolchildren with other health abnormalities were under a regular medical check-up and sent for rehabilitation to specialized doctors.

DISCUSSION OF RESULTS

According to the research, children and adolescents with health group 2 prevail among other schoolchildren of different age both in 2015, and 2020. Schoolchildren with chronic diseases in the compensatory stage (health group 3) are ranked second and constitute 20 to 30% of all those examined, irrespective of age. The value of absolutely healthy children and adolescents (health group 1) remains low. Some authors state that the dynamics is associated with increased neuropsychic load, hypodynamia, disrupted daily routine and nutrition, and long-term use of gadgets both in learning, and for playing various computer games [8,13].

Our researches have shown that eye disorders, musculoskeletal diseases, nervous and GIT diseases, including scoliosis, progressing with age, are the most frequently found

Table 1. Distribution of children and adolescents aged 7–17 years into health groups (2015 and 2020)

Health group	2015		2020	
	7–14	15–17	7–14	15–17
	%	%	%	%
I	3.9*, **	3.0*,**	7.1*,**	2.7*,**
II	64.6	63.8	70.2	65.3
III	30.8	32.4	21.6	30.7
IV	0.7	0.8	0.2	0.4
V	0	0	0.9	0.9

Note. Significant differences at p <0,05, *- significant differences in the registration frequency of children belonging to health groups 1 and 2 within one observation period, ** — significant differences in the registration frequency of children belonging to health groups 1 and 3 within one observation period.

Table 2. Incidence of school-related diseases in children and adolescents based on regular medical check-up results (per 1,000 of those examined)

Disease	2015		2020	
	7–14 years	15–17 years	7–14 years	15–17 years
	‰	‰	‰	‰
Locomotor system pathology, incl. scoliosis	226.0 21.0	261.0 38.0	172.0 15.0*	242.0 46.6
Visual organ pathology	231.0	307.0	251.0	317.0
Gastrointestinal pathology	43.0*	81.0	29.0*	72.0
Speech defects	34.0*	2.0	27.0*	5.0
Nervous disorders	86.0	78.0	65.0	82.0

Note*. The differences between the groups of children and adolescents aged 7 to 14 years and 15 to 17 years within one period of observation are statistically significant (p < 0.05).

Table 3. A number of adolescents aged 15 to 17 years who underwent medical and preventive care (based on the results of regular medical check-ups held in 2020)

Item No.	Parameters	Number of patients	
		(abs.)	%
1	Hospitalized children: young men young women	27 14 13	0.70 0.36 0.34
2	Children obtaining health resort treatment: young men young women	164 71 93	4.26 1.85 2.41
3	Those who required surgery: young men young women	12 12 0	0.31 0.31 0
4	Those who underwent surgery: young men young women	10 10 0	0.26 0.26 0
5	Those who required vision correction: young men young women	343 135 208	28.13 11.10 17.03
6	Those who wear corrective glasses: young men young women	343 135 208	28.13 11.10 17.03

events in children and adolescents at school. This was confirmed by other authors [3,6,14]. Concern on schoolchildren's health and emerging trends in their health impairment with age was brought up in a number of reports during the VII Congress of School and University Medicine held on October 21–22, 2021.

The trial results confirm the previous data about high incidence of school-related diseases among children and adolescents, emergence of children with health groups 3 to 5, and their insufficient preventive mitigation. In our opinion, outpatient pediatricians need a closer cooperation with the Center of Children's Health to render medical and preventive aid to schoolchildren. Apart from finding diseases and analyzing the structure at different age, the Center employees carry out considerable preventive work associated with implementation of healthy lifestyles in a family and prevention of school-related disorders among schoolchildren, their parents and teachers.

We believe that administration of schools, education and healthcare departments need to adopt a strategy aimed at the implementation of 'Health Saving Educational and Health-Improving Technologies in Educational Establishments' taking into account suggestions of the leading domestic hygienists [15,16]. School health workers need to regularly speak at teacher-parent meetings devoted to sensible nutrition, physical education and methods of prevention of school-related diseases cooperating with doctors from children's outpatient clinics.

CONCLUSION

Percentage of healthy children with no signs of the examined school-related abnormality at school is reduced. Pathological abnormalities are mainly found in 15–17-year-old adolescents. The obtained results show that children and adolescents must obtain intensive preventive and therapeutic aid as soon as they go to school, and not during the teen years only.

Doctors and teachers at schools need to cooperate and implement health-saving educational and health-improving technologies at schools and actively participate in joint parental involvement medical and pedagogical programs aimed at prevention of school-related diseases.

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SCIENTIFIC JUSTIFICATION OF THE INNOVATIVE APPROACH TO HEALTH CONTROL IN STUDENTS FROM GENERAL EDUCATIONAL INSTITUTIONS OF VARIOUS TYPES

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Increasing academic load, intensification of academic activity, use of not priorly certified innovative pedagogical technologies have been linked with steadily declining health in students. This is how a search for new effective methods of formation, strengthening and increasing health of students is initiated. An important task is to provide for scientific justification of the innovative approach to health control in students from general educational institutions of various types. Heavy academic activity, research of the functional condition of the central nervous, respiratory and cardiovascular systems were assessed in lyceum and school students in Grades 9–10. Students from an 'at-risk' group had their psychophysiological condition corrected; the effectiveness was assessed by comparison of psychophysiological indicators before and after the session. When intensive academic activity is involved, adolescents from a lyceum had better operational indicators of the central nervous system, and functional indicators of the respiratory system as compared with schoolchildren. Students from the both groups had reduced biological, social and psychological adaptation. Sessions of functional biocontrol resulted in the increased number of those examined with normal working capacity and satisfactory biological adaptation against the background of a decreasing number of adolescents with a high level of psychoemotional stress. Functional biocontrol is an effective correction method of psychophysiological state of those educated. This determines the necessity of its use in educational institutions of various types.

Key words: students, physical and mental health, functional biocontrol

Author contributions: Setko AG — trial concept and design, editing, Zhdanova OM, Tyurin AV — data collection and processing, Zhdanova OM — text statistical processing and writing.

Compliance with ethical standards: written informed consent forms required to undergo an examination were obtained from all the students and their parents. The research was approved by the local ethics committee of the FSBEI Orenburg State Medical University of the Ministry of Health of the Russian Federation (protocol No. 258 dated 09.10.2020).

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НАУЧНОЕ ОБОСНОВАНИЕ ИННОВАЦИОННОГО ПОДХОДА К УПРАВЛЕНИЮ ЗДОРОВЬЕМ ОБУЧАЮЩИХСЯ ОБЩЕОБРАЗОВАТЕЛЬНЫХ ОРГАНИЗАЦИЙ РАЗЛИЧНОГО ТИПА

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На фоне возрастающих учебных нагрузок, интенсификации учебной деятельности, применения инновационных педагогических технологий, не апробированных ранее, уровень здоровья учащихся неуклонно снижается, что инициирует поиск новых эффективных методов формирования, укрепления и повышения состояния здоровья школьников. Важная задача научно обосновать инновационный подход к управлению здоровьем учащихся общеобразовательных организаций различного типа. У учащихся 9–10-х классов лицея и школы проведена оценка напряжённости учебной деятельности; исследование функционального состояния центральной нервной, дыхательной, сердечно-сосудистой систем. Учащимся «группы риска» проведена коррекция психофизиологического состояния, эффективность которого оценивалась путем сравнения психофизиологических показателей до и после выполнения тренинга. В условиях высокой напряженности учебного процесса у лицеистов в сравнении со школьниками увеличивались оперативные показатели центральной нервной системы и функциональные показатели дыхательной системы, при этом у учеников обеих групп установлено снижение уровня биологической и социально-психологической адаптации. После проведения тренингов функционального биоуправления увеличилось число обследуемых с нормальной работоспособностью и удовлетворительной биологической адаптацией, на фоне снижения количества подростков с высоким психоэмоциональным напряжением. Функциональное биоуправление является эффективным методом коррекции психофизиологического состояния обучающихся, что определяет необходимость его использования в общеобразовательных организациях различного типа.

Ключевые слова: учащиеся, состояние физического и психического здоровья, функциональное биоуправление

Вклад авторов: Сетко А. Г. — концепция и дизайн исследования, Жданова О. М., Тюрин А. В. — редактирование, сбор и обработка материала, Жданова О. М. — статистическая обработка и написание текста.

Соблюдение этических стандартов: предварительно от всех учащихся и их родителей были получены письменные информированные согласия на включение в обследование. Исследование одобрено локальным этическим комитетом ФГБОУ ВО ОрГМУ МЗ РФ (протокол № 258 от 09.10.2020).

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INTRODUCTION

Physical, mental and social health of the rising generation is the top priority of state politics as it is a marker of the future of the country and its economic, political and cultural establishment [1]. In accordance with the Federal Law on Education in the Russian Federation, safety and public health organization of students is an absolute priority for those institutions that regulate educational activity. However, educational institutions do not commonly complete these tasks at present. Increasing academic load, intensified academic activity and use of innovative pedagogical technologies without hygienic expertise in educational practice diminish adaptation reserves and increase the level of acute and chronic morbidity in students [1–3]. The students' health is progressively declined. This is very typical of innovative schools where learning activity is accompanied with intense educational load requiring boosting attention span, high mobility of mental processes, increasing the 'physiological cost' of education of children and adolescents in innovative institutions [1–3]. Thus, the actual problem is to preserve and support health of schoolchildren, initiating the search for new methods of health assessment in students of modern general educational institutions.

Purpose of the study is to provide for scientific justification of the innovative approaches to health management in students of general educational institutions of various types.

MATERIALS AND METHODS

15–16-year-old students in Grades 9–10 from two educational institutions were included into the study: adolescents from a multidisciplinary lyceum for gifted students formed the first group (n=112), whereas the second group included students from a traditional school (n=110). Training process intensity was estimated using the chronometric method by way of registration of various types of activity during training sessions with subsequent determination of the level of intellectual, emotional, sensory load, monotonicity and operating regimen following the Federal recommendations [4]. The central nervous system functional condition was diagnosed with variational chronoreflexometry [5], taking into account the nervous system functional level (SFL), nervous response stability (RS), the functionality of the formed functional system (FFS) and mental capacity. The functional condition of the cardiovascular system was examined with variation pulsometry and automated ORTO-expert [6] program using time indices (median (M), mode (Mo), mode amplitude (AMo), range ($_{\Delta}$X), standard deviation (SDNN), square root of R-R interval (RMSSD) and spectral indices (high-frequency (HF), low-frequency (LF), very low-frequency (VLF)) oscillations in heart rate; integral indices such as the vegetative balance index (VBI), vegetative rhythm index (VRI), indicator of the adequacy of heart rate regulation processes (IARP), determination of biological adaptation based on regulatory system stress indices according to V. P. Kaznacheev (1981).

The functional state of the respiratory system was examined using spirography and taking into account lung capacity (LC), forced lung capacity (FLC), forced expiratory volume in 1 second (FEV_1), peak flow rate (PFR), maximum expiratory flow at 25% of vital capacity (MOC_{25}), maximum expiratory flow at 50% of vital capacity (MOC_{50}), maximum expiratory flow at 75% of vital capacity (MOC_{75}), and average expiratory flow at 25–75% of vital capacity ($COC_{25–75}$). The students' mental health was evaluated using the 'Integral Evaluation of Dysadaptation Psychogenic Forms' method developed by N. P. Setko et al. (2016).

The psychophysiological state was corrected in 130 students from the examined educational institutions using the method of functional biocontrol with diaphragmatic and relaxation breathing on a hardware and software system and automatic registration of temperature disturbances, breathing frequency, ratio of expiratory and inspiratory duration, respiratory sinus arrythmia, and level of myotonia. The psychoemotional condition was determined by coefficients of the total deviation from the autogenic norm, and vegetative coefficient based on M. Lüscher color test. The effectiveness of functional biocontrol was evaluated by comparison of mental capacity, biological adaptation data and M. Lüscher color test results two weeks before and after the diaphragmatic and relaxation breathing.

Mathematical analysis of data was done using parametric methods of medical statistics and calculating the arithmetic mean, standard deviation, and mean square error. The parametric Student's t-test was used to find statistically significant differences. Calculations for the analysis were performed using Microsoft Office and Statistica 13.0.

RESULTS AND DISCUSSION

It is established that in the lyceum for gifted children, academic activity reached 3 class and 1 degree intensity due to pronounced intensity of intellectual (3.1±0.26 points), sensory (2.8±0.11 points), emotional (3.1±0.35 points) load and operating mode (3.0±0.11 points), when the monotonicity of academic activity only (2.3±0.24 points) corresponded to the acceptable level. At secondary school, the academic process intensity was optimal (class 1.0), including the level of sensory (1.5±0.16 points), emotional (1.3±0.15 points) load and labor monotonicity (1.4±0.15 points); it did not exceed the acceptable level by intellectual load (1.6±0.22 points) and operating mode (1.8±0.08).

Increased cognitive load probably helped gifted lyceum students train the nervous processes and form operating CNS indices. This was confirmed by increased reaction stability from 1.1±0.10 units to 1.3±0.07 units ($p \leq 0.05$) and functional capabilities of the nervous system from 2.1±0.11 units to 2.4±0.08 units ($p \leq 0.05$). In students from the 1st and 2nd groups, the basic functional level of the nervous system had no significant differences and amounted to 2.4±0.02 units and 2,4±0,03 units ($p \geq 0,05$), respectively.

The established functions of the central nervous system were reflected through distribution of students by the level of mental capacity. Thus, the predominant amount of those examined from the 1st (67.6%) and 2nd groups (60.6%) had optimal mental capacity. However, 28.4% and 4.1% of the 1st group students and 25.5% and 13.4% of the 2nd group adolescents had worse and significantly reduced capacity, respectively.

The lyceum students had significantly higher indices of the functional state of the respiratory system as compared with schoolchildren (Table 1). In adolescents from the 1st group, the values of LC, FLC, PFR, FEV1, MOC_{25}, MOC_{50}, MOC_{75} and $FEF_{25–27}$ exceeded the same values in students from the 2nd group by 11.1%, 6.6%, 20%, 22.8%, 18.7%, 13.6% and 13.8%, respectively.

In students from the 1st group, the values of peak flow rate, MOC_{25}, FEV_1, FLC and LC exceeded the same values in students from the 2nd group (physiological norm) by 2.5, 2.2, 1.5, 1.3 and 1.2 times, respectively (Table 2).

Lyceum students reported the following increased parasympathetic indices as compared to schoolchildren: ΔX from 0.33±0.023 s to 0.35±0.045 s ($p \geq 0.05$), SDNN from 0.075±0.0062 s to 0.086±0.0178 s ($p \geq 0.05$), RMSSD

Table 1. Indices of the functional state of the respiratory system in students (l/c)

Indices	Groups of students	
	1st	2nd
Lung capacity	3.6±0.36	3.2±0.13*
Forced lung capacity	3.0±0.12	2.8±0.12*
Peak flow rate	4.0±0.19	3.2±0.16*
Forced expiratory volume in one second (FEV1)	2.3±0.11	2.2±0.11
Maximum expiratory flow at 25% of vital capacity (MOC_{25})	3.5±0.15	2.7±0.15*
Maximum expiratory flow at 50% of vital capacity (MOC_{50})	3.2±0.18	2.6±0.14*
Maximum expiratory flow at 75% of vital capacity (MOC_{75})	2.2±0.11	1.9±0.11*
Forced mid-expiratory flow rate (FEF 25–75%)	2.9±0.14	2.5±0.13*

*$p \leq 0.05$ when the 1st group is compared with the 2nd group

Table 2. Distribution of students considering the correspondence of the functional state of the respiratory system to the physiological norm (%)

Indices	Groups of students	Degree of correspondence of the functional state of the respiratory system to the physiological norm		
		In the Range	Reduced	Significantly reduced
Lung capacity	1st	77.2	17.7	5.1
	2nd	66.2	25.4	8.5
Forced lung capacity	1st	68.4	17.7	13.9
	2nd	52.1	29.6	18.3
Peak flow rate	1st	49.4	41.8	8.9
	2nd	19.7	57.7	22.5
Forced expiratory volume in one second (FEV1)	1st	44.3	40.5	15.2
	2nd	29.6	31.0	39.4
Maximum expiratory flow at 25% of vital capacity (MOC_{25})	1st	46.8	40.5	12.7
	2nd	21.1	49.3	29.6
Maximum expiratory flow at 50% of vital capacity (MOC_{50})	1st	68.4	29.1	2.5
	2nd	53.5	40.8	5.6
Maximum expiratory flow at 75% of vital capacity (MOC_{75})	1st	92.4	7.6	-
	2nd	87.3	11.3	1.4
Forced mid-expiratory flow rate (FEF 25–75%)	1st	93.7	5.1	1.3
	2nd	80.3	19.7	-

from 0.075±0.0081 s to 0.081±0.0148 s ($p \geq 0.05$), and HF from 2325.9±409.38 ms^2 to 2531.0±719.29 ms^2 ($p \geq 0.05$). This certified an increased activity of the parasympathetic division of the vegetative nervous system in lyceum students and predominance of sympathetic effects in students from the secondary school (Table 3). Based on the scale of V. P Kaznacheev (1981), the value of strain of regulatory systems corresponded to the strain of mechanisms of biological adaptation and amounted to 119.9±31.58 units — 148.7±33.39 units ($p \geq 0.05$) for students from the 1st, and 2nd groups.

Thus, a satisfactory level of biological adaptation was determined in 28.4% and 15.5% of lyceum and school students only, poor adaptation and its disruption in 8.8% and 19.5% of lyceum students and 7.4% and 35.1% of schoolchildren, respectively, with disruption of biological adaptation mechanisms in the majority of students from the 1st (43.6%) and 2nd groups (42.1%).

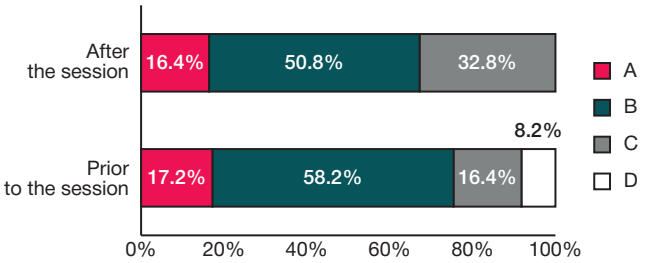
Assessment of mental adaptation has shown that 82.3% lyceum students and 75.7% schoolchildren had a normal level of mental adaptation. The average and high intensity of mental dysadaptation with high emotional stress was determined in 8.0–9.7% of lyceum students and 6.1–18.2% of school adolescents.

To decrease the level of mental stress and to increase adaptation capabilities and mental capacity in those examined, a method of functional biocontrol was used. It has been shown that in adolescents, muscular tension reduced from 4186.0±470.39 V to 2787.6±351.40 V ($p \leq 0.05$) after the first 4-minute session of diaphragmatic and relaxation breathing with a peripheral temperature increase from 27.9±0.43 C^0 to 28.9±0.62 C^0 ($p \geq 0.05$). This shows that the students' psychoemotional condition was improved. The session was followed by a decreased respiratory rate from 11.3±0.53 times per minute to 10.3±0.58 times per minute ($p \geq 0.05$),

Table 3. Heart rate variability indices in students

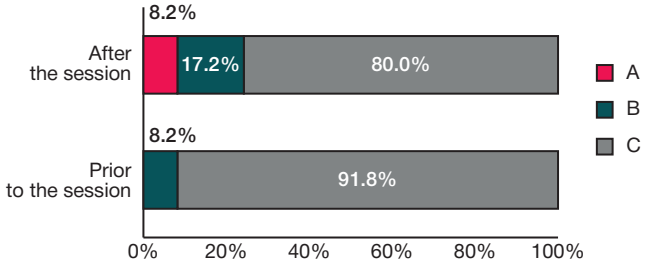
Indices	Groups of students	
	1st	2nd
Median (M, s)	0.7±0.04	0.4±0.38
Mode (Mo, s)	0.7±0.04	0.7±0.01
Mode amplitude (AMo,%)	34.3±4.50	38.2±2.17
Range ($_{\Delta}$X, s)	0.33±0.023	0.35±0.045
Standard deviation (SDNN, s)	0.75±0.0062	0.86±0.0178
Square root of R-R interval (RMSSD, s)	0.075±0.0081	0.081±0.0148
Very low-frequency oscillations in heart rate (VLF, ms^2)	3543.3±1086.12	5115.1±796.72
Low-frequency oscillations in heart rate (LF, ms^2)	3688.4±990.56	3584.0±455.47
High-frequency oscillations in heart rate (HF, ms^2)	2531.0±719.29	2325.9±409.38
Vegetative balance index (VBI, units)	159.0±25.7	192.8±28.91
Vegetative rhythm index (VRI, units)	5.3±0.44	6.1±0.56
Indicator of the adequacy of regulation processes (IARP, units)	48.1±3.33	56.3±3.89
Regulatory system stress index (SI, units)	119.9±31.58	148.7±33.39

*p≤0.05 when the 1st group is compared with the 2nd group



A ≤ 0,6 — predominance of fixation on rest and mitigation of own efforts; B = 0.6–1.11 physiological standard; C = 1.1–1.5 optimum vegetative balance to implement all human capabilities under stress; D ≥1.5 excessive stress

Fig. 1. Distribution of students depending on whether the vegetative coefficient is in the range prior to and after diaphragmatic and relaxation breathing sessions (%)



A ≤10 condition characterized by a high activity and positive attitude to task accomplishment; B = 10–14 physiological standard; C ≥14 high level of non-productive, neuropsychic intensity.

Fig. 2. Distribution of students depending on whether the overall deviation is in the autogenic range prior to and after diaphragmatic and relaxation breathing sessions (%)

reducing the respiratory sinus arrythmia from 27.1±2.65 units to 23.5±2.34 units (p≥0.05). This is how the additional body burden was decreased due to a synchronous activity of the cardiovascular and respiratory systems.

Among the students who trained on a regular basis, a number of those examined with an optimal vegetative balance increased twice; if, prior to the session, 8.2% students reported excessive stress, then the condition was not found after the session (Fig. 1).

At the same time a number of students with a high level of neuropsychic stress reduced from 91.8% to 80.0% against the background of increased specific gravity of students with a physiological standard from 8.2% to 17.2%, and an increased number of those examined with high activity and positive attitude to work (to 8.2%).

It is stated that prior to the session, only 16.7% of the students had a satisfactory level of biological adaptation, whereas all the other students (16.7% and 66.6%) had an unsatisfactory level and disturbed biological adaptation, respectively. Following the session, 25.0% of the adolescents had a satisfactory level of biological adaptation, 66.7% of those examined reported stressed adaptation mechanisms and only 8.3% had disruption of biological adaptation (Fig. 2).

After the sessions, the number of students with normal mental capacity increased from 9.1% to 18.2%, those with insignificantly reduced capacity increased from 59.1% to 72.7%, whereas the number of students with reduced capacity decreased from 31.8% to 9.1%.

CONCLUSION

When intensive academic activity is involved, adolescents from a multidisciplinary lyceum demonstrated better operational indicators of the central nervous system, and functional indicators of the respiratory system as compared with schoolchildren. Students from the both groups had functional stress with reduced biological, social and psychological adaptation. It is proved that diaphragmatic and relaxation breathing is effective; when done on a regular basis, it reduces psychoemotional stress, improves adaptation reserves and mental capacity. Thus, functional biocontrol is an effective correction method of psychophysiological state of those educated. This determines the necessity of its use at educational institutions of various types including innovative institutions for gifted children.

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HYGIENIC ASSESSMENT OF THE MODE OF USING MOBILE ELECTRONIC DEVICES BY MEDICAL STUDENTS

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The hygienic assessment of the mode of using mobile electronic devices (ED) was carried out to develop preventive activities aimed at education of medical students. A total of 518 medical students were surveyed. The survey was created in Google Forms. The obtained data were processed with Statistica 13 PL. The study was conducted in accordance with the principles of biomedical ethics and did not expose the participants to any danger. Data on a habitual mode of using mobile electronic devices by medical students during their traditional educational process were obtained through the survey: half of them never did eye gymnastics, over 75.0% reported holding their mobile ED very close to the eyes, 75.0% of those surveyed used mobile ED in the lack of light. While assessing the mode of ED use by medical students, it was established that the visual organ sustained the largest burden. Preventive activities are necessary to avoid negative consequences and produce useful skills of using ED during education of future doctors at a university.

Keywords: medical students, electronic devices, hygienic education.

Author contributions: Ievleva OV — literature analysis, study design, data collection, statistical processing, writing an article.

Compliance with ethical standards: the study was a pproved by the Local Ethics Committee of Pirogov Russian National Research Medical University (Protocol No. 203 dated December 20, 2020). Voluntary informed consent was obtained from every participant. Online interview was carried out on a voluntary basis using online services. The study corresponded to ethical guidelines for biomedical research and did not expose the participants to any danger.

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ГИГИЕНИЧЕСКАЯ ОЦЕНКА РЕЖИМА ИСПОЛЬЗОВАНИЯ МОБИЛЬНЫХ ЭЛЕКТРОННЫХ УСТРОЙСТВ СТУДЕНТАМИ-МЕДИКАМИ

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Для разработки профилактических мероприятий с целью воспитания студентов медицинского ВУЗа проведена гигиеническая оценка режима использования мобильных электронных устройств (ЭУ). Проведен опрос, в котором приняли участие 518 студентов-медиков. Опрос проводился с помощью онлайн-сервиса Google Forms. Полученные данные обрабатывались с помощью пакета статистического анализа Statistica 13 PL. Исследование соответствовало требованиям биомедицинской этики и не подвергало опасности участников. С помощью анкетирования получены данные о привычном режиме использования мобильных электронных устройств в период проведения традиционного образовательного процесса студентами-медиками: половина студентов-медиков никогда не делают гимнастику для глаз, более 75,0% студентов-медиков отметили, что во время работы держат мобильное электронное устройство очень близко к глазам, 75,0% респондентов отметили, что часто работают с мобильным электронным устройствам в условиях недостаточной освещенности. При оценке режима использования ЭУ студентами-медиками установлено, что наибольшую нагрузку получает зрительный анализатор, чтобы избежать негативных последствий необходимо проводить профилактические мероприятия и вырабатывать полезные навыки использования ЭУ на этапе обучения будущих врачей в ВУЗе.

Ключевые слова: студенты-медики, электронные устройства, гигиеническое воспитание.

Вклад автора: Иевлева О. В. — анализ литературы, дизайн исследования, сбор материала, статистическая обработка, написание статьи.

Соблюдение этических стандартов: данное исследование было одобрено ЛЭК РНИМУ им. Н. И. Пирогова (Протокол № 203 от 20.12.2020 года). Добровольное информированное согласие было получено для каждого участника. Проведение онлайн-опроса проводилось на добровольной основе с использованием онлайн-сервиса. Исследование соответствовало требованиям биомедицинской этики и не подвергало опасности участников.

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The use of digital tools in educational environment has increased over the last decades. This is accompanied by growing risks of using mobile electronic devices (ED). Domestic and foreign publications indicate that the influence of modes of using mobile electronic devices on young adult health is shown insignificantly [1, 2, 3].

These aspects are essential for development of prophylactic measures to reduce risks associated with the use of ED in medical students as future specialists dealing with population-based preventive issues [4, 5, 6, 7, 8, 9].

Purpose: to assess the mode of ED use in order to provide medical students with hygienic education.

MATERIALS AND METHODS

For this study, Google Forms Questionnaires have been created [7, 10]. The questionnaires were compiled by staff members of Hygiene Department of Faculty of Pediatrics of Pirogov Russian National Research Medical University, Moscow, Russia, certified as specialists in 'Hygienic Education', 'Epidemiology', 'Hygiene of Children and Adolescents', 'General Hygiene'.

Data on a habitual mode of using mobile electronic devices by medical students getting traditional education are obtained with the help of a questionnaire survey, as those surveyed have been using the electronic devices since 9.5±1.3 years.

No difference in age and gender are found between the groups.

The obtained data were processed using Statistica 13 PL (StatSoft, USA) software. Charts and diagrams were created using Microsoft Excel.

The study did not infringe upon any human rights, did not expose those surveyed to danger, corresponded to the principles of biomedical ethics, and was reviewed and approved by the Ethics Committee of Pirogov Russian National Research Medical University, Russia, in accordance with the principles of GCP (Protocol No. 203 as of December 20, 2020). Voluntary informed consent was obtained from every participant. Online interview was conducted on a voluntary basis using online services. All the trials were performed observing ethical standards set out in the Declaration of Helsinki and Directives of the European Community (8/609EC).

RESULTS

Examination of the habitual mode of using mobile electronic devices by medical students showed that half of the students never did eye gymnastics or any other type of gymnastics after working with mobile electronic devices, which is contrary to hygienic recommendations (Fig. 1).

Over 75.0% of medical students noted that they held a mobile electronic device very close to eyes while working, which doesn't correspond to hygienic recommendations (in accordance with par. 3.5.7 of Sanitary Rules and Regulations 2.4.3648–20 'Sanitary and Epidemiological Requirements for Upbringing and Education, Rest and Health Improvement of Children and Adolescents') (Fig. 2).

While working with mobile electronic devices, 9.5% of medical students use local lighting only, which is contrary to hygienic recommendations (in accordance with par. 3.5.5 of Sanitary Rules and Regulations 2.4.3648–20 'Sanitary and Epidemiological Requirements for Upbringing and Education, Rest and Health Improvement of Children and Adolescents'), 33.4% use general lighting, whereas the rest use mixed lighting. Over 75.0% of those surveyed noted that they frequently used mobile electronic devices in the lack of light. 85.0% make use of their mobile electronic devices while in transport (in accordance with par. 3.5.5 of Sanitary Rules and Regulations 2.4.3648–20 'Sanitary and Epidemiological Requirements for Upbringing and Education, Rest and Health Improvement of Children and Adolescents').

65.0% of medical students continue exploiting mobile electronic devices during meals.

According to the survey among medical students, the accumulated operation time (M±σ) is 413.5±14.0 minutes per day for a smartphone, and 227.1±8.0 minutes per day for a pad. This almost coincides with objective data of a special healthy lifestyle application for individual smartphones (Screen Time).

According to Screen Time, a smartphone (M±σ) was used for 336.4±15.0 minutes per day, i.e., about 5.6 hours per a regular day; a pad (M±σ) was utilized for 259.0±10.0 minutes per day, i.e., about 4.4 hours per a regular day. 61.5% of the time (208.6±15.0) is spent on using social media for a smartphone and 56.3% (146.1±18.0) for a pad (Fig. 3).

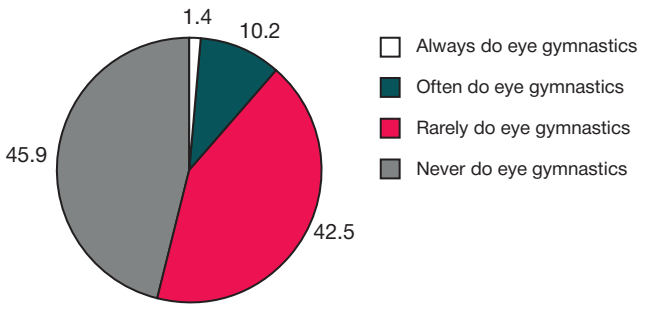

Fig. 1. Eye gymnastics performed by medical students after working with mobile electronic devices (a pad and a smartphone),%

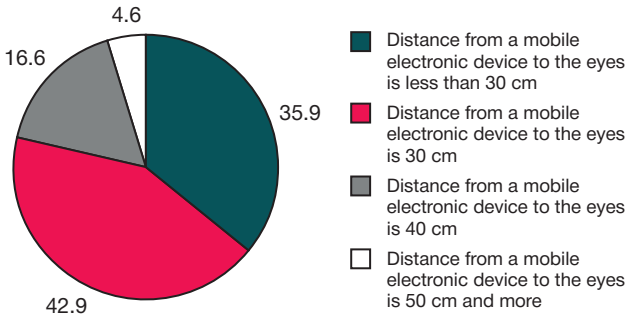

Fig. 2. Distance from a mobile electronic device (a pad and a smartphone) to the eyes while working,%

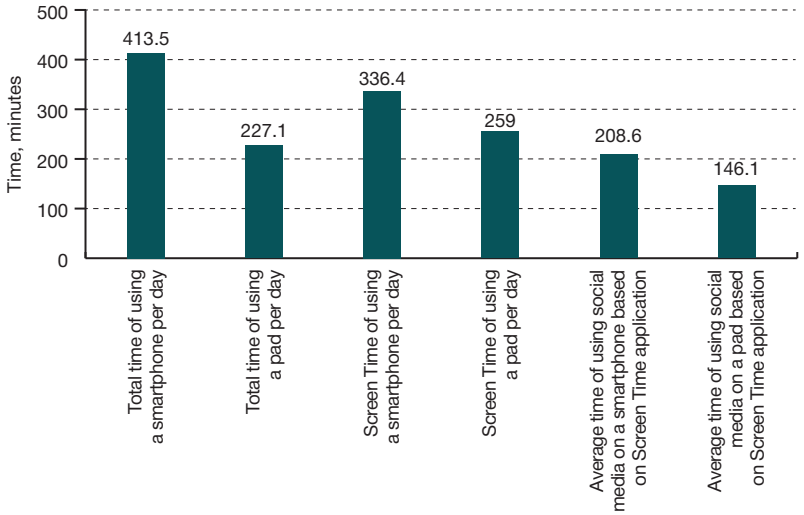

Fig. 3. Time spent on using mobile electronic devices (a pad and a smartphone) by medical students per day, the average time of using social media per day considering the data obtained during a week, M±m, minutes

Table 1. Hygienic assessment of the influence produced by the mode of use of mobile electronic devices on occurrence of eye complaints in medical students

Factors associated with the mode of use of mobile electronic devices	Pearson coefficient		
	Value	p	Correlation
Use of mobile electronic devices at night	0.71	p≤0.05	high
How much time before sleep are mobile electronic devices stopped being used?	0.72	p≤0.05	high
Lighting (local, general) used while dealing with mobile electronic devices	0.71	p≤0.05	high
Distance at which a mobile electronic device is located from the eyes	0.73	p≤0.05	high
How often (how many times a day) time is checked on a smartphone	0.72	p≤0.05	high
How often (how many times a day) social media are viewed	0.72	p≤0.05	high
How often mobile electronic devices are used to perform urgent and not urgent tasks (replies to letters, messages, etc.)	0.72	p≤0.05	high
Screen Time is installed on a mobile electronic device and used to control working time	0.74	p≤0.05	high

Sanitary Rules and Regulations 1.2.3685–21 'Hygienic Standards and Requirements for Ensuring the Safety and (or) Harmlessness of Environmental Factors for Humans' indicate the total duration of using a pad per day at an educational institution and at home; they also state that when two or more electronic devices are used, the total operation per day should not exceed the limit value for each of them. Based on the results of our study, medical students used both a pad, and a smartphone. The total time of using these electronic devices is exceeded more than twice, and was probably spent not on education, but on leisure (communication in social media).

Medical students working with mobile electronic devices also have different complaints (computer vascular syndrome and carpal tunnel syndrome).

When using mobile electronic devices and after that, medical students often report difficulties when changing their eye focus from near to distant objects, apparently changed color of objects, double vision, skin crawling sensation and darkened vision, excessive light sensitivity, impaired visual performance, visual fatigue in 16.0% of cases; the complaints are never found in 38.0% of cases. When using mobile electronic devices and after that, medical students often have pain in the eye sockets and forehead, pain during eye movement, red eyes, gritty eyes, eye watering, smarting eyes, eye dryness and burning eyes in a quarter of cases; the complaints never occur in 25.0% of cases only.

When using mobile electronic devices and after that, medical students often have pain with decreased sensitivity and paresthesia in the palmar surface of the I–IV fingers, certain weakness and discomfort during hand movement in 9.0% of cases.

Research results of the influence produced by the mode of use of mobile electronic devices on the eye of medical students are found in table 1.

Based on the obtained data it was established that such factors as lighting mode, posture (distance to the eyes) and frequency of ED use per day produced a significant effect on eye complaints in medical students.

DISCUSSION

Thus, the study enabled to find pressing issues for hygienic education of medical students such as organization of lighting when working with mobile electronic devices; posture with an optimal distance to the eye; time count using Screen Time.

Based on domestic and foreign literature it can be stated that in recent decades, the influence of gadgets on a modern person has been increased [11, 12]. Thus, time of using gadgets is progressing with age. Increased use of ED produces an increased negative effect on human health, as hygienic skills of using ED are not established in adolescents [13, 14, 15].

Today, the educational process includes the use of digital technologies influencing general health of the younger generation. A correct inclusion of these technologies into the life of medical students requires a structured and elaborated scheme with an explanation and development of useful skills to decrease a negative influence of information technologies on students' health [14, 15].

It was followed by simple but easily accomplished rules included into health protection check list. The check lists were offered to medical students to be used within the program of hygienic education.

CONCLUSIONS

Vision protection check lists were developed and approved to ensure hygienic education of medical students. They contain simple and easily accomplished recommendations:

1. When working with electronic devices, observe the schedule of work and rest: do not forget about intervals. After working for 30–60 minutes have a rest for 5–10 minutes. Do not use any other gadgets during that time!
2. Do not put a strain on your eyes when going home. Just stay offline while in transport.
3. Do eye gymnastics. To understand how to do it, use gadget-based application, for instance, *Relaxation*.
4. If you are busy for gymnastics, just close your eyes and relax, thinking about something good.

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THE INCIDENCE OF SLEEP DISTURBANCES AMONG MEDICAL STUDENTS

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Sleep disturbance is a common health problem that can influence the quality of life. There are several types of sleep disorders, such as obstructive sleep apnea, insomnia, narcolepsy, periodic limb movement disorder, and circadian dysregulation. Medical students are probably more prone to sleep disturbances due to their extreme academic stress. In this research, the incidence of sleep disturbance among medical students was examined, and the concomitant risk factors were determined. That was one-time research. A questioning was used to collect social, demographic and sleeping data. 678 1st, 2nd and 3rd year medical students were surveyed. 29% complained of at least one sleep disturbance. The most widely spread sleep disturbance observed among 51.8% medical students included insomnia (initial insomnia and sleep maintenance). 4th year students and those who spend much time on smartphones were more prone to sleep disturbances. Sleep disturbances are common among medical students. They need to be discovered and paid attention to before the situation gets worse.

Keywords: students, sleep disorders, insomnia, health.

Author contributions: Literature analysis, research planning — Chernykh NY, Vasilieva MV, data collection and processing — Chernykh NY, Melikhova EP, Skrebneva AV, statistical processing — Skrebneva AV, editing — Melikhova EP.

Compliance with ethical standards: The participation was voluntary; all those surveyed signed an informed consent prior to study enrollment.

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РАСПРОСТРАНЕННОСТЬ НАРУШЕНИЙ СНА СРЕДИ СТУДЕНТОВ-МЕДИКОВ

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Нарушения сна являются общей проблемой здоровья и могут повлиять на качество жизни. Существует несколько типов нарушений сна, таких как синдром обструктивного апноэ во сне, бессонница (инсомния), нарколепсия, периодическое двигательное расстройство конечностей, нарушения циркадного ритма. Студенты-медики, возможно, более склонны к развитию нарушений сна из-за их высокого академического напряжения. В настоящем исследовании оценивалась распространенность нарушений сна среди студентов-медиков, и определялись сопутствующие факторы риска. Обследование было единовременным. Для сбора социо-демографических данных и данных сна использовалось анкетирование. Опрошено 678 студентов-медиков трех лет обучения. 29% жаловались, по крайней мере, на одно нарушение сна. Самые распространенные нарушения сна среди студентов были инсомнические — нарушения засыпания и поддержания сна — 51,8%. Студентки, студенты четвертого года обучения и те, кто проводит значительное время за смартфонами, были более подвержены нарушениям сна. Нарушения сна распространены среди студентов-медиков. Необходимо обнаружить и обратить на них внимание прежде, чем ситуация ухудшится.

Ключевые слова: студенты, нарушения сна, инсомния, здоровье.

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Соблюдение этических стандартов: Участие было добровольным, все обследуемые подписали информированное согласие перед включением в исследование.

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Sleep is a cornerstone of a human life. Our health is closely connected to our sleep. The sleep patterns are important to many physiological human functions such as learning capacity, consolidation of memory, neurocognitive functions and mental health [1,2]. Somnolence is one of the factors negatively affecting health. Sleep disruption can impair vigilance, attention and cognitive processes [3, 4, 5]. Research shows that sleep disturbances are connected to mental health and are early signs of anxiety and depression. Ignoring the sleep disturbances can result in impaired attention, underperformance, decreased overall health, and problems with social relations [6, 7, 8, 9]. The prevalence of sleep loss varies between 22% and 65%.

Numerous chronic diseases such as hypertension, diabetes and coronary heart disease are also connected to deprivation of sleep [10, 11].

Medical students belong to the part of the population more prone to sleep deprivations as high academic load results in a lack of sleep [12]. Sleep disorders affect life quality, general health and learning progress. That's why the disorders need to be revealed until the problem is aggravated even more [13]. In medical students, deprivation of sleep influences cognitive functions. According to numerous studies, 70–76% of medical students have a bad sleep quality [14, 15,16]. The research of sleep deprivation in this population is relevant due to the high influence on physical, mental and psychic health, and academic achievements.

PURPOSE

The research aims to reveal the prevalence of sleep disturbances among medical students by examining seven sleep disorders

(obstructive apnea, insomnia, narcolepsy, restless leg syndrome (periodic limb movement disorder), circadian dysregulation, somnambulism and night fears).

MATERIALS AND METHODS

Students from the department of general medicine were involved into the research. From April 03 to June 27, 2020 1,668 2nd to 4th year students from the VSMU were enrolled. The Sleep-50 questionnaire was used. The 1st, 5th and 6th year students and incomplete questionnaires were excluded. The total number of participants was 678.

For investigational purposes, the sample size was determined with a known number of observations in the overall population according to A. M. Merkov's formula (1962):

$$n = \frac{(p \times q \times t^2 \times N)}{(N \times \Delta^2 + p \times q \times t^2)}, \text{ where}$$

n — the minimum sample size;
N — the overall population;
p — the studied event probability (in this case, it is unknown, so we consider it equal to the maximum possible value, i.e. 50%), the sign overall frequency;
t — the confidence factor (t=2 at p=0,05);
Δ — the error margin (5%);
q — the optionality (100-p).

The values of t and Δ are selected to observe the high confidence of poll results (in 95% of cases the maximum error was 5%).

The overall population (N) of students was 1,668. Thus, the sample was (people):

$$n = \frac{(50 \times 50 \times 2^2 \times 1668)}{(1668 \times 5^2 + 50 \times 50 \times 2^2)} = 323$$

The study can be considered representative when it is participated by at least 323 people.

The interview consisted of two parts. The first part included social and demographic data such as age, gender, family status, body mass index (BMI). The academic year and average score were registered. The questionnaire included questions about chronic diseases, sleep disturbance family history, smoking status, coffee consumption, time spent on smartphones and/or TV. It was found out whether the student performed physical exercises within two hours before sleep and whether he/she slept in a very cold room. The second part embraced the Sleep-50 questionnaire [16].

The research uses the Sleep-50 questionnaire scale validated by Sportmaker and his point rating system. The questionnaire consisted of 50 questions (items) and 7 sections (subscales). Each subscale was used to estimate a particular sleep disturbance.

The results were calculated on a 4-point grading scale (1 — not at all; 2 — some; 3 — much; 4 — very much) [17]. 3 or 4 scores assigned to any item pointed at a symptom of a particular sleep disorder.

The analysis of the correlation between social and demographic data and sleep disturbances was performed. The MicrosoftExcel 2013 program was used to process the values. Parametric methods such as calculation of average group values (M), the average data error (m) and use of the Student's t-test (t) were utilized to estimate the statistical significance of group values. Meanwhile, the possibility of a statistical error concerning the conclusion about the statistical value significance was less than 5% (p<0.05).

RESULTS

The participants had the following general characteristics. There were 268, 244 and 166 2nd, 3rd and 4th year students, respectively (fig. 1), with 388 women and 290 men (fig. 2).

Only 7% of those surveyed were married. 15.8% of them had chronic diseases. 17% of students smoked, 80% had strong coffee, 15% had sleep disturbances in family history, 8% exercised for two hours before bedtime and 7% slept in a very cold room.

The Sleep-50 questionnaire was used to diagnose the most frequent sleep disturbances. 29% complained of at least one sleep disturbance. Initial insomnia and sleep maintenance were the most frequent disorders that amounted to 51.8% (fig. 3).

Combined sleep disturbances were determined. 3.2% of those surveyed reported two combined sleep disturbances, whereas 2.1% of them had three combined sleep disorders.

The relation between sleep disturbances and several academic and social variables were examined. No significant differences were found between poor academic performance, body mass index and sleep disorders. No difference in the average scoring was found among students with and without sleeping disorders. However, significant differences were found in the time spent by the students on TV and/or smartphones and sleeping disorders (p<0.05). The correlation ratio between two variable was 0.75 (according to the Chaddock scale).

A correlation between the categorical variable and sleep disturbances was discovered. There was an interaction between a gender and sleep disorder, as women had the problem more frequently than men.

Considering an insignificant sample, the analysis of the correlation between sleep disturbances and family status is not representative (7% of those surveyed).

Moreover, an increasing intensity of sleep disturbances was observed during the 2nd — 4th years of studying at the University. The relation with other categorical values was insignificant.

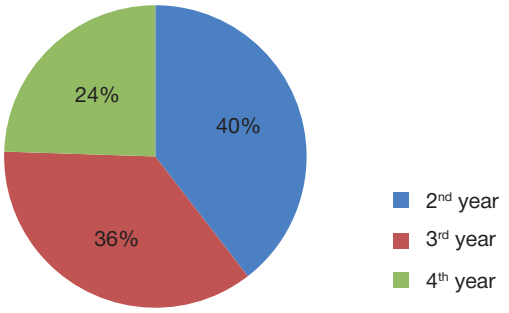

Fig.1. Distribution of students by course years,%

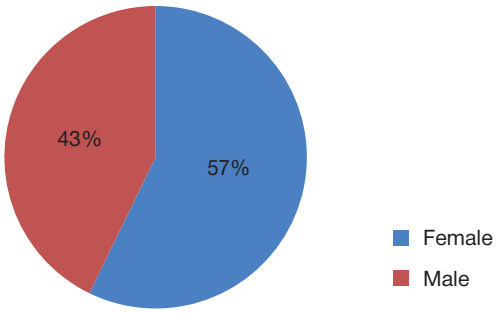

Fig. 2. Distribution of students by gender,%

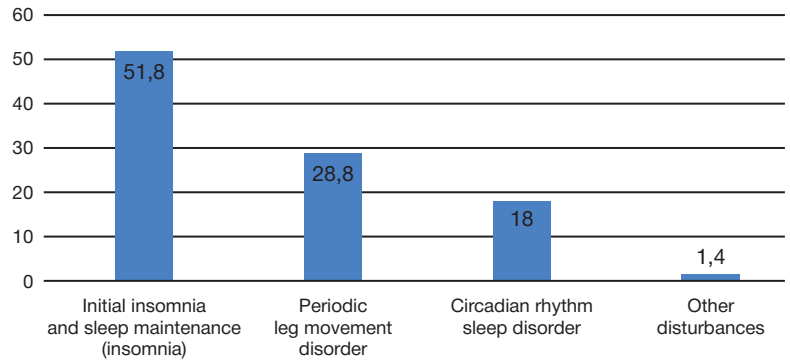

Fig. 3. Distribution of sleep disturbance types,%

DISCUSSION OF RESULTS

A certain level of sleep disturbances, increased during the studying, was determined among medical students. According to other studies, the disturbances influence memory consolidation, learning ability, physiological functions and general health [18].

We observed the relation between time spent on TV and smartphones and sleep disturbances. The mean time spent on TV and smartphones by medical students suffering from sleep disturbances was 7 hours. On the other hand, those without sleeping disturbances spent about 5 hours on the same.

This was also seen during researches involving medical students. For instance, in Iran, the incidence of excessive use of mobile phones was 10.7%, whereas the incidence of bad sleep quality was 61.7%.

A similar study in India has shown that over two thirds of medical students had poor sleep quality because they used mobile phones for a long time. Hossein and other researchers found out that surfing social media on smartphones negatively affected the academic achievements [19]. In any case, sleep disturbances developed due to excessive use of mobile phones can be an intermediate step towards possible poor academic achievement.

A connection between gender and sleep disturbances was another important outcome of this research. Women are psychologically more dependent on their environment as compared with men. They have a more pronounced need to inform someone of their bad sleep. A greater risk of sleep disturbance in female students can be associated with a menstrual cycle.

It is of note that the research was conducted during a continuous global COVID-19 crisis accompanied by accumulation of stress among students. Their participation in the academic life was significantly reduced. According to many authors, an increased level of anxiety and stress was determined in medical education [20, 21, 22, 23, 24, 25].

CONCLUSION

Sleeping disorders are common among medical students. The disorders produce an impact on their physical, mental and psychological health. The problems must be revealed and solved until the condition is aggravated. Sleeping disorders are more common in seniors. It means the number of disorders is constantly increased as learning goes on. Female students are at a higher risk. Medical students have to be well aware of the time spent on TV and mobile phones.

The consequences of the global COVID-19 crisis continued in 2020–2021 and intense use of mobile phones and social media are depicted on the sleeping model of medical students. The issues need further discussion.

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COMPARATIVE ANALYSIS OF CHEMICAL CONTAMINATION OF BABY FOODS AND PRIMARY PEDIATRIC MORBIDITY

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The safety of baby foods is key to a child's health, which, in turn, is one of the prioritized national goals. As they grow, children get exposed to numerous negative environmental impacts. Chemical contamination of baby foods can increase pediatric morbidity. The aim of this study was to investigate possible correlations between baby food contamination and primary pediatric morbidity using data on 65 Russian regions collected in 2012–2017 by the Russian Federal Information Public Health Surveillance Foundation. The data were processed in Microsoft Word 2010 and Microsoft Excel 2010. Of 67,940 samples of baby foods analyzed for chemical contamination, priority pollutants (toxic element) were detected in 14.1%. The most contaminated were fruit and vegetable purees (47.1%), followed by milk formulas and cultured dairy products (19.9%). We also analyzed 32,914 indicators of pediatric morbidity. The Pearson correlation analysis detected reliable correlations between baby food contamination and the primary incidence of endocrine disorders in infants, as well as the primary incidence of obesity, diabetes mellitus and cancer in children aged 0 to 14 years.

Keywords: chemical contamination, toxic elements, baby foods, pediatric morbidity

Compliance with ethical standards: the study was approved by the Ethics Committee of Pirogov Russian National Research Medical University (Protocol No.15 dated December 14, 2015).

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СРАВНИТЕЛЬНЫЙ АНАЛИЗ ХИМИЧЕСКОЙ КОНТАМИНАЦИИ ПРОДУКТОВ ПИТАНИЯ ДЛЯ ДЕТЕЙ РАННЕГО ВОЗРАСТА И ПЕРВИЧНОЙ ЗАБОЛЕВАЕМОСТИ ДЕТЕЙ

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Безопасность продуктов детского питания — это залог здоровья подрастающего поколения, что является важной задачей органов государственной власти. Быстро растущий детский организм подвержен влиянию неблагоприятных факторов окружающей среды. Чужеродные химические вещества в продуктах детского питания могут привести к росту заболеваемости детей. Целью исследования явилось выявление зависимости контаминации продуктов питания для детей раннего возраста и первичной заболеваемости детского населения по данным Федерального информационного фонда данных социально-гигиенического мониторинга Российской Федерации (ФИФ СГМ РФ) по 65 субъектам за 2012–2017 гг. Полученные базы данных обрабатывались с использованием компьютерных программ «Microsoft Word 2010» и «Microsoft Excel 2010». За шестилетний период из 67940 проанализированных проб продуктов питания для детей раннего возраста на содержание химических веществ были выявлены приоритетные контаминанты — токсичные элементы (14,1%). Из проанализированных продуктов питания для детей раннего возраста наиболее контаминированными являются продукты прикорма на плодоовощной основе (47,1%), на втором месте — молочные и кисломолочные продукты (19,9%). Был проведен анализ 32914 показателей первичной заболеваемости детского населения. Проведенный корреляционный анализ (по Пирсону) установил достоверные связи между контаминацией продуктов питания для детей раннего возраста и уровнями первичной заболеваемости эндокринной системы детей раннего возраста, а также уровнями первичной заболеваемости ожирением, сахарным диабетом и злокачественными новообразованиями детей от 0 до 14 лет.

Ключевые слова: химическая контаминация, токсичные элементы, детское питание, заболеваемость детского населения

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As diseases with a significant social impact, including endocrine disorders and cancer, are on the rise, concerns are growing about the health of children and adolescents [1–4]. Of all known toxic contaminants, heavy metals like lead, cadmium, arsenic, and mercury, which represent the group of priority pollutants, pose the most danger to children [5–7]. Heavy metals tend to accumulate in organs and tissues and thus affect the child's health when ingested with food even at subthreshold concentrations [8–16].

The aim of this study was to conduct a comparative analysis of baby food contamination and the primary incidence of endocrine disorders and cancer in the pediatric and adolescent populations.

METHODS

Data used for the analysis was obtained from the Russian Federal Information Public Health Surveillance Foundation and covered the period from 2012 to 2017. Information about baby food contamination was extracted from Form 18, which aggregates data on the environmental health from Russian regions, and Statistical Form 12, which aggregates data on the primary incidence of diseases reported by local medical facilities and which we used to analyze morbidity in 2 cohorts: infants and children aged 0 to 14 years.

The obtained data were processed in Microsoft Word 2010 and Microsoft Excel 2010; relative and mean values were

calculated. A correlation analysis was conducted to investigate the relationship between baby food contamination with heavy metals (lead, cadmium, arsenic, and mercury) and the primary incidence of endocrine, nutrition and metabolic disorders among infants and cancer, obesity, types 1/2 diabetes mellitus among children aged 0 to 14 years in 65 Russian regions. The significance of differences was tested using Pearson's correlation; calculations were performed in Microsoft Excel 2010.

RESULTS

In 2012–2017, a total of 67,940 samples of baby foods were analyzed for chemical contamination; of them 33,091 were tested for the presence of toxic chemicals. Chemical contamination was detected in 15,589 samples (22.9%), whereas contamination with heavy metals (lead, cadmium, arsenic, mercury) in 9,566 samples (14.1%). Contamination above the maximum allowable level (MAL) was detected in 129 samples; subthreshold contamination levels were observed in 9,437 samples.

Half of the tested baby food samples (4,505 samples, 47.1%) were fruit and vegetable purees; they were the most contaminated. Adapted or partially adapted milk formulas and cultured dairy products made up one-fifth of the samples (6.631 samples, 20.1%) and were the second most contaminated baby foods (1,896 samples, 19.9%). The numbers of the analyzed infant cereals and canned pureed meat (with or without vegetables) and fish (with or without vegetables) products were comparable: 4,601 vs 3,909 samples, respectively. Contaminants were present in 1,685 purred meat and fish samples (17.6%) and in 1,151 infant cereal samples (12%). The rest types of baby foods made up less than 5% of the analyzed samples, and their contribution to the total contamination with heavy metals was less than 3%.

The primary incidence of endocrine disorders among infants was analyzed based on 10, 121 indicators. It fell by 18.2% over the analyzed period but its mean values grew by 21.7% relative to the background incidence.

The primary incidence of obesity among children aged 0 to 14 years was analyzed based on 10,914 indicators. Over the analyzed period, it increased by 16.3%; the mean values also increased by 41% relative to the background incidence.

The primary incidence of type 1 diabetes among children aged 0 to 14 years was analyzed based on 6,110 indicators. Over the analyzed period, it increased by 21.6%, while the mean values rose by 80.1% relative to the background incidence.

The primary incidence of type 2 diabetes among children aged 0 to 14 years was analyzed based on 6,110 indicators. Over the analyzed period, it fell by 36.4% but the mean values increased 28-fold relative to the background incidence.

The primary incidence of cancer among children aged 0 to 14 years was analyzed based on 6,110 indicators. Over the analyzed period, it fell by 4% but the mean values increased 2.2-fold relative to the background incidence.

Possible correlations between baby food contamination and the primary incidence of endocrine disorders and cancer were investigated. The results are presented in the Table below.

DISCUSSION

The obtained results are similar to the results of the comparative analysis of chemical contamination of foods for children aged 0 to 14 years and primary morbidity in this age group. Previously, reliable correlations were established for chemical contamination of foods for children aged 0 to 14 years and the primary incidence of cancer and obesity in this age group ($r=0.27$; $p \leq 0.05$ and $r=0.13$; $p \leq 0.05$, respectively) [17].

The established correlations are consistent with the results of other studies showing the effects of air, water, soil, and food contamination on the incidence of endocrine disorders and cancer in some Russian regions.

For example, Kislitsyna LB, Kiku PF et al. have demonstrated the impact of water pollution with heavy metals on the risk of cancer and non-cancerous health problems in children and the impact of food pollution with heavy metals on the risk of cancer in both adults and children [18–21].

Luzhetsky KP et al. have described the effects of water, air and food pollution with heavy metals on the risk of endocrine disorders, such as overweight, obesity, diabetes mellitus, and thyroid disorders, in children and adults [2, 22–24].

Kolnet IV and Studenikina EM have compared carcinogenic and non-carcinogenic risks in children following exposure to soil contaminated with heavy metals [25].

Setko AG et al. have described heavy metals as priority pollutants of food and calculated carcinogenic and non-carcinogenic risks associated with exposure to toxic chemicals in water and foods [26–28]

The established correlations are consistent with the joint report of UNEP and WHO recognizing chemical contamination as an endocrine disruptor [29].

CONCLUSION

The analysis has revealed correlations between contamination of baby foods with heavy metals (lead, cadmium, arsenic, and mercury) and the primary incidence of endocrine disorders, including obesity and types 1 and 2 diabetes mellitus, in infants and children aged 0 to 14 years, as well as the primary incidence of cancer in children aged 0 to 14 years.

These findings raise the need for taking measures to minimize contamination of baby foods with heavy metals. This will prevent and reduce the risk of endocrine disorders and cancer.

Table. Pearson's correlation coefficient (r) for primary pediatric morbidity ($p \leq 0.05$) in 2012–2017.

Disease	Years, 2012–2017
Endocrine disorders in infants	0.136
Obesity in children aged 0 to 14 years	0.184
Type 1 diabetes mellitus in children aged 0 to 14 years	0.274
Type 2 diabetes mellitus in children aged 0 to 14 years	0.042
Cancer in children aged 0 to 14 years	0.049

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MENTAL HEALTH OF THE CHILDREN WHO ARE ACTIVE USERS OF DIGITAL MEDIA

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The article provides a literary review of studies on the impact of digitalization on indicators of mental health and well-being (emotional well-being, behaviour, communication, learning) of children and adolescents. The vast majority of researchers note the prevalence of different disorders in children and adolescents, including inattention, hyperactivity, anxiety, depressive symptoms, obsessive disorders etc.

Keywords: children, teenagers, digital environment, mental health, prevalence of violations

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НЕРВНО-ПСИХИЧЕСКОЕ ЗДОРОВЬЕ ДЕТЕЙ — АКТИВНЫХ ПОЛЬЗОВАТЕЛЕЙ ЦИФРОВЫХ СРЕДСТВ

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В статье приводится литературный обзор исследований о влиянии электронных девайсов, в том числе использующихся в образовательном процессе, общении в социальных сетях и компьютерных играх на показатели нервно-психического здоровья и благополучия (эмоциональное состояние, поведение, общение, обучение) детей и подростков. Подавляющее большинство исследователей отмечают увеличение распространенности различных нарушений у школьников и молодежи, в том числе невнимательности, гиперактивности, тревоги, депрессивной симптоматики, обсессивных расстройств и др.

Ключевые слова: дети, подростки, цифровая среда, психическое здоровье, распространенность нарушений.

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INTRODUCTION

On the one hand, scientific and technological progress, digitalization of economy, medicine and education improve the life quality and enhance safety of users, significantly simplifying access to data (on-line learning, leisure, communication) by alternating practices and making human activity more effective. On the other hand, we see a threat to the established way of life, neuropsychic health and mental well-being of children and adolescents [1].

First of all, this concerns young users, especially children and adolescents, as they are the most vulnerable to Internet addiction and private life safety, improper use of personal data and cybercrime, loss of control over private data, fake news, harmful content, loss of social skills, and independence due to delegation of the tasks to personal assistants, etc. [1, 2].

The conducted trials reveal a number of risks associated with digital technologies, including social and mental risks [3, 4, 5]. First and foremost, children and adolescents are vulnerable to similar risks due to the lack of experience and ability to properly assessing information, non-critical attitude to arriving offers, different situations and communications, insufficient reflection and comprehension of the motives and purposes of others. According to researchers [6], new information technologies are currently both the tool and environment for social development of a person and education as a child and as an adolescent. They inevitably result in questions about their influence on the neuropsychic health and mental readiness for education [7].

There exist numerous controversial relations between digitization and neuropsychic health and well-being in general. They are not examined yet. Scientifically valid prognosis about remote consequences of digitalization and its effect produced on health are lacking. Meanwhile, studies in the area are being performed, and there already exist data pointing at short-term consequences and both positive, and negative outcomes of spreading digital technologies and Internet among children and adolescents [7, 8].

MATERIALS AND METHODS

The purpose of this literature review was to study the effect of digitalization on the values of neuropsychic health and well-being, daily practices of users, including education and other aspects of social life of children and adolescents based on the review of Russian and foreign research.

RESULTS AND THEIR DISCUSSION

According to Kaspersky Laboratory, over half of Russian adolescents (56%), their peers from Europe (51%) and USA (40%) spend their free time on the Internet [8].

Many studies are devoted to the effect of digital technologies on neuropsychic health and well-being [9, 10]. The publications often mention such disturbances of neuropsychic health such as suicidal behavior, depression and agitation, self-destructive behavior, Internet dependence, substance misuse, and psychosomatic disorders [11, 12].

Many works cite data on the growing spread of depression, including amongst adolescents of today [13]. The risk of depression increases as a child grows up, with girls being prone

to depression more frequently than boys [12]. The spread of depression symptoms among adolescents under 18 years of age is around 11% [14, 10].

Some authors believe that the growing rate of depression in adolescents and young people is connected with their long-term stay in digital environment and frequent use of smartphones and other electronic gadgets.

The majority of researches also note an unfavorable effect produced by different digital devices on their users' sleep. Less sleep results in anxiety, depression, impaired self-assessment in children and adolescents worsening their neuro psychic health and mental well-being [12].

Interactive sessions, videogames, and passive screen time such as constant review of feeds due to the fear of missing information, especially before sleeping, worsen the quality of sleep and disturb the process of falling asleep due to psychic overexcitement by reducing the sleeping hours and melatonin production [15].

Reduction of sleep results in consumption of more calories, changing not just the quantity, but also the quality of food. Short sleep increases craving for sweets, carbohydrate-rich products, and salty snacks. Chronic sleep deprivation results in a weakened immune system, hormonal disturbances, etc. [16].

Long-term daily use of various gadgets (over 6 hours a day) produces a negative influence on neuropsychic health of children and adolescents who complained of a feeling of isolation, dissatisfaction with life, poor academic progress, etc. [17]. According to the results of the research based on the evidence from teenage parents and according to the classification of mental disorders (DSM-5), the most frequent symptoms included disorders of attention, attention deficit hyperactivity disorders (ADHD), obsessive and phobic disorders, low mood, and mixed anxiety depressive disorders, which correlated with a number of adolescents' accounts in social media [18].

Digital technologies possess a large potential for increasing the quality of education [7], influence the various aspects of life both of adults, and children, and adolescents, their emotional sufferings, communication with social environment, etc. Overuse of virtual communication by adolescents without actual intercommunication can decrease self-assessment, increase feelings of anxiety and depression, and strengthen the feeling of isolation [19].

CONCLUSION

Analysis of scientific literature shows that the influence of new technologies on the life of children and adolescents is much more diverse and deeper than it may seem.

Excessive and long-term use of modern digital media by children and adolescents can result in the development of neuropsychic disturbances such as depression, suicidal behavior, loss of sleep, obsessive, phobic and emotional disturbances, substance misuse, harmful habits and dependencies, and psychosomatic diseases.

The most important research task is to examine the effects of digitalization on various aspects of mental health and well-being of young users, including medical, mental, educational, social and other aspects of life of children and adolescents.

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PECULIARITIES OF LOW-MINERALIZED DRINKING WATER CHEMICAL CONTAMINATION INFLUENCE ON HEALTH OF THE POPULATION OF THE RUSSIAN FAR EAST

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Prioritized drinking water contaminants found in water supply systems of the Russian Far East and their possible unfavorable influence on the population health have been reviewed. It is shown that drinking water natural mineral composition peculiarities have to be borne in mind when the level of somatic morbidity of the population is determined, which is essential due to intensified economic advancement of the region.

Keywords: water supply systems, drinking water, chlorinated hydrocarbons, manganese, iron, biogenic elements, disease incidence, Russian Far East

Author contributions: Koval'chuk VK made a significant contribution into the review concept and design, edited the final variant of the manuscript sent to the editorial office; Yamilova OYu made a significant contribution into literature data search and analysis, prepared the first variant of the article.

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ОСОБЕННОСТИ ВЛИЯНИЯ ХИМИЧЕСКИХ ЗАГРЯЗНИТЕЛЕЙ МАЛОМИНЕРАЛИЗОВАННОЙ ПИТЬЕВОЙ ВОДЫ НА ЗДОРОВЬЕ НАСЕЛЕНИЯ ДАЛЬНЕГО ВОСТОКА

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Представлен обзор приоритетных загрязнителей питьевой воды систем водоснабжения на Дальнем Востоке и их возможное неблагоприятное влияние на здоровье населения. Показана значимость учета особенностей природного минерального состава питьевой воды в формировании уровня соматической заболеваемости населения, что имеет особое значение в связи с интенсификацией экономического развития этого региона страны.

Ключевые слова: системы водоснабжения, питьевая вода, хлорированные углеводороды, марганец, железо, биогенные элементы, заболеваемость, Дальний Восток России

Вклад авторов: Ковальчук В. К. внес существенный вклад в концепцию и дизайн обзора, выполнил редактирование окончательного варианта рукописи, присланной в редакцию; Ямилова О. Ю. внесла существенный вклад в поиск и анализ литературных данных, подготовила первый вариант статьи.

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Drinking water is a key factor of human environment. Scarcity and poor quality of drinking water is a national problem faced by many developing countries with an arid and monsoon climate. The increased effect of anthropogenic load on sources of water supply results in its more pronounced unfavorable influence on population health, especially in urban areas.

In recent years, the rate of economic growth of the Far East of Russia has significantly outpaced the rates of water supply system upgrading. The process is very significant, as about 80% of the population take drinking water from the central water supply systems. Two- and one-step water treatment processes are commonly used to purify water at local water stations. The two-step processes still utilize the water treatment technology developed in the 50–60s years of the last century and include as follows: reactant treatment, precipitation (or clarification) of water, filtration and disinfection (chlorination or ultraviolet irradiation). Long-term observations have shown that this technology doesn't remove dissolved organic impurities of natural and human origin from water due to a rise in anthropogenic water pollution levels and systematic deficit of reagents [1]. The pollutants can react with chlorine ions to form the so-called chlorinated hydrocarbons [2]. High wear of water distribution networks can pose a challenge to drinking water quality. The networks are primarily made of metal pipes with no anticorrosive coat, which is a secondary source of water contamination with metal oxides, especially those of Fe [3].

According to scientific publications, availability of any contaminant in drinking water does not necessarily produce a negative effect on human health due to minimal levels and short-term exposure, whereas toxicity commonly depends on individual susceptibility [4,5,6,7,8]. The influence of any chemical substance on population health must be assessed during a thorough hygienic trial of many years, especially at population level.

Since the beginning of the XXth century, chlorination is the principal effective way of drinking water disinfection. Chlorinated hydrocarbons such as trihalomethanes (THM) (chloroform, bromodichloromethane, dibromochloromethane, and bromoform) are formed in chlorination of not sufficiently clarified and discolored water at water stations. Formation of trihalomethanes is due to the interaction of active chlorine with organic substances and bromide ions in water. The first by-products of the interaction of chlorine with organic compounds were found in 1974, when trihalomethanes were discovered. At present, over 600 of different by-products of drinking water disinfection are found; many of them are not regulated yet. Trihalomethanes belong to the most common class. The process of trihalomethane formation takes up to tens of hours [9]. Increased and high levels of chlorinated organic

compounds in drinking water is a risk factor for human health, leading to a rise in cases among children and overall morbidity, development of regulatory abnormalities [9,10,11,12,13,14]. Recent experimental toxicological trials have shown that the most common groups of water chlorination by-products (trihalomethanes) influence spermatogenesis, sperm mobility and morphology, decreasing fertility in male rats and rabbits. Based on the results of toxicological Chinese trials, influence of drinking water chlorination by-products can pose a threat to male health [15], has mutagenic, cytotoxic and genotoxic properties [12,16]. It is asserted that during pregnancy, the effect of THM is associated with a low length and body mass of a fetus [13]. A relation between the impaired fat and carbohydrate metabolism and the increased level of trihalomethanes in tap water is found in children from the Perm Territory [10]. Recent toxicological and epidemiological trials show an increased risk of cancer, including cancer of the urinary bladder, in people who for a long time have drinking water with THM at concentrations several times higher than those permissible for drinking water [9,11,12,17,18].

Based on the IARC (International Agency for Research on Cancer) classification, trichloroethylene belongs to group 2A (probably carcinogenic to humans), whereas chloroform belongs to group 2B (possibly carcinogenic to humans). It has been established that in the countryside of the Primorsky Territory (Ussurian lowlands), the individual carcinogenic risk of trichloroethylene contained in well water can be equal to $1.54 \cdot 10^{-6}$, which corresponds to 1.54 of additional cases of cancer per million of exposed people [17]. In chronic experimental trials it has been shown that peroral chloroform induces malignant hepatomas, renal adenomas and adenocarcinomas in mice and rats [15]. Based on hazard indices, the central nervous system, kidneys, liver, skin and mucous membranes, blood, bones and immune systems, hormonal exchange, digestive and blood circulation organs are unfavorably affected by contaminating chemical substances [4,6,7,9,17].

It should be noted that carcinogenic properties of many water chlorination by-products are manifested through a chronic influence of increased and high carcinogenic doses on a body. This occurs most frequently when the technological process of water handling is disturbed or in an extreme effect on the water regimen of a water supply source (flood, sewage emergency release). Under these conditions, a causal effect between contamination of water with chlorinated hydrocarbons and cancer occurrences is seen during a shorter period. It's more difficult to confirm the leading role of these substances in the development of cancer in population if the level of chlorinated organic compounds in drinking water is low. Moreover, water can contain compounds with carcinogenic activity of another origin [4,9], hampering assessment of a potential risk for human health, when a found in water cancer-causing chemical produces an effect.

In the largest part of the Russian Far East, water in sources is soft and low-mineralized (based on a medical classification) and ultra-fresh (based on a technical classification), the latter explaining its high corrosive activity towards water-bearing fittings [3]. According to the literature, long-term use of drinking water with increased levels of Fe up to 5 mg/L can result in dryness and pruritis of skin, pathological changes in the mucous membranes, blood and immune system, and siderosis (over 37.8 mg/L) [3,19,20]. It is believed that a very high level of iron in drinking water is a reason for iron accumulation in a body and development of ecologically dependent pathologies [21]. Siderosis, resulting from iron accumulation, is commonly transformed into hepatic and pancreatic cancer. A higher iron level makes proliferation of tumor cells more intense. However, unlike chelated iron, ions of Fe can initiate mutagenesis [19,21]. Data from different sources indicate at the causal effect between a higher iron entry into the body and incidence of colorectal cancer or occurrence of premalignant polyps (adenomas). However, the process mechanisms are under investigated now [22,23]. However, increased body saturation with iron impairs the body resistance and can lead to a higher overall morbidity, neoplasms, cardiomyopathies, arthropathies, and an increased number of endocrine and neurogenerative disorders [21]. Excess of iron can result in an intensified oxidative stress, which is currently considered as a link of such pathological processes as Alzheimer disease and Parkinson's disease [21,24]. Disbalance of iron in a body promotes excessive accumulation of toxic metals in the central nervous system (manganese, copper, cobalt, cadmium, aluminum, etc.) [25].

Manganese is also a top-priority drinking water contaminant in ore-bearing regions of the Russian Far East, primarily, on water pipes with underground sources. It is mainly of a natural origin, though it is also formed in water pipes due to water microflora activity or industrial soil contamination (for instance, improper removal of dry-charged batteries or other toxic substances [26]. Just like with iron, high levels of manganese in drinking water can alter health of adults and children. Manganese is a mineral element, which is both essential, and potentially toxic. This depends on the dose level. It is important in a number of physiological processes, and can be a powerful neurotoxicant, when in excess [25,27,28,29].

Though certain mechanisms of manganese absorption and transportation are not fully examined yet, some articles state that iron and manganese can have common absorption and transport pathways. When Mn and Fe compete for the same transport systems, iron-deficiency anemia is developed in case the arrival of Fe is normal [30,31]. On the contrary, consumption of manganese from food is decreased when the nutritional level of Fe is increased. Moreover, the biological availability of manganese can be influenced by the level of Fe. Intestinal absorption of manganese is increased when there is not enough Fe; increased Fe stores (ferritin levels) are associated with a lower consumption of manganese. Men commonly consume less manganese than women. This can be explained by the fact that men usually have higher Fe stores. Besides, iron deficiency increases the risk of manganese accumulation in the brain [25,30].

Manganese can commonly be found in underground waters when manganese minerals are weathering and leaching from geological materials into water beds. Its water concentration can vary greatly. However, we have not enough articles devoted to the effect produced by manganese found in water on population health. In has been found out that in research studies of adults and children, high levels of manganese in water can produce a neurotoxic effect [32,33]. In Bangladesh, increased manganese concentration in water (mean concentration of 800 μg/l) is related to the decreased intelligence quotient (IQ) for 142 children not elder than 10 years old [34]. In Canada, a medical examination of 362 children aged 6 to 13 years has shown that high manganese concentrations can trigger more hyperactive and oppositional behavior in children [35]. This is supplemented by a Canadian trial, where an interrelation between impaired memory, motor functions and long-term consumption of manganese with water (exceeding 100 and 180 μg/l, respectively) was found [36]. In other words, the central nervous system is a target organ for excess exposure to manganese in an ionic form [32,29].

It has been shown that, apart from a negative effect on the central nervous system, chronic consumption of drinking water with a high level of manganese can trigger diseases of genitourinary system, skin and subcutaneous fat, stress of thyroid sphere, complications of pregnancies and deliveries, allergic reactions, disturbances of cellular immunity and non-specific

resistance, and mutagenic activity [27,30,31,37]. Currently, a reference dose of manganese, which goes with drinking water, is equal to 0.14 mg/kg. This is the dose used to assess the risk for human health during exposure to chemical substances.

The Russian Far East is known to be a part of an extensive biogeochemical province with a marked deficiency of some biogenic elements in the environmental objects. In particular, laboratory research performed in the Sakha Republic, Jewish Autonomous Region, Magadan Region and Primorsky Territory has shown that water taken from the potable water distribution systems contains low levels of calcium, magnesium, fluorine and other micronutrients [38,39,40,41,42]. By total dissolved solids, the water can be classified as ultra-fresh (0.5 g/l), and as very soft (up to 1.5 mg-equ/L) or soft (1.5–3 mg-equ/L) when classified by hardness. Very low mineralization of drinking water is important for human health.

Over the last decade, a number of scientific publications that point at the relation between some pathological conditions and long-term use of too soft drinking water with low levels of carbonates, calcium and magnesium hydrocarbonates, needed for a normal human life, has risen considerably [40,43,44,45]. Moreover, long stay on the territories with a pronounced disbalance of calcium and magnesium in drinking water is one of pathogenic risk factors of urolithiasis in urinary organs [42,46]. A causal relationship between a high incidence of cardiovascular morbidity, including hypertensive disease and ischemic heart disease, and long-term use of low-mineralized drinking water has been proven earlier [44,47]. In the Russian Far East, territories with high cardiovascular risk mainly include a seaboard of the northwest part of the Pacific Ocean, especially its southern part, located to the east from the Sikhote-Alin in the Primorsky Territory. Water from water supply systems is mineralized the least and has the largest possible deficiency of magnesium and calcium [1,40,46]. The value of water found biogenic elements for a human body is based on their almost 100% bioavailability; in food products, the same value is equal to 25–40% only and can be found mainly in milk and milk products.

In conclusion of a review of scientific publications, it's necessary to mention reports about a higher toxicity of lead, arsenic, contained in very soft, low-mineralized drinking tap water [44,45,48]. This phenomenon can also be typical of drinking water chlorates. However, available literature lacks publications on that issue. A probability of changing the toxicity of drinking water anthropogenic contaminants depending on its mineralization level requires a shift from traditional approaches limiting only upper and maximum allowable concentrations of certain substances in drinking water by organoleptic and toxicological signs of harmfulness, to the optimization approach, regulating the minimum levels of biogenic elements, responsible for total hardness of water. This approach that has been implemented in a setting of environmental standards for the quality of pre-packed drinking water definitely reflects the most progressive tendencies in the doctrine of drinking waters and is actual for the Russian Far East.

The presented analysis of scientific literature makes it possible to compile a research program to provide a rationale for a set of preventive activities. The activities are aimed at the weakening of an unfavorable effect of drinking water quality in water supply systems produced on the health of inhabitants of the Far East, which is essential due to expected intensified economic advancement of the region.

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