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COMPARATIVE ANALYSIS OF PHYSICAL DEVELOPMENT IN CHILDREN LIVING IN SAMARA AND NIZHNY NOVGOROD

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Analysis of physical development in children and adolescents is an integral to the monitoring of child population. Health status of children and adolescents is an essential criterion of societal welfare. Numerous studies of physical development in children indicate the heterogenous nature of growth and developmental processes in children living in various regions of Russia. The study was aimed to perform the comparative analysis of physical development between children aged 15–17 living in Samara (a total of 714 children were examined, among them 368 boys and 346 girls) and children of the same age group living in Nizhny Novgorod (a total of 689 children, among them 351 boys and 338 girls). In school students aged 16–17, significant differences in the mean height were revealed: adolescents living in Samara were taller than those living in Nizhny Novgorod ($p = 0.001$). The same trend was observed in girls of the same age group. Comparative analysis showed that girls aged 15–17 living in Samara were significantly taller ($p < 0.001$) than girls who lived in Nizhny Novgorod. Assessment of body weight showed that the weight of boys aged 15–16 who lived in Samara was significantly higher compared to boys living in Nizhny Novgorod ($p = 0.009$). No significant differences were revealed between the groups of 17-year-old boys and the groups of girls aged 15–17 ($p = 0.7$). The findings on the differences in the anthropometric indicators of children living in Samara and Nizhny Novgorod justify the need for periodic development and use in healthcare practice of the regional standards for assessment of physical development in children and adolescents.

Key words: hygiene of children and adolescents, physical development, regression scales

Author contribution: Sazonova OV — academic advising; Bogomolova ES, Kalyuzhny EA — data acquisition and processing; Gavryushin MYu — research initiator, design, data acquisition; Trubetskaya SR — literature analysis, manuscript writing and editing.

Compliance with ethical standards: the study was approved by the Ethics Committee of the Samara State Medical University (protocol No. 2 dated February 24, 2021). The informed consent was obtained from all subjects (their legal representatives).

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СРАВНИТЕЛЬНЫЙ АНАЛИЗ ФИЗИЧЕСКОГО РАЗВИТИЯ ДЕТЕЙ Г. САМАРА И Г. НИЖНИЙ НОВГОРОД

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Анализ физического развития детей и подростков является неотъемлемой частью мониторинга детской популяции. Состояние детского и подросткового здоровья — это неотъемлемый критерий уровня благополучия общества. Многочисленные исследования физического развития детского населения свидетельствуют о неоднородных процессах роста и развития детей в разных регионах России. Целью исследования был сравнительный анализ физического развития детей в возрасте от 15–17 лет, проживающих на территории г. Самара, всего обследовано 714 детей (из них 368 мальчиков и 346 девочек) с данными физического развития той же возрастной группы детей, проживающих в г. Нижний Новгород, всего 689 детей (из них 351 мальчик и 338 девочек). В возрастной группе школьников 16–17 лет выявлены высоко достоверные различия в средних значениях показателя длины тела: показатель у подростков, проживающих в г. Самара, выше, чем у детей в г. Нижний Новгород ($p = 0,001$). Аналогичная тенденция наблюдалась и у девочек той же возрастной категории. В ходе сравнительного анализа было выявлено, что длина тела у девочек 15–17 лет из г. Самара достоверно выше ($p < 0,001$), чем у девочек, проживающих в г. Нижний Новгород. Результаты анализа массы тела показали, что у юношей 15–16 лет, проживающих в г. Самара, достоверно более высокая масса тела по сравнению с юношами из г. Нижний Новгород ($p = 0,009$). В возрастных группах 17 лет у юношей и 15–17 лет у девушек достоверных различий выявлено не было ($p = 0,7$). Полученные результаты различий антропометрических показателей детей г. Самара и г. Нижний Новгород обосновывают необходимость периодической разработки и использования в практическом здравоохранении региональных нормативов (стандартов) для оценки физического развития детей и подростков.

Ключевые слова: гигиена детей и подростков, физическое развитие, антропометрические показатели

Вклад авторов: Сазонова О. В. — научное руководство; Богомолова Е. С., Калюжный Е. А. — сбор материала, обработка результатов; Гаврюшин М. Ю. — инициатор исследования, дизайн, сбор материала; Трубецкая С. Р. — анализ источников, подготовка и правка статьи.

Соблюдение этических стандартов: исследование одобрено этическим комитетом ФГБОУ ВО СамГМУ Минздрава России (протокол № 2 от 24 февраля 2021 г.). Добровольное информированное согласие было получено для каждого участника (его законного представителя).

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Physical development is a conventional indicator of physical capacity in children and adolescents. According to research, in the regions of our country a little over 60% of boys and about 67% of girls show the harmonious physical development. In 18% of boys and 14% of girls, disharmonious physical development results mainly from overweight [1–3]. Protecting the health of the younger generation is integral to provision health-care of the nation. Individual and collective assessment of the adolescent development is the most important method used to monitor the status of the adolescent health [4]. Considerable research on the physical development of children and adolescents indicates the growth and development heterogeneity in children living in certain cities and regions of Russia. There is evidence of the increasing number of children having poor physical development due to the increasing number of children with low weight and height. In recent years, rapid deterioration of physical development is observed in children who live in the Volga Federal District. The incidence of non-communicable diseases, such as obesity, increases, the number of healthy children decreases, and there are more and more children with chronic disorders [5]. Technogenic contaminants are the other important factor contributing to growth and development of a child. It has been found that the impact of this factor varies both within the region and between the regions of one federal district [4–6, 7]. Accordingly, the growth and developmental processes in the child population are heterogeneous.

The study was aimed to perform the comparative analysis of physical development in children of secondary school age living in Samara and Nizhny Novgorod.

METHODS

Research involved comparison of our data on the physical development of boys and girls aged 15–17 living in Samara with the data on the physical development of children of the same age group living in Nizhny Novgorod. The Samara survey sample included 714 children, among them 368 boys (51.5%) and 346 girls (48.5%), and the Nizhny Novgorod survey sample included 689 children, of them 351 boys (51%) and 338 girls (49%). Inclusion criteria: age 15–17 years, permanent residence in the territory of Samara and Nizhny Novgorod regions; compliance with the health status group I or II based on medical documentation; informed consent to the study participation submitted by parents (legal representatives). Exclusion criteria:

age at the time of examination less than 14 years 6 months and one day or over 17 years 6 months and one day; permanent residence outside of Samara and Nizhny Novgorod regions; no informed consent to participation (refusal of participation) provided by parents (legal representatives).

The main anthropometric indicators (height, body weight) were measured. Then the following parameters were calculated based on the anthropometric measurements: mean values (M), standard deviation (σ), standard error of the mean (m), minimum and maximum values (min and max). The data were compared with the data obtained when studying the groups of school students of the same gender and age (aged 15–17) living in Samara and Nizhny Novgorod [5, 7]. The raw data were acquired and stored using the Microsoft Excel 2013 software (Microsoft, USA). Statistical processing of the results included the analysis of variance performed using the Statistica 13.1 software package (StatSoft Inc., USA). Statistical significance of the differences was analyzed using the Pearson's χ^2 test. The differences were considered significant at $p < 0.05$.

RESULTS

The findings have revealed no significant differences in height between the groups of 15-year-old boys living in Samara and Nizhny Novgorod ($p=0.2$).

It should be noted that in school students aged 16–17, significant differences in the mean height have been revealed: adolescents living in Samara are taller than those living in Nizhny Novgorod ($p=0.001$).

The same trend is observed in girls of the same age group.

Comparative analysis has shown that the girls aged 15–17 living in Samara are significantly taller ($p < 0.001$) than those living in Nizhny Novgorod (Table 1).

Analysis of our data on body weight has revealed the following: body weight of boys aged 15–16 living in Samara is significantly higher compared to boys living in Nizhny Novgorod ($p = 0.009$). At the same time, no significant differences have been revealed between the groups of 17-year-old boys and the groups of girls aged 15–17 ($p > 0.05$). Perhaps it has something to do with the fact that modern teenagers are more and more concerned about their appearance, tend to maintain good physical shape and are engaged in sports. This could also result from the influence of mass media presenting movies and programs, claiming the slim boys and girls are successful and attractive, as a fashion trend (Table 2).

Table 1. Height of boys and girls aged 15–17

Age, City	Height, boys, cm M + m					Height, girls, cm M + m				
	N	Samara	N	Nizhny Novgorod	P	N	Samara	N	Nizhny Novgorod	P
15	138	170.1 ± 0.7	116	168.8 ± 0.81	0.2	111	165.8 ± 0.6	123	161.8 ± 0.45	$P < 0.001$
16	123	176.3 ± 0.8	102	171.1 ± 0.87	0.001	120	166.5 ± 0.8	112	162.8 ± 0.54	0.001
17	107	179.6 ± 1.1	133	174.7 ± 0.57	0.001	115	167.3 ± 1.3	103	163.5 ± 0.37	0.005

Table 2. Body weight of boys and girls aged 15–17

Age, City	Body weight, boys, cm M + m					Body weight, girls, cm M + m				
	N	Samara	N	Nizhny Novgorod	P	N	Samara	N	Nizhny Novgorod	P
15	138	62.2 ± 1.1	116	58.6 ± 0.82	0.009	111	54.4 ± 1.1	123	55.1 ± 0.76	0.6
16	123	67.7 ± 1.5	102	62.6 ± 0.88	0.009	120	55.7 ± 1.3	112	56.1 ± 0.87	0.7
17	107	67.1 ± 2.1	133	66.8 ± 0.76	0.89	115	57.3 ± 2.1	103	57.9 ± 0.77	0.7

DISCUSSION

The regional approach to assessment of physical development in children and adolescents is used in many regions [3, 6, 8, 9]. The sources are scientific papers on the hygiene of children and adolescents and developmental physiology, teaching resources, scientific and practical experience of hygienists [10–12]. Our study, focused on the comparative analysis of physical development in school students, revealed the significant differences in height between boys aged 16–17 living in Samara and Nizhny Novgorod. The same was observed when studying body weight: boys aged 15–16 who lived in Samara had a significantly higher weight compared to boys living in Nizhny Novgorod. The differences observed are in line with the data of other studies conducted in the Volga Federal District [6, 13]. The decrease in the mean body weight in the 17-year-old boys living in Samara by 0.6 kg compared to the 16-year-old boys, along with the increase in the mean height by 3.3 cm, are consistent with the results of similar studies [14, 15]. Here we could endorse the views of the authors that in boys the increase in body height stops at the age over 18–19 years, along with the changes in the body proportions and limb length. At the age of 17 years, the percentage of individuals actively and systematically engaged in physical exercise and sports also increases, which is reflected in the variable trait of body height. Thus, based on the major anthropometric indicators, physical development of children aged 15–17 living in the

same region varies, which could be due to the environmental impact, lifestyle, as well as climatic, geographical, and social factors [10–13]. Consequently, correct assessment of physical development as a stage in the premorbid diagnosis of pediatric disorders, performed during the routine check-ups, should be based on the regional anthropometric indicators. Assessment based on the regional regression scales for body weight and height taking into account the ratios between the major anthropometric indicators is considered the most appropriate method, which meets not only the requirements of modern legislation on the essential reports, but also the challenge of assessing the physical development of the individual child and the child population as a whole [13]. In turn, anthropometric data, acquired by studying the homogeneous groups of children, are the representative material for the establishment of standards for physical development and construction of regional regression scales for prediction of body weight from height [6].

CONCLUSION

The study of physical development in school students aged 15–17 living in two regions of the Volga Federal District revealed the significant differences in the major anthropometric indicators. The findings justify the need for the development and use in healthcare practice of the regional standards for assessment of physical development in adolescents of this age group.

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KEY HEARING LOSS RISK FACTORS FOR CHILDREN, ADOLESCENTS AND YOUTH ASSOCIATED WITH USE OF MOBILE ELECTRONIC DEVICES WITH HEADPHONES

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The number of research papers about the impact electronic devices produce on the younger generation that uses them is constantly growing. This study aimed to identify the leading hearing loss risk factors for children, adolescents and youth associated with use of mobile electronic devices with headphones. In the 2017–2021 academic years, we surveyed 518 students in Moscow and 1000 schoolchildren and students in the towns of Izhevsk and Tchaikovsky. The survey was designed to collect data on the conditions in which the respondents use mobile electronic devices with headphones, design features of the headphones used and their hearing health status. The inclusion criteria were: status of a schoolchild, student, signed and submitted informed consent form, questionnaire correctly completed by the respondent or his/her legal representative, one or more years of using mobile electronic devices. The conducted study does not endanger the participants and complies with the biomedical ethics requirements. Statistica 13 PL software was used for statistical processing of the data collected. Fourteen percent of the respondents reported hearing deterioration in the course of the last year. Prolonged use of mobile electronic devices with headphones increases the risk of hearing loss by 10.4 times, listening to audio files at maximum volume — by 3.2 times, listening to audio files while in a moving vehicle — by 7.1 times. Most schoolchildren and students with hearing impairments have been using headphones for at least a year, preferred in-ear headphones with silicone tips, used them at maximum volume daily, for more than two hours a day, including while in a moving vehicle. The recommendations for students and schoolchildren is to limit the time of use of their electronic devices with headphones and use them at a lower volume; complying with the recommendations can improve the functional state of their health. It is also recommended not to use headphones while in a moving vehicle. If hearing begins deteriorating, it is necessary to cease using mobile electronic devices with headphones. Today, schoolchildren and students are exposed to the hearing impairment risks associated with use of mobile electronic devices with headphones, which makes the search for the most efficient ways of forming healthy lifestyle habits among them even more urgent.

Keywords: schoolchildren, students, mobile electronic devices

Author contribution: Pavlova GV — research supervisor, article authoring; Markelova SV, Martiusheva VI — collection of material, statistical processing, literature analysis.

Compliance with ethical standards: this study was approved by the Ethics Committee of Pirogov Russian National Research Medical University (Minutes #203 of 20.12.2020) and Ethics Committee of Izhevsk State Medical Academy of the Ministry of Health of Russia (Minutes #655 of 23.04.2019). Each participant signed a voluntary informed consent form. The conducted study does not endanger the participants and complies with the biomedical ethics requirements.

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ВЕДУЩИЕ ФАКТОРЫ РИСКА НАРУШЕНИЙ ОРГАНА СЛУХА ПРИ ИСПОЛЬЗОВАНИИ ДЕТЬМИ, ПОДРОСТКАМИ И МОЛОДЕЖЬЮ МОБИЛЬНЫХ ЭЛЕКТРОННЫХ УСТРОЙСТВ С НАУШНИКАМИ

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В научной литературе появляется все больше публикаций о влиянии использования мобильных электронных устройств на подрастающее поколение. Целью данного исследования являлось выявление ведущих факторов риска нарушений органа слуха при использовании детьми, подростками и молодежью мобильных электронных устройств с наушниками. В 2017–2021 учебных годах было проведено анкетирование 518 студентов Москвы и 1000 школьников и студентов Ижевска и Чайковского. С помощью опроса получены данные об условиях использования мобильных электронных устройств с наушниками и конструктивных особенностях наушников, состоянии органа слуха. Критерии включения — школьник, студент, наличие подписанного информированного согласия, корректно заполненный респондентом или его законным представителем опросник, стаж использования мобильных электронных устройств — год и более. Проведенное исследование не подвергает опасности участников и соответствует требованиям биомедицинской этики. Статистическая обработка проведена с использованием Statistica 13 PL. 14,0% респондентов отметили ухудшение слуха в течение последнего года. Риск снижения слуха повышается при длительном использовании мобильных электронных устройств с наушниками в 10,4 раза, прослушивании аудиофайлов на максимальной громкости — в 3,2 раза, прослушивание аудиофайлов в транспорте — в 7,1 раз. Большинство школьников и студентов, которые имели нарушения слуха, имели стаж использования наушников не меньше года, использовали внутриканальные наушники на максимальной громкости ежедневно, длительностью более двух часов в день, в том числе и в транспорте. Учащимся рекомендуется ограничение времени и снижение громкости использования электронных устройств с наушниками, что благоприятно влияет на их функциональное состояние здоровья. Рекомендуется не использовать аудионаушники в транспорте. При появлении жалоб со стороны органа слуха необходимо прекращение использования мобильных электронных устройств с наушниками. В современных условиях у школьников и студентов существует риск нарушения слуха, связанный с использованием мобильных электронных устройств с наушниками, что делает особенно актуальным поиск наиболее эффективных форм формирования установок ЗОЖ у молодежи.

Ключевые слова: школьники, студенты, мобильные электронные устройства

Вклад авторов: Павлова Г. В. — научное руководство, написание статьи; Маркелова С. В., Мартюшева В. И. — сбор материала, статистическая обработка, анализ литературы.

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Modern mobile electronic devices — smartphones — are small but powerful computers that can continuously receive audio and video data, and the potential harm they can do is increasingly associated with the duration of use of such devices [1–5].

According to WHO, 1.1 billion young people worldwide are at risk of hearing loss because of the exposure to noise in recreational and entertainment settings. Nearly 50% of all adolescents and young adults aged 12 to 35 use their personal audio devices with sound volume hazardously high. About 15% of schoolchildren have hearing impairments [6–8].

However, current scientific literature does not have a sufficient number of publications investigating hearing hazard risk factors the younger generation is exposed to, including those related to the conditions of use of mobile electronic devices with headphones and their design features.

This study aimed to identify the leading hearing loss risk factors for children, adolescents and youth associated with use of mobile electronic devices with headphones

MATERIALS AND METHODS

In the 2017–2021 academic years (September through May), we surveyed 518 students in Moscow and 1000 schoolchildren and students in the towns of Izhevsk and Tchaikovsky. Using a standardized questionnaire we collected data on the conditions in which the respondents use mobile electronic devices with headphones, design features of the headphones used and their hearing health status.

The inclusion criteria were: status of a schoolchild, student, signed and submitted informed consent form, questionnaire correctly completed by the respondent or his/her legal representative, one or more years of using mobile electronic devices. The exclusion criteria were: different age, lack of signed informed consent form, lack of the correctly completed questionnaire, using mobile electronic device for less than a year. The study did not endanger participants; it meets the biomedical ethics requirements and conforms to the provisions of the Declaration of Helsinki (1983).

Statistical processing of the data was enabled by Statistica 13.0 (StatSoft Inc.; USA).

RESULTS

With the help of the questionnaire, we established the pattern of use of mobile electronic devices with headphones habitual for schoolchildren and students, as well as design features of the headphones.

By design, there are basically four types of headphones. Over-ear headphones with good noise isolation, good sound quality at a lower volume level; such headphones deliver sound into the auricle and not the ear canal, which reduces the impact on the eardrum; ear cushions of over-ear headphones completely cover the auricles and fit snugly to the head. On-ear headphones fit well to the ear but do not wrap around it completely, do not create increased sound pressure on the acoustic apparatus and have average noise isolation. In-ear headphones (earphones) with silicone tips offer good sound isolation and good sound quality at a lower volume level, but they are put into the external auditory canal, which brings the sound source as close as possible to the inner ear and affects the eardrum. Plastic in-ear headphones (also called “classic earphones”) are put in the auricle in front of the ear canal; they offer poor sound isolation, which translates into higher sound volume levels associated with their use. A design feature of the headphones that should be mentioned is the Active Noise

Cancellation (also known as Active Noise Control and Active Noise Reduction) technology, which eliminates unwanted noise by adding a specially generated sound to the audio stream. The drawback of this technology is the increased pressure on the eardrums: together with music and noise, we hear “anti-noise”, i. e., inverted ambient noise.

Among the surveyed schoolchildren and students of Izhevsk and Chaikovsky, 88.2% prefer in-ear headphones with silicone tips, 8.9% use plastic in-ear headphones and 2.9% use headphones of other types. In Moscow, 95.7% of students prefer in-ear headphones with silicone tips. Headphones of 72.3% of the surveyed schoolchildren and students of Izhevsk and Tchaikovsky are wired, the remaining part of the participants use wireless headphones. On the contrary, in Moscow 71.4% of students that participated in the study use wireless headphones and the rest use wired. Ninety percent of the respondents have been using headphones for no more than 3 years. As for the noise canceling technology, 15.7% of the headphones had it.

Among the respondents, 14.1% usually listen to audio files in headphones at maximum volume.

Students have the longest experience of using mobile electronic devices with headphones: 10.2 ± 1.5 years, while for schoolchildren this value is 7.4 ± 0.9 . It is typical for students to use mobile electronic devices with headphones in moving vehicles, while commuting; this setting adds its own specifics to the use case. Over half of the respondents (53.1%) often listen to music on electronic devices with headphones in places where the noise level is high, such as public transport and public spaces, and 49.2% of the participants underestimate the risk of doing so when in a moving transport, i. e. the risk the respective environment, with its insufficient lighting and loud noises, poses to eyes and hears. The degree of risk associated with high noise levels in transport settings is underestimated by 28.4% of students and schoolchildren. While in a moving public transport, 18% of young people listen to music on electronic devices with headphones at a volume of 8.6 ± 1.4 out of 10. The average time of using mobile electronic devices with headphones in transport settings is 17.2 ± 1.2 minutes. Only 15.7% of respondents agree to refrain from listening to audio files in headphones when the level of ambient noise is high. Tinnitus, buzzing in ears that follows listening to audio files in headphones, is known to 22.9% of respondents.

Overall, 14.0% of the respondents mentioned hearing deterioration over the past year, and specifically among students this figure was 13.8% (Table).

Calculation of relative risk showed that the risk of hearing deterioration increases 10.4 times when mobile electronic devices with headphones are used for long periods of time, grows 3.2 times when audio files are played at maximum volume, goes up 7.1 times if listening happens in public transport settings.

There were no hearing deterioration cases registered among those who did not use mobile electronic devices with headphones. Most schoolchildren and students whose hearing was impaired have been using headphones for at least a year, preferred in-ear headphones with silicone tips and used them at maximum volume every day, for more than two hours a day, including while in transport.

DISCUSSION

The study revealed that students and schoolchildren use mobile electronic devices with headphones in 95.0% of cases, which confirms the importance of prevention campaigns

Table 1. The impact of use of mobile electronic devices with headphones on the development of hearing impairment in schoolchildren and students during the last year

Factors	Pearson coefficient		
	Value	p	Strength of association
Length of use of ED with headphones	0.89	$p \leq 0.05$	strong
Audio file listening volume	0.83	$p \leq 0.05$	strong
Falling asleep with headphones on	0.82	$p \leq 0.05$	strong
Use of ED with headphones in transport settings	0.75	$p \leq 0.05$	strong
Type of headphones	0.71	$p \leq 0.05$	strong
Weekly headphones use frequency	0.71	$p \leq 0.05$	strong
Installed noise canceling technology	0.70	$p \leq 0.05$	strong

among children, adolescents and youth aimed at instilling a proper attitude towards using mobile electronic devices with headphones, with such campaigns, in particular, incorporating the necessary information into curricula [9,10].

Numerous research papers highlight the impact of mobile electronic devices on the body systems of children, adolescents and young people. In particular, such devices affect the organ of sight, neuropsychic systems, musculoskeletal system etc. [11,12,13].

However, the effects arising from the use of mobile electronic devices with headphones have not been investigated sufficiently. Russian research literature offers no evidence-based information on the safe level of volume and length of use of headphones, which disallows drawing a complete picture of preventive and protective measures designed to safeguard the hearing organ with the modern technological advancements factored in [6, 14].

The effect of sound is cumulative; adverse changes of the hearing organ accumulate gradually, during exposure to this harmful factor. The development of hearing loss is associated with gradual damage to the ear and its deteriorating adaptive

capability: as a result of high sound pressure, the time it takes the hearing organ to recover between headphones use sessions increases. Prolonged exposure to excessive acoustic energy adversely affects hearing and can lead to its partial or significant loss [15].

Hearing disorders translate into gaps in received information and poor speech intelligibility, which, in turn, affect the psycho-emotional state of a person and lead to deterioration of the quality of life. More and more often, mobile electronic devices with headphones are used without restriction, and this trend will push up the number of people suffering from speech intelligibility and deteriorating hearing [16].

CONCLUSIONS

Today, schoolchildren and students are exposed to the hearing impairment risks associated with use of mobile electronic devices with headphones, which makes the search for the most efficient ways of forming healthy lifestyle habits among them even more urgent.

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HYGIENIC ASSESSMENT OF THE ACADEMIC LOAD IN MODERN STUDENTS

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In modern school education, a system, developing high academic loads among schoolchildren, is being formed. The loads pose a serious problem, creating inevitable medical consequences, and producing a negative effect on the morbidity and structure of the pathology for this group of children and adolescents. Given the situation, control over the academic load, its rational distribution and initiating supervision over the academic process intensity are relevant. Basic negative factors of academic process organization were found in the course of academic schedule analysis in 1.728 classes and estimating the academic process intensity during 3.500 lessons. The maximum non-conformities to hygienic standards were found in high school students from cities. It was established that a weekly academic load was exceeded after school owing to extended learning activities, and irrational distribution of a weekly academic load because of difficult subjects. Intellectual, sensory and emotional loads were the leading criteria of an intense academic process. Highly intense academic load was noted for such school subjects as Russian, Algebra, Foreign language, Chemistry and Geometry. The same subjects are taught in different major classes with a various degree of intensity. This required scored correction of how difficult the subjects are in senior major classes.

Key words: students, schoolchildren, academic schedule, academic load

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ГИГИЕНИЧЕСКАЯ ОЦЕНКА УЧЕБНЫХ НАГРУЗОК У СОВРЕМЕННЫХ УЧАЩИХСЯ

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В современном школьном образовании формируется система, программирующая высокие учебные нагрузки среди школьников, которые представляют собой серьезную проблему в аспекте создания неизбежных медицинских последствий, негативно влияя на заболеваемость и структуру патологии этой группы детского и подросткового населения. В сложившихся условиях важным является контроль за учебной нагрузкой, рациональностью ее распределения, а также внедрения контроля за напряженностью учебного процесса. Анализ учебных расписаний у 1728 классов, а также оценка напряженности учебного процесса на 3500 уроках выявила основные негативные факторы организации учебного процесса. Максимальное количество несоответствий гигиеническим требованиям установлено у городских учащихся старших классов. Установлено превышение недельной учебной нагрузки во внеурочное время за счет дополнительных занятий, нерациональное распределение недельной учебной нагрузки с учетом трудности предметов. Ведущими критериями, формирующими напряженность учебного процесса, являлись интеллектуальные, сенсорные и эмоциональные нагрузки. Высокой напряженностью учебного процесса характеризовались уроки русского языка, алгебры, иностранного языка, химии, геометрии. Отмечена различная степень напряженности одних и тех же предметов, преподающихся в классах различного профиля, что требует корректировки балльной оценки трудности предметов в старших профильных классах.

Ключевые слова: учащиеся, школьники, учебное расписание, учебная нагрузка

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Under conditions of educational renewal, increased scope of academic information, constant modernization of academic programs, and active use of electronic educational tools it's important to preserve the working capacity of students and mitigate a negative effect produced by the mentioned factors on neuropsychological profiles of students [1]. Non-rational organization of an academic process is especially important for students' health due to its duration, regularity and complexity of its action [2]. Thus, rational planning of an academic day is an important basis which allows balancing between the process of education and processes restoring students' physical and mental functions [3].

The purpose is to provide a hygienic assessment of academic loads in students of modern institutions of general education.

PATIENTS AND METHODS

Hygienic assessment of academic loads is provided by way of determining the level of a weekly academic load, rational drafting of academic schedules in accordance with the Sanitary Rules and Regulations 1.2.3685–21 in 280 classes of primary school, 869 classes of secondary school, and 579 classes of high school. To estimate the intensity of education, the academic process intensity was assessed during 3,500 lessons at municipal and village schools using a natural experiment with chronometry. It corresponded to the Federal recommendations of rendering medical aid to students ФР РОШУМЗ-16–2015 (version 1.1) 'Hygienic Assessment of Learning Activity Intensity'.

Statistical analysis of the obtained data was done using MS Excel spreadsheets, Statistica 9 computer programme, and

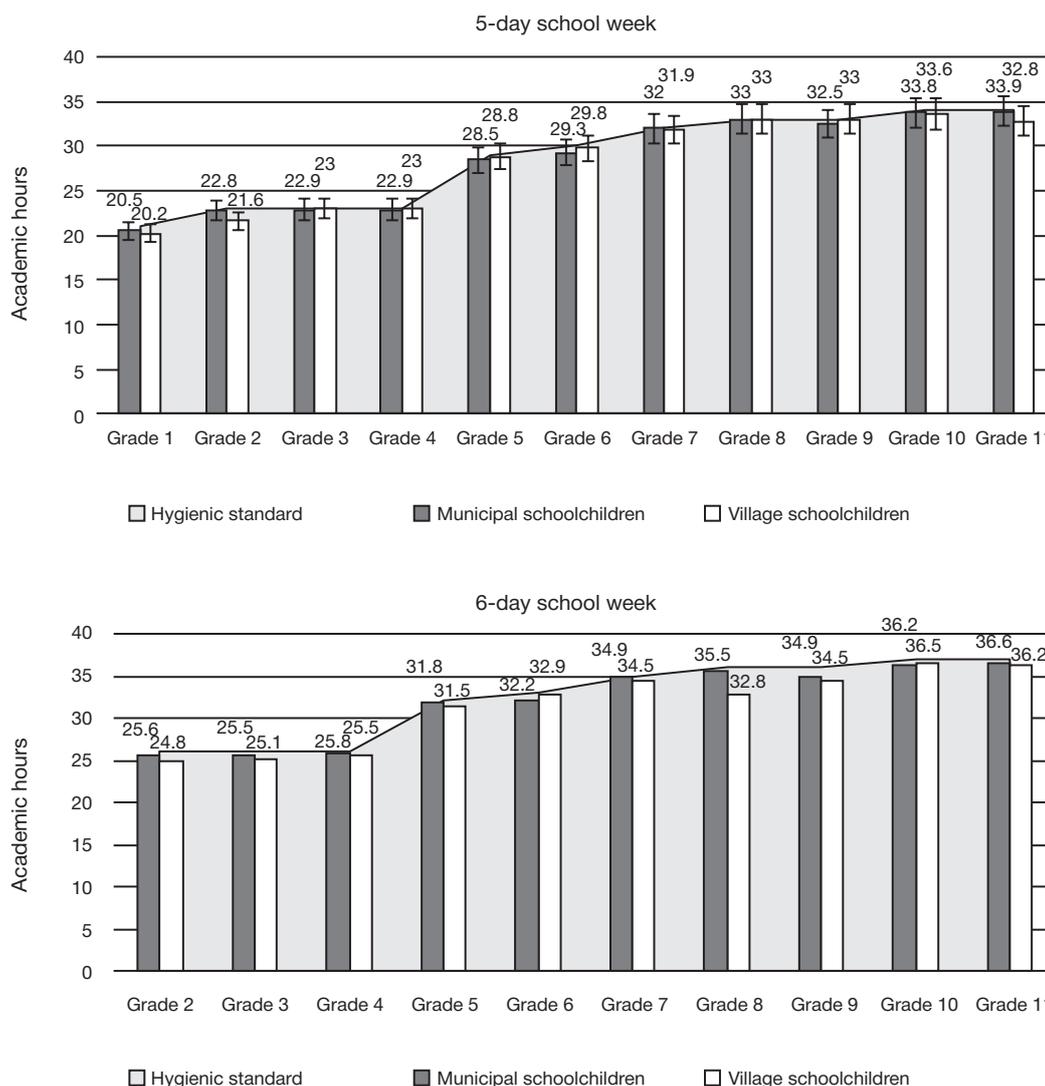


Fig. 1. Indicators of a weekly academic load in schoolchildren from cities and villages

SPSS (Statistical Package for the Social Sciences) program for Windows XP. Statistical processing of the obtained data was performed using standard methods of variation statistics and calculating arithmetic means (M), standard deviations (δ), mean error in the arithmetic average (m), as preliminary examination of distribution of random values, that correspond to the analyzed values, has revealed their conformity with the normal distribution law (χ^2 -square was used as a fitting criterion). To find statistically significant differences, the parametric method (t-test method) with calculation of a non-sampling error and Student's coefficient and non-parametric method with a Mann-Whitney test were used in the compared groups.

STUDY OUTCOMES

Compliance with an academic load is an important factor of fatigue prevention in the course of both an academic day and academic week; it is established in every examined school (Fig. 1). At the same time, analysis of weekly extracurricular activity in the form of out-of-school activities, zero lessons, and facultative studies demonstrated that in senior students the accepted values were exceeded by a factor of 1.5 (Fig. 2). The maximum excess up to 18.6 ± 1.5 hours per week in relation to hygienic standards was found in senior students of municipal schools.

A distinctive feature of modern school education is that it is successful when mental activity of students is intensified in the lack of school hours along with an active use of information and communication training aids, actual use of a working schedule significantly different from the agreed one, which doesn't take into account the physiological features of a changed working capacity during an academic day or week in students. It is established that in $35.8 \pm 0.04\%$ municipal classes and $23.7 \pm 0.03\%$ rural classes, the schedules are compiled in a non-rational way, where the maximum non-correspondence to hygienic standards is found in schedules of $64.5 \pm 0.06\%$ senior grades (Fig. 3).

Academic days with the largest and smallest total scores of academic subject difficulty in the form of double-peaked and single-peaked curves were alternated in $33.2 \pm 0.04\%$ of analyzed schedules of municipal schools and in $34.3 \pm 0.04\%$ schedules of rural schools (table 1).

It was established that 66.8% municipal and 65.7% rural schedules were irrationally developed. In students of secondary and high schools, a maximum number of schedules not corresponding to the requirements has been developed. Thus, in $38.5 \pm 0.06\%$ schedules of secondary municipal school students, the maximum total scoring load was determined both during warming-up and impaired productivity; in $36.3 \pm 0.06\%$

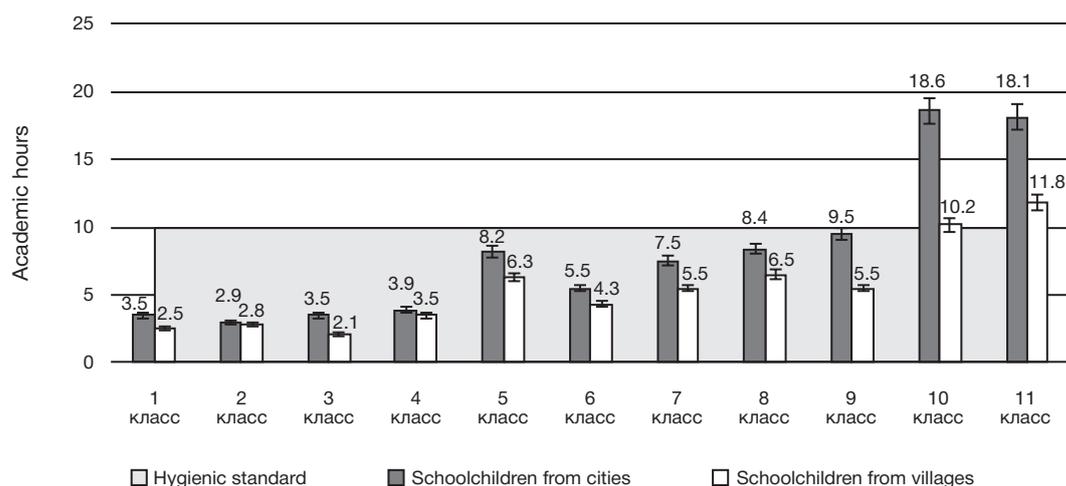


Fig. 2. The volume of a total weekly extracurricular academic load (hours)

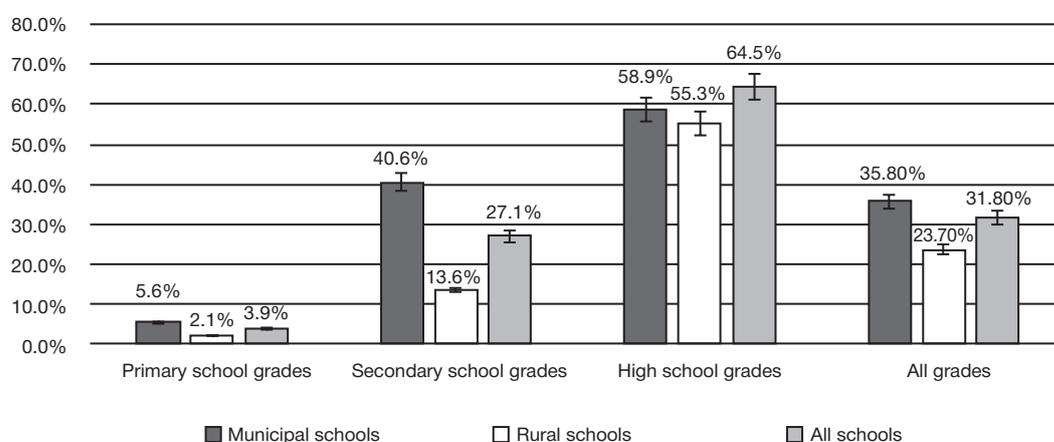


Fig. 3. Share of grades with a schedule not corresponding to hygienic requirements as far as academic load distribution is concerned

Table 1. Indicators of developing a rational schedule (P±σp%)

Indicators	Schedule							
	of primary school		of secondary school		of high school		all grades	
	city	village	city	village	city	village	city	village
	n=45	n=30	n=60	n=40	n=64	n=38	n=169	n=108
rationality indicators								
Double-peaked or single-peaked distribution of a total weekly scoring load	85,6 ±0,04	88,3 ±0,06	12,5 ±0,03	10,7 ±0,05	1,6 ±0,04	3,8 ±0,08	33,2 ±0,04	34,3 ±0,04
irrationality indicators								
Maximum total scoring load while warming-up	3,5 ±0,03	3,2 ±0,02	22,1 ±0,05	22,2 ±0,06	36,3 ±0,06	54,1 ±0,08	25,6 ±0,03	30,1 ±0,04
Maximum total scoring load during impaired productivity	2,6 ±0,02	1,7 ±0,02	26,9 ±0,06	33,4 ±0,07	25,4 ±0,05	20,2 ±0,06	11,7 ±0,02	10,4 ±0,03
Maximum total scoring load for the same schedule while warming-up and during impaired productivity	8,3 ±0,04	6,8 ±0,04	38,5 ±0,06	33,7 ±0,07	36,7 ±0,06	21,9 ±0,07	29,5 ±0,03	25,2 ±0,04
TOTAL (%)	100	100	100	100	100	100	100	100

and 54.1±0.08% schedules of high municipal and rural schools, the maximum total scoring load was found during warming-up. In 36.7±0.06% of high municipal school schedules, the maximum total scoring load was additionally found during warming-up. In 36.7±0.06% of high municipal school schedules, the maximum total scoring load was determined both during the warming-up period, and impaired productivity.

A potential reserve of educational process organization health-saving constituent, consisting not only in a hygienically

optimal schedule structure, but also in the intensity rate of lessons, which supports high capacity for work, optimal body functioning, lack of excessive fatigue and harmonious development of schoolchildren [4]. In municipal students, academic activity was first-degree and intense (class 3.1), amounting to 2.9±0.05 points, due to first-degree intense intellectual load (3.3±0.01 points), sensory load (3.2±0.07 points), monotonicity (3.6±0.03 points) and regimen (2.9±0.05 points) of academic work (table 2). In schoolchildren from

Table 2. Indicators of intense academic activity in schoolchildren from cities and villages (in points)

Indicators and criteria of intensity	Schoolchildren from cities		Schoolchildren from villages	
	points	intensity class	points	intensity class
1. Intellectual load:				
1.1. Scope of work	3.5±0.05	3.1	2.9±0.03*	3.1
1.2. Comprehension of signals and their assessment	3.8±0.02	3.2	2.6±0.02*	3.1
1.3. Distribution of functions by the degree of a task complexity	2.0±0.05	2	1.8±0.03	2
1.4. Type of the accomplished academic activity	3.8±0.03	3.1	2.5±0.02*	2
Overall estimate of intellectual loads	3.3 ±0.01	3.1	2.5±0.03*	2
2. Sensory load:				
2.1. Duration of focused surveillance (% of time)	3.5±0.05	3.1	3.2±0.02*	3.1
2.2. Density of information messages within 40 minutes of work	3.8±0.02	3.2	3.5±0.02*	3.1
2.3. Size of a differentiation object depending on the font	3.5±0.03	3.1	2.9±0.05*	3.1
2.4. Type and number of training aids used during lessons	3.6±0.05	3.2	2.5±0.03*	2
2.5. Working with optical devices (% of time)	1.0±0.04	1	1.5±0.02	1
2.6. Observation over video terminal screens	3.5±0.04	3.1	3.3±0.05*	3.1
2.7. Load on an auditory analyzer (when it is necessary to perceive speech and use audio materials)	3.3±0.02	3.1	2.5±0.05	2
2.8. Load on the vocal apparatus (% of time)	2.8±0.02	3.1	2.4±0.04	2
Overall estimate of sensory loads	3.2±0.07	3.1	2.7±0.5	3.1
3. Emotional load:				
3.1. Extent of responsibility for the own activity result	3.5±0.05	3.1	2.8±0.03*	3.1
3.2. Risk level to form a negative situation	1.3±0.02	1	1.5±0.03	1
3.3. Extent of responsibility to form a negative situation for other people	1.0±0.02	1	1.1±0.02	1
3.4. Number of conflict situations associated with learning activity per an academic day	1.0±0.02	1	1.3±0.03	1
Overall estimate of emotional loads	1.7±0.05	2	1.7±0.03	2
4. Monotonous load:				
4.1. A number of elements required to implement a simple task	3.7±0.05	3.2	3.5±0.02	3.1
4.2. Duration of simple tasks (in seconds)	3.6±0.04	3.1	2.5±0.03*	3.1
4.3. Time of active actions (% of time)	3.8±0.25	3.2	2.6±0.03*	3.1
4.4. Monotonicity of academic environment (% of time)	3.3±0.02	3.1	3.1±0.02	3.1
Overall estimate of monotonous loads	3.6±0.03	3.2	2.9±0.03	3.1
5. Working regimen				
5.1. Actual duration of academic time considering all types of activity	3.6±0.02	3.2	2.6±0.02*	3.1
5.2. Academic shifts	1.8±0.06	2	1.5±0.01	1
5.3. Availability and duration of regulated breaks	3.5±0.05	3.1	2.5±0.01*	2
Overall estimate of the working regimen	2.9±0.02	1	2.2±0.02	2
Overall indicator of intensity	2.9±0.05	3.1	2.4±0.03*	2

* $p \leq 0,05$ to compare the organization of an academic process in rural and municipal schools

villages, the academic activity was acceptable (class 2); with the overall estimate being 2.4 ± 0.03 points, and first-degree intensity was established based on two criteria only such as sensory load (2.7 ± 0.5 points) and academic work monotonicity (2.9 ± 0.03 points).

In municipal students, 6 indicators were estimated as intense second-degree indicators (class 3.2.), including 1 indicator of intellectual load such as 'signal perception and estimation' (3.8 ± 0.02 points); 2 indicators of sensory load such as 'density of information messages within 40 minutes of work' (3.8 ± 0.02 points); 'type and number of training aids used during a lesson' (3.6 ± 0.05 points); 2 indicators of work monotonicity such as 'a number of elements required to implement a simple task' (3.7 ± 0.05 points) and 'time of active actions' (3.8 ± 0.25 points); and 1 indicator of academic working

regimen such as 'actual duration of academic time considering all types of activity' (3.6 ± 0.02 points). In students from villages, no indicators of second-degree intensity were found out.

In the students of the 5th grade, the maximum class of academic activity intensity (class 3.2.) was set for algebra (3.7 ± 0.10 points) due to intense 2-degree (class 3.2.) intellectual load (3.8 ± 0.10 points), sensory load (3.7 ± 0.12 points) and intense subject-related academic activity with 1-degree monotonicity (3.2 ± 0.10 points) (Table 3).

In students of the 10th grades, intense second-degree academic activity was also set for literature (3.7 ± 0.10 points) due to intense 2-degree sensory load (3.8 ± 0.10 points) and working regimen (3.7 ± 0.10 points) and intense 1-degree work monotonicity (3.3 ± 0.11 points); and for algebra (3.7 ± 0.11 points) due to intense 2-degree sensory load

Table 3. Intensity of academic activity in schoolchildren by school subjects (intensity class/ M±m in points)

Subject	Indicator of intensity	Grades							
		Grade 5	Grade 6	Grade 7	Grade 8	Grade 9	Grade 10	Grade 11	
Russian	Intellectual load	3.2	3.1	2	2	2	3.1	3.2	
		3.7±0.10	2.8±0.10	2.4±0.12	2.1±0.10	2.2±0.10	3.3±0.11	3.8±0.10	
	Sensory load	2	2	3.1	2	2	3.1	3.1	
		2.4±0.11	1.9±0.10	3.3±0.10	1.8±0.12	1.7±0.10	2.8±0.12	2.9±0.10	
	Emotional load	3.1	2	2	2	2	2	3.1	
		3.5±0.13	1.7±0.10	2.1±0.11	1.9±0.11	2.4±0.12	2.3±0.10	2.8±0.12	
	Monotonicity	3.1	3.1	2	2	2	3.1	3.2	
		2.8±0.10	3.4±0.12	1.8±0.11	2.1±0.10	1.9±0.12	3.4±0.10	3.8±0.11	
	Working regimen	3.1	2	2	2	3.1	3.1	3.2	
		3.4±0.12	2.4±0.10	2.1±0.11	1.7±0.12	2.9±0.11	3.8±0.12	3.9±0.10	
	Overall estimate	3.1	2	2	2	2	3.1	3.2	
		3.2±0.11	2.3±0.10	2.2±0.11	1.9±0.10	2.1±0.11	3.1±0.10	3.7±0.11	
	Literature	Intellectual load	2	3.1	2	2	2	2	2
			2.3±0.11	3.0±0.11	1.9±0.10	1.8±0.11	2.3±0.10	1.9±0.12	2.4±0.10
Sensory load		3.1	3.1	3.1	3.1	3.1	3.2	3.2	
		3.3±0.11	3.1±0.10	2.8±0.10	3.0±0.11	3.3±0.12	3.8±0.10	3.9±0.11	
Emotional load		2	2	2	2	2	2	3.1	
		2.3±0.10	1.8±0.12	1.8±0.10	1.6±0.12	2.1±0.11	2.0±0.10	3.3±0.12	
Monotonicity		3.1	2	2	2	2	3.1	3.1	
		2.9±0.10	2.3±0.10	1.8±0.11	2.2±0.11	1.7±0.10	2.7±0.12	3.1±0.11	
Working regimen		2	2	2	2	2	3.2	3.2	
		2.1±0.11	1.8±0.10	1.6±0.12	1.9±0.12	1.7±0.12	3.7±0.10	3.8±0.10	
Overall estimate		3.1	2	2	2	2	3.2	3.2	
		2.6±0.10	2.4±0.11	1.9±0.10	2.1±0.11	2.2±0.11	3.7±0.10	3.8±0.11	
Algebra		Intellectual load	3.2	3.2	3.1	3.1	3.1	3.1	3.1
			3.8±0.10	3.5±0.11	2.8±0.12	2.6±0.10	3.3±0.11	3.3±0.11	3.4±0.10
	Sensory load	3.2	3.2	3.1	3.1	3.1	3.2	3.1	
		3.7±0.12	3.6±0.10	3.8±0.11	2.7±0.10	3.0±0.12	3.7±0.12	3.4±0.11	
	Emotional load	2	2	2	2	2	2	3.2	
		1.9±0.12	1.8±0.10	1.7±0.12	2.1±0.10	2.0±0.12	2.4±0.11	3.8±0.10	
	Monotonicity	3.1	2	2	2	2	2	3.2	
		3.2±0.10	2.1±0.12	1.9±0.12	1.6±0.11	2.1±0.12	2.3±0.12	3.7±0.12	
	Working regimen	2	2	2	2	2	3.1	3.2	
		1.9±0.10	2.1±0.11	1.7±0.10	1.8±0.12	1.6±0.12	3.3±0.12	3.7±0.10	
	Overall estimate	3.2	3.1	3.1	3.1	3.1	3.2	3.2	
		3.7±0.10	2.7±0.11	2.6±0.12	2.8±0.10	2.6±0.10	3.7±0.11	3.6±0.11	
	Geometry	Intellectual load	3.2	3.1	2	2	2	3.1	3.1
			3.8±0.10	3.4±0.11	2.2±0.10	1.8±0.12	1.7±0.10	2.8±0.10	3.4±0.12
Sensory load		3.1	3.1	3.1	3.1	3.1	3.1	3.2	
		2.8±0.12	2.9±0.11	2.6±0.10	3.1±0.12	3.3±0.10	3.2±0.12	3.8±0.10	
Emotional load		2	2	2	2	2	2	3.2	
		2.2±0.10	1.8±0.11	2.3±0.10	1.8±0.11	1.7±0.10	2.1±0.12	3.8±0.10	
Monotonicity		2	2	2	2	2	3.1	3.1	
		1.8±0.11	1.9±0.10	1.6±0.12	1.8±0.10	1.7±0.11	3.4±0.10	3.3±0.10	
Working regimen		2	2	2	2	2	3.1	3.2	
		2.3±0.10	2.1±0.10	1.9±0.12	2.1±0.11	1.9±0.10	3.4±0.10	3.7±0.12	
Overall estimate		3.1	3.1	2	2	2	3.1	3.2	
		2.8±0.10	2.6±0.11	2.1±0.11	2.0±0.10	2.1±0.11	2.9±0.10	3.7±0.11	

Table 3 cont.

Subject	Indicator of intensity	Grades						
		Grade 5	Grade 6	Grade 7	Grade 8	Grade 9	Grade 10	Grade 11
Biology	Intellectual load	2	2	2	2	2	2	2
		1.8±0.10	1.6±0.11	1.7±0.10	1.7±0.11	2.4±0.11	2.2±0.12	2.2±0.11
	Sensory load	3.1	2	2	2	2	3.1	3.1
		3.3±0.12	2.1±0.12	1.8±0.12	1.9±0.11	1.7±0.10	2.8±0.11	3.4±0.10
	Emotional load	2	2	2	2	2	2	3.1
		2.4±0.12	1.7±0.10	1.9±0.10	1.6±0.11	2.2±0.12	2.1±0.11	3.2±0.10
	Monotonicity	2	2	2	2	2	2	2
		2.3±0.10	1.6±0.10	1.7±0.11	2.0±0.10	2.2±0.10	2.3±0.12	2.4±0.10
Working regimen	2	2	2	2	2	3.1	3.1	
	1.9±0.12	2.0±0.12	1.7±0.10	1.7±0.12	1.9±0.12	2.9±0.10	3.3±0.10	
Overall estimate	2	2	2	2	2	3.1	3.1	
	2.3±0.12	1.8±0.11	1.7±0.11	1.8±0.10	2.1±0.10	2.6±0.11	2.9±0.10	
Chemistry	Intellectual load	3.1	3.1	2	2	2	3.1	3.1
		3.0±0.12	2.9±0.10	1.7±0.12	1.8±0.10	1.6±0.11	2.9±0.10	3.2±0.10
	Sensory load	2	2	2	2	2	3.1	3.1
		1.9±0.10	1.7±0.11	1.7±0.12	1.6±0.10	1.8±0.11	3.3±0.12	3.4±0.10
	Emotional load	2	2	2	2	2	2	3.1
		1.8±0.10	1.6±0.11	1.6±0.10	1.7±0.12	1.7±0.10	1.8±0.11	3.4±0.12
	Monotonicity	3.1	2	2	2	2	2	3.1
		2.9±0.11	2.4±0.11	1.9±0.12	2.2±0.10	1.8±0.11	2.1±0.11	3.1±0.10
Working regimen	2	2	2	2	2	3.1	3.1	
	2.4±0.10	1.9±0.11	1.9±0.10	2.1±0.12	1.8±0.12	3.2±0.11	3.4±0.10	
Overall estimate	3.1	2	2	2	2	3.1	3.1	
	2.8±0.10	2.1±0.11	1.8±0.11	1.9±0.10	1.7±0.11	2.7±0.12	3.3±0.11	
History	Intellectual load	2	2	2	2	2	3.1	3.1
		2.3±0.10	2.2±0.11	2.3±0.12	2.1±0.10	2.4±0.10	2.7±0.12	3.1±0.12
	Sensory load	3.1	3.1	3.1	3.1	3.1	3.1	3.2
		3.3±0.12	3.2±0.10	3.2±0.11	3.1±0.10	3.1±0.12	3.4±0.10	3.8±0.10
	Emotional load	2	2	2	2	2	2	3.1
		1.8±0.10	1.7±0.10	1.7±0.12	1.6±0.10	1.7±0.11	1.9±0.10	3.1±0.10
	Monotonicity	2	2	2	2	2	2	2
		1.6±0.10	1.7±0.11	1.6±0.11	1.8±0.10	1.8±0.12	1.6±0.12	1.9±0.10
Working regimen	2	2	2	2	2	3.1	3.2	
	1.9±0.10	1.8±0.10	1.8±0.12	1.7±0.12	1.6±0.10	2.8±0.10	3.7±0.10	
Overall estimate	2	2	2	2	2	3.1	3.1	
	2.2±0.10	2.2±0.11	2.1±0.11	2.1±0.10	2.1±0.12	2.6±0.11	3.1±0.10	
Foreign language	Intellectual load	3.1	3.1	3.1	3.1	2	3.1	2
		2.8±0.10	2.8±0.11	2.9±0.10	3.1±0.10	2.4±0.10	2.6±0.11	2.5±0.10
	Sensory load	3.1	3.1	3.1	3.1	3.1	3.1	3.1
		3.3±0.12	2.7±0.10	2.8±0.12	3.3±0.11	2.9±0.10	2.9±0.11	3.4±0.10
	Emotional load	3.1	3.1	3.1	3.1	3.1	3.1	3.1
		2.1±0.10	2.2±0.11	2.1±0.11	2.3±0.10	3.1±0.10	3.3±0.11	3.3±0.10
	Monotonicity	3.1	3.1	3.1	3.1	3.1	3.1	3.1
		3.1±0.11	2.9±0.12	2.8±0.10	2.8±0.11	3.2±0.12	3.2±0.10	3.3±0.10
Working regimen	3.2	3.1	3.1	3.1	3.1	3.2	3.2	
	3.8±0.10	3.5±0.10	3.4±0.10	2.9±0.10	3.1±0.10	3.8±0.12	3.8±0.11	
Overall estimate	3.1	3.1	3.1	3.1	3.1	3.1	3.2	
	3.0±0.11	2.8±0.11	2.8±0.10	2.9±0.10	2.9±0.11	3.2±0.11	3.3±0.10	

■ – intense –1 and 2-degree academic activity (class 3.1., 3.2)

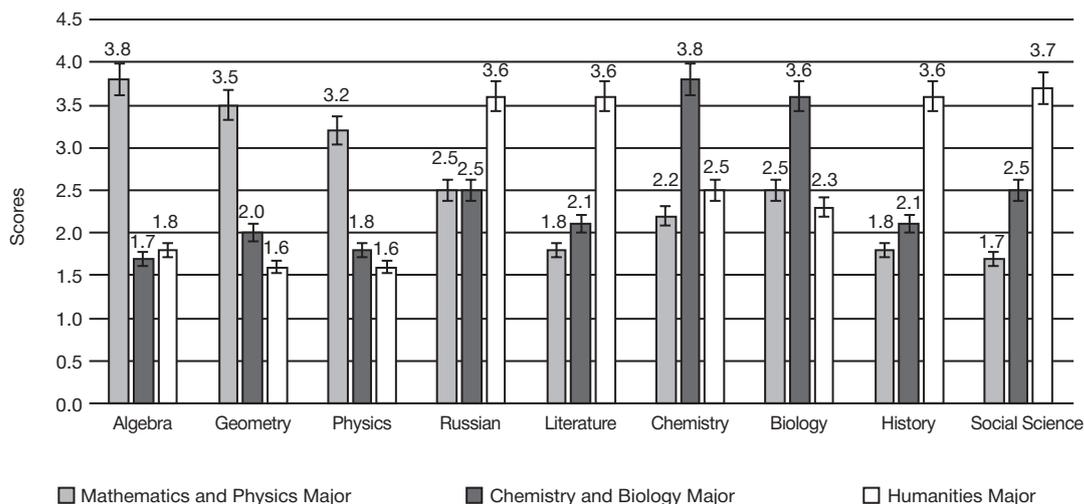


Fig. 4. Intensity of school subjects depending on specialization

Table 4. Correction factors to rank the difficulty of the subjects studied in high school

School subjects	Score (ranked by difficulty) in accordance with the Sanitary Rules and Regulations 1.2.3685–21)	Specialization-based correction factors			Score (ranked by difficulty) based on correction factors		
		Mathematics and Physics Major	Chemistry and Biology Major	Humanities Major	Mathematics and Physics Major	Chemistry and Biology Major	Humanities Major
Physics	13	1.0	0.50	0.50	13	7	7
Geometry	8	1.0	0.46	0.46	8	4	4
Algebra	7	1.0	0.45	0.45	7	3	3
Chemistry	12	0.54	1.0	0.54	6	12	6
Biology	7	0.71	1.0	0.71	5	7	5
Russian	6	0.70	0.70	1.0	4	4	6
Literature	7	0.50	0.50	1.0	4	4	7
History	10	0.5	0.5	1.0	5	5	10
Social science	5	0.48	0.48	2.0	2	2	10

(3.7 ± 0.12 points) and intense 1-degree intellectual load (3.3 ± 0.11 points) and working regimen (3.3 ± 0.12 points).

In students of the 11th grades, intense 2-degree academic activity was observed for 5 subjects such as the Russian language (3.7 ± 0.11 points), literature (3.8 ± 0.11 points), algebra (3.6 ± 0.11 points), geometry (3.7 ± 0.11 points) and a foreign language (3.3 ± 0.10 points). As far as the examined subjects for the 11th grade students go, intense academic activity for every indicator such as intellectual, sensory, emotional loads, monotonicity and academic labor regimen corresponded to class 3 only (which is intense). This shows an increased risk of unfavorable effect produced by a highly intense academic process on the organisms of the 11th grade students.

The obtained data partially correspond to the scale measuring the difficulty of school subjects. This is probably because the rate of the subject difficulty is universal and is not associated with the rate of difficulty for teaching depending on specialization, as high school teachers in general educational institutions note that it's the specialization that defines the degree of subject difficulty. Thus, classes specializing in chemistry and biology offer a more difficult course of biology as compared to classes specializing in mathematics and physics. This assumption was confirmed in the comparative analysis of subject-associated academic activity intensity depending on specialization (Fig. 4). Thus, intensity of major subjects was 1.6–2.2 times higher than the one of the same subjects in non-major classes.

Considering the above, an important hygienic issue of scientific justification of a differentiated approach defining difficulties of subjects depending on specialization in high school is becoming obvious. Therefore, it is suggested that correction factors need to be used, taking into account the frequency in difference between the subject intensity depending on specialization. This will enable more rational practical development of a schedule, considering a real difficulty of subjects depending on specialization (Table 4).

DISCUSSION

In many studies, the problem of students' health preservation is associated with academic loads, their rational distribution and occurrence of new risk factors such as use of electronic training aids [1–4].

The data about the correspondence of academic loads within a week to hygienic standards basically do not correspond to the published data of other authors [5]. This is probably because in this study a differentiated approach was used to estimate a weekly academic load during and after class time, but not their overall estimate. If a number of hours didn't exceed the permissible levels during class time, then the academic load in high school students analyzed after class exceeded the regulated scope by a factor of 1.5. According to published data, a high academic load after class can be explained by active and deep study of certain subjects and

active attendance of extracurricular activities by a significant number of high school students [6–7].

The problem of non-rational distribution of a weekly academic load depending on subject difficulty corresponds to other authors' data, whereas systematic publications of these results denote immediacy of the issue [8–10].

The issue of academic process intensification has been increasingly focused lately. It is believed to be an important factor resulting in development of fatigue, stress-induced functional disturbances of organs and systems, disturbed physical development and chronic pathology in senior schoolchildren [11–16]. The academic process established intensity is significantly dependent on intellectual, sensory and emotional loads. The academic process intensity is higher in municipal students than in those from villages. Intensity data about the entire academic process and separate subjects are compliant with data of other researchers [7]. In this research, it was attempted to compare subject difficulties and the academic process intensity for the first time. It is known that students of the 10th grades start specializing in certain subjects, and

in classes with different specialization the same subjects are studied with different intensity. This hypothesis was reflected in the cited data and determined the perspective of studying the real difficulty of subjects in high school and scientific justification of school subject scoring correction.

CONCLUSION

Organization of an academic process in modern educational institutions is characterized by increased duration of extracurricular activity, especially among high school students, non-rational development of schedules without taking into account the dynamics of the physiological curve of working capacity, high intensity of academic activity due to intellectual and sensory loads against the background of monotonous and non-rational organizational regimen of academic activity. The mentioned facts can be risk factors of fatigue development and augmentation in students, whereas the fatigue itself can be predictor of health deterioration, especially when digital educational environment is being implemented actively.

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NUTRITIONAL STATUS AND LIFE SPAN OF HUMANS

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Social factors such as bad living conditions, harmful labor conditions, low quality of medicine, loss of social contacts, etc., and lifestyle factors such as mal- and over-nutrition, hypodynamia, bad habits, etc. are the main issues of premature ageing. In this article, the alimentary factor such as the risk of premature ageing has been considered from the point of view of over- and malnutrition (protein-energy undernutrition) and its influence on the rate of ageing. The effect of overnutrition has been examined in the literature review of Russian and foreign investigators. Scientific publications show that one alimentary factor can be used to produce a significant influence on life span and frequency of some degenerative diseases. The relationship between malnutrition in the older population and biological age has been evaluated. 408 those surveyed from the city of Voronezh aged 55 to 70 were included into the study. The examination was nonrecurrent. The biological age of those surveyed was determined using the method by V. P. Voitenko. Malnutrition was assessed with the MNA (Mini Nutritional Assessment) tool. Malnutrition is observed among 2.2% of elderly patients, 58.8% of those surveyed are at risk for malnutrition, whereas 39% of them have a normal alimentary status. It is established that the biological age is correlated with the alimentary status. Statistically significant differences are found in the mean group values of the biological age in the subgroup of people with a normal alimentary status in relation to the subgroup of people with a risk for malnutrition ($p < 0.05$): the values were 56 ± 1.7 and 64 ± 1.4 , respectively. The publication shows a direct and indirect influence of the alimentary status (both overnutrition, and malnutrition) on the rate of senescence.

Keywords: nutritional status, life span, nutrition, senescence (ageing), biological age

Author contributions: Skrebneva AV analyzed literature and planned the investigation, Vasil'yeva MV collected and processed the material, Skrebneva AV and Melikhova EP wrote the text, Skrebneva AV performed statistical processing, Melikhova EP was responsible for editing.

Compliance with ethical standards: the participation was voluntary. All participants signed the informed consent form prior to inclusion into the study.

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ПИЩЕВОЙ СТАТУС И ПРОДОЛЖИТЕЛЬНОСТЬ ЖИЗНИ ЧЕЛОВЕКА

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Среди причин преждевременного старения на первом месте стоят социальные факторы (плохие жизненные условия, вредные условия труда, низкое качество медицины, потеря социальных контактов и многое другое) и факторы образа жизни: недостаточное или избыточное питание, гиподинамия, наличие вредных привычек и т. д. В данной работе такой алиментарный фактор, как риск преждевременного старения, рассмотрен с двух позиций: избыточного и недостаточного (белково-энергетическая недостаточность) питания и его влияния на темп старения организма. Влияние избыточного питания изучено в результате проведенного литературного обзора российских и зарубежных исследователей. Работы показывают, что при помощи одного алиментарного фактора можно в значительной мере воздействовать на продолжительность жизни и частоту некоторых заболеваний дегенеративного характера. Нами проведена оценка взаимосвязи между недостаточностью питания пожилых людей и биологическим возрастом. В исследовании приняли участие 408 респондентов в возрасте от 55 до 70 лет, проживающих в г. Воронеже. Обследование было единовременным. Биологический возраст респондентов оценивался методом В. П. Войтенко. Анализ недостаточности питания проводили с использованием анкеты «Краткая оценка питания» (MNA — MiniNutritionalAssessment). 2,2% пожилых людей имеют недостаточное питание, 58,8% респондентов — риск развития недостаточного питания, 39% — нормальный пищевой статус. Установлено, что биологический возраст коррелирует с пищевым статусом. Получены статистически значимые различия в среднегрупповых значениях биологического возраста в подгруппе лиц, имеющих нормальный пищевой статус по отношению к подгруппе лиц, имеющих риск развития недостаточности питания ($p < 0,05$): показатели составили $56 \pm 1,7$ и $64 \pm 1,4$ года соответственно. В работе показано прямое или косвенное влияние пищевого статуса, причем как избыточного, так и недостаточного, на скорость процесса старения организма.

Ключевые слова: пищевой статус, продолжительность жизни, питание, старение, биологический возраст

Вклад авторов: Скребнева А. В., Васильева М. В. — анализ литературы, планирование исследования, Скребнева А. В., Мелихова Е. П. — сбор и обработка материала, написание текста, Скребнева А. В. — статистическая обработка, Мелихова Е. П. — редактирование.

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

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The issue of comprehending the nature of senescence, its warnings and possibility of life prolongation has been receiving the attention of revered scientists for a long time (I. I. Mechnikov, A. A. Bogomolets, A. Steinach, S. Voronov, V. N. Anisimov, V. N. Shabalin, V. Kh. Khavinson, O. N. Tkacheva, etc.) [1–

6]. From the point of view of modern science, ageing should be considered as a constant and inevitable process, starting soon after the individual's growth is over, and in some cases even earlier. Ageing is not typical of the last third part of our life, as it is with us during the entire life. Morphological and

functional involution of many organs, occurring during the life, results in significantly decreased accustomization and reduced capability of regulatory mechanisms to support the internal environment consistency. A series of experiments has shown, that simultaneous to establishment of the general character of senescence phenomena, in some cases the rate of ageing can be significantly influenced and slowed down. Ecological factors capable to accelerate or slow down the ageing process are found.

Many degenerative diseases, which are currently manifested at a very early age, represent just premature ageing of certain systems of organs, which is just a reaction to modern conditions of life [7]. It is possible that the conditions stopped corresponding to the ecological optimum, to which a human was slowly adapted during the long-term evolution.

Nutrition is a factor that determines the life span. Non-rational nutrition is one of the basic reasons for an increased senescence rate of a body. Elderly people commonly consume less proteins and energy as compared to the younger ones. With age, the gastrointestinal tract undergoes certain changes such as reduced strength of contraction, failure of the sphincter to effectively relax for the intestine; atrophy, delay in motor activity, reduced gastric acid secretion for the stomach; malabsorption of D-xylose, large amount of fats, vitamin D, folic acid, calcium and zinc for the small intestine; atrophy of the muscle segment, increased amount of collagen and elastane, increased time of food transition for the large intestine; atrophy of the gland, increased diameter of the glands for the pancreas; reduced reaction to cholecystokinin, increased bile lithogenicity for the gallbladder. Consequently, individualized nutrition is required with age, taking into account metabolic profiles and condition of separate organs and systems [8].

According to A. Yu. Baranovsky and L. I. Nazarenko, in protein malnutrition of people over 60 years of age, the biological age can exceed the calendar one by 40% and more. In too high calorie diet predominantly due to carbohydrates in people aged over 60, the biological age can exceed the calendar one by 50% and more [9].

Thus, the purpose of our publication is to study the influence of mal- and overnutrition on human body ageing.

MATERIALS AND METHODS

The study object includes population older than working age from the city of Voronezh. All study participants were informed about the purpose and course of the work. Those surveyed aged 55 to 70 who signed the informed consent were included into the study.

The study object is the alimentary status as the factor influencing life span. For the study, a sample size was calculated based on A. M. Merkov's formula (1962) with a known number of observations in a population:

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

n — the minimum sample size;

N — the number of a general population;

p — the probability value of the studied phenomenon (it is not known in this case, that's why it was estimated to be equal to the maximum possible value or 50%), the sign rate in the aggregate;

t — confidence coefficient ($t=2$ at $p=0,05$);

Δ — margin of a value error (5%);

q — the value of optionality (100- p).

The values of t and Δ are selected to follow the high confidence of survey results (95% cases in case of an admissible error of $\pm 5\%$).

On 01.01.2021, the general population (N) of the elderly from the city of Voronezh was 490 thousand people:

$$n = \frac{(50 \times 50 \times 2^2 \times 49000)}{(490000 \times 5^2 + 50 \times 50 \times 2^2)} = 400$$

Thus, the study can be considered representative, as the number of participating elderly people in the city of Voronezh was at least 400 people.

The biological age was determined using the method by V. P. Voitenko defining the ageing rate of a human being [10]. Certain measurements such as SBP, BP (with a tonometer), pulse pressure (PP) (difference between SBP and BP), body mass in kg, statistical balancing in seconds, and timed inspiratory capacity in seconds should be taken in the one surveyed. The heart rate (HR) is measured when standing on the left leg, with closed eyes, hands down, with no shoes (done thrice, the best option is chosen). During the breath-holding test a patient takes a deep breath and holds it; the results are measured in seconds. Consequently, the one surveyed fills in the Health Self-Assessment Inventory (HSAI), which has 29 questions. The obtained data are used to calculate the actual (ABA) and proper (PBA) biological age by formulas different for men and women (formulas 1–4).

$$ABA_{\text{women}} = -1.463 + 0.415 \times PP + 0.248 \times BW + 0.694 \times \text{HSAI} - 0.14 \times \text{HR} \quad (1)$$

$$ABA_{\text{men}} = 26.985 + 0.215 \times \text{SBP} - 0.149 \times \text{IBH (inspiration breath hold)} + 0.723 \times \text{HSAI} - 0.151 \times \text{HR} \quad (2)$$

$$PBA_{\text{women}} = 0.581 \times \text{RA (real age)} + 17.24 \quad (3)$$

$$PBA_{\text{men}} = 0.629 \times \text{RA} + 18.56 \quad (4)$$

The rate of human ageing is assessed based on the obtained results. Thus, if the difference between ABA and PBA is 0, then the ageing rate corresponds to statistical standards. If the difference exceeds 0, the ageing rate is increased (pathological type of ageing), if it is less than 0, then it is slowed down (decelerated type of ageing).

The Mini Nutritional Assessment (MNA) tool was used to assess malnutrition in participants. The questionnaire was utilized to assess the nutritional status recommended by the European Association of Clinical Nutrition (ESPEN), and to assess and screen patients with a risk for malnutrition in the elderly [11]. The questionnaire consists of two (screening and rating) parts. The screening part consists of 6 questions with 14 maximum score possible. The second part of the questionnaire, or the rating one, is used when the score is 11 or less. Taking into consideration the accumulated scoring, the nutritional status can be concluded. If the score is 24.0 or more, the nutritional status is normal, the score of 17.0–23.5 denotes the risk of malnutrition, whereas the score of 17.0 and less means insignificant (poor) nutrition.

Literature was reviewed to study the effect of the alimentary factor on premature ageing.

The data were processed using Microsoft Excel 2013. Correlation analysis of the interrelation between the biological age and nutritional status was performed.

To process the values, parametric methods estimating the validity of statistical study results were utilized based on the use of a mean deviation ($m = \frac{\sigma}{\sqrt{n}}$), mean error in the difference between the values of the two groups ($m_{\text{differences}} = \sqrt{m_1^2 + m_2^2}$) and estimation of the statistical significance between the mean group values based on Student's t-test.

STUDY OUTCOMES

The influence of nutrition on the biological age of the elderly was assessed and analyzed. 408 of those surveyed from the city of Voronezh aged 55 to 70 participated in the study. According to the results obtained during the survey of the nutritional issue, it was found out that 2.2% of the elderly have insufficient nutrition, 58.8% are at risk for malnutrition, and 39% possess a normal nutritional status.

In the performed study it was found out that the biological age is correlated with the nutritional status. The lowest values of the biological age are typical of the people with a normal nutritional status. In the group with malnutrition, no significant difference in the values was found in the course of a statistical analysis due to a small sample (9 people), large variance and significant error of the mean ($m \pm 6.2$).

Statistically significant differences in the mean group values of the biological age were obtained in the subgroup of people with a normal nutritional status as compared with the subgroup of people at risk for malnutrition ($p < 0.05$): the values were 56 ± 1.7 and 64 ± 1.4 , respectively (table).

The obtained data require a subsequent analysis of the condition of those participants with the risk of malnutrition in order to find the reasons for its development and possible successful correction.

Thus, malnutrition produces an influence on a human's life time. The elderly people with a catabolic stress due to chronic diseases, traumas and age, reduced physical activity and sarcopenia have a critical need in increased and optimized consumption of proteins.

However, the results obtained during the analysis of scientific data from Russian and foreign studies have shown that an excessive amount of food is a factor of premature ageing.

DISCUSSION OF RESULTS

In his works examining the effect produced by the alimentary factors on life span of rodents, the American scientist McCay shows the correlation between the amount of food, on the one hand, and the rate of growth, life span and rate of some degenerative diseases, on the other hand.

McCay compared two groups of rats of the same line, fed and grown under the similar conditions during the entire life. The only difference was that the control animals were fed ad lib, whereas the experimental animals had a quantitatively limited, but fortified foods. If in control rats, the growth of skeleton stopped when they were 175 days old, and they died at the age of 2.5 years, then the experimental rats continued their slow growth until they were 300, 500, 700 and even 1000 days old, depending on the age when they were given a regular diet. It is extremely important to notice that the growth arrest due

to caloric reduction was always accompanied with distinctly increased life span in animals. In the first experiment, one experimental rat held the record for longevity (1.421 days). In other words, its life span was twice as high as the average life span of the control animals. In the second experiment, when all the control animals have already died, the experimental animals, who have reached the age of 1.000 days, started growing again [12].

It is equally important that slow ageing is accompanied with a reduced rate of degenerative diseases. Lymphatic sarcomas, commonly occurring in control animals aged over 400 days (54%), were found less frequently in the experimental group (6%) and developed much later (aged above 800–1000 days). Another example is as follows. Nephrosclerosis, which is the most frequently occurring degenerative disease in rats of this strain, was almost lacking in animals with retarded growth (2 of 197 of the studied animals). The cited facts confirm that no distinction can be drawn between the physiological and pathological ageing, as both categories of events are inseparably associated. Thus, pathological ageing of any system is virtually an intensification of a common physiological process.

From the physiological point of view, rats with retarded growth occupy an intermittent position between the control animals of the same age and younger species. Their activity and metabolism are decreased, whereas the reproductive ability is manifested only when the food is not restricted any longer.

McCay's data are confirmed in the works by Riesen, Herbst, Walliker, Elvehjem, who worked with rats; and Robertson, Marston, Wolter, Ball, Barner, Visscher, who used mice [13,14].

The study data demonstrate that one alimentary factor only can significantly influence life expectancy and rate of some degenerative diseases in mammals. It has long been known, that life span of poikilothermic vertebrates strongly varies depending on metabolism and growth rate, it was difficult to imagine that a similar dependence can be observed in superior vertebrates, who are less dependent on changes in the environmental conditions.

All the data obtained in tests with mice and rats can't be applicable to a human being. It is known that the rodents are more flexible than carnivores and primates. Thus, rats have no ossification of epiphyseal plates even when the bones stop growing.

Though the values of mortality and reasons for people's death are examined rather well, we still have no proof that the life span of people (like the life span of rodents) has a direct dependence on the amount and quality of food. The issue has so many variables that its statistical analysis is rather difficult.

However, a set of data about some groups of population in Europe and America shows that nutrition and a way of life produce a clear influence on the length of the coming adult life,

Table. Estimation of the difference in the biological age in population older than the working age depending on the nutritional factor

Estimation of the nutritional factor	Estimation of nutrition			Biological age	
	M±m	max÷ min, число лиц	%	M±m	max÷ min
Malnutrition (less than 17 б)	14±0.8	13.5÷15 (9)	2.2	58±6.2	58÷69
Risk of malnutrition (17–23.5 б)	21±0.3	17÷23.5 (240)	58.8	64±1.4	55÷70
Normal nutritional status (24 and over)	26±0.3	24÷30 (159)	39	56±1.7	55÷69

Note: — significant difference in the value as compared with the subgroup of those with a normal nutritional status ($p < 0.05$).

and occurrence of degenerative diseases at a younger age. The diseases should be considered as bad cases of normal ageing.

Based on the available data we can confidently conclude that the majority of the richest people suffer from excessive nutrition and restricted muscular activity. The people's weight is ultimately above the line. In a number of works, a negative influence of adiposity on life time has been stressed.

In the research by Dublin and Marks it has been shown that among those of 50–59 years old with the weight exceeding the normal value by 15–24%, the mortality rate was 17% higher than the respective value for the entire population. If the weight was exceeded by 25–34%, then the mortality rate was higher by 41%. Among those who were 20 to 59 years old, a higher weight made a higher mortality rate [15]. In subsequent studies it has been found out that the mortality rate of obese people was higher than the one of those with a normal weight irrespective of their gender. Besides, there is a higher risk that young people (20 to 30 years old) suffering from obesity can die as compared to people aged 40 to 64. The mortality of obese men aged 20 to 29 is higher than the one of those with a normal weight by 80%, whereas in people aged 50 to 64 the excess makes 31% [16].

It is important to notice that the increased mortality rate is mainly associated with the increased rate of degenerative cardiovascular and renal diseases, which is a kind of premature ageing of separate organs.

Excessive amount of food can't be the only factor of premature ageing of those people who consume excessive amount of food in a limited physical activity. The type of food and too high content of animal fat in the diet should be taken into account.

It is known that the rate of atherosclerosis and one of its most dangerous manifestations such as myocardial infarction is various in different populations. It must be accepted that the criteria, that form the basis of the statistical collection, are not always comparable. The anatomical criterion is the best one. However, the studies are time-consuming, difficult and rarely conducted. Clinical criteria such as the electrocardiographic ones are not that valuable, but allow to collect a vast amount of data.

Nevertheless, the revealed differences between separate groups of population with a different way of life are so great,

that they can't be attributable to imperfect methods of material collection only.

The influence of different aspects of a mode of life on the span of life was found in the last century. Thus, based on the results obtained during the examination of 10,000 people and analysis of 1,000 cases of necropsy, Kimura concluded that in Japan, the coronary arteries were affected 10 times less frequently than in the USA [17]. According to the statistical data of that period, the mortality rate due to coronary atherosclerosis is 231.8 (per 100,000 of population) for men aged 45 to 49 in the USA, and only 24.1 in Japan. The mortality rate is 637.9 and 60.3 for men aged 55 to 59, and 1,402.8 and 125.1 for men aged 65 to 69. Significant differences were found when diets of these groups were compared. According to Keys etc., fats constitute only 9% of calories in Japan and 40–43% in the USA [18]. Significant differences in serum total cholesterol were discovered as well: 141.5±3 mg/% in those from Japan (men aged 40–49) and 242.5 mg/% in those from the USA, who were of the same age.

The differences are not due to racial features, but due to a different type of nutrition. In the Japanese Americans aged 40–49 with 39% of fat in the diet, total cholesterol is 246.2±5.8 mg/% [18]. Consequently, they have a higher infarction frequency as compared to those who live in Japan.

Thus, the results show that along with other factors, both malnutrition, and overnutrition produce a huge influence on duration of life.

CONCLUSIONS

The work deals with direct and indirect influence of the alimentary status on the rate of ageing. It is demonstrated that people leading a sedentary life consume much more food than it is needed to satisfy their caloric requirements. Besides, the type of diet was changed as well. Today people eat more meat, sausages, dairy cream and butter than fifty years ago, whereas the share of fresh vegetables significantly dropped. This resulted in an increased consumption of animal fat, leading to premature ageing of the cardiovascular system.

Thus, leading a healthy way of life, satisfying all hygienic requirements to rational nutrition at an early age belong to an important principle of premature ageing prevention.

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FOOD PATTERNS AND CHEMICAL CONTAMINATION OF BABY FOOD

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Studying nutrition patterns in children remains relevant for analysis of nutritional status in the population, including children. Child nutrition is considered the environmental factor that eventually defines the child's health status and life expectancy. The large scale commercial market of adapted and partially adapted milk formulas for bottle feeding usually encourages mothers to refuse to breastfeed and transfer their babies to bottle feeding, which could be unsafe for the child. Supplementary and complementary foods could contain various foreign substances, which could increase chemical load on the growing child's body by means of the consumed food products. The study was aimed to assess nutrition patterns in infants based on the questionnaire survey of 600 mothers in various healthcare institutions and to evaluate chemical contamination of the products for bottle feeding/supplementary feeding of infants, as well as of complementary foods based on the data acquired by the Federal Information Fund for Social and Hygienic Monitoring of the Russian Federation in 65 federal subjects in 2012–2017. The data obtained were processed using the Microsoft Word 2010 and Microsoft Excel 2010 software. It has been found that 37.3% infants are breastfed, 62.7% of infants are bottle-fed or supplemented. In 74.7% of cases complementary foods are introduced at the age of 4–6 months. Fruit and vegetable products are most commonly used as first complementary foods, after which cereal foods (cereal mixes) and canned meat are introduced. These types of food products have the highest concentrations of heavy metals (lead, cadmium, arsenic, mercury).

Ключевые слова: химическая контаминация, токсичные элементы, детское питание, структура питания, грудное вскармливание, продукты прикорма

Keywords: chemicals, toxic elements, baby food, food pattern, breastfeeding, complementary feeding products

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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СТРУКТУРА ПИТАНИЯ И ХИМИЧЕСКАЯ КОНТАМИНАЦИЯ ПРОДУКТОВ ПИТАНИЯ ДЛЯ ДЕТЕЙ РАННЕГО ВОЗРАСТА

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Для анализа качества питания населения, в том числе детского, остается актуальным изучение структуры питания детей. Питание детей — это фактор окружающей среды, который в дальнейшем определяет состояние здоровья и продолжительность жизни детей. Появление на рынке большого количества адаптированных и частично адаптированных молочных смесей для искусственного вскармливания способствует тому, что часто матери отказываются от грудного вскармливания и переходят на искусственное вскармливание, что может быть небезразлично для детского организма. Продукты докорма и прикорма могут содержать различные чужеродные вещества, что будет увеличивать химическую нагрузку на растущий детский организм через продукты питания. Целью исследования явилось: изучение структуры питания детей первого года жизни по данным анкетирования 600 матерей в различных ЛПУ; оценка химической контаминации продуктов для искусственного вскармливания/докармливания и прикорма на первом году жизни по данным федерального информационного фонда социально-гигиенического мониторинга Российской Федерации (ФИФ СГМ РФ) по 65 субъектам за 2012–2017 гг. Полученные данные обрабатывались с использованием компьютерных программ «Microsoft Word 2010» и «Microsoft Excel 2010». Установлено, что 37,3% детей первого года жизни находятся на грудном вскармливании, 62,7% детей получают искусственное вскармливание/докармливание. Возраст введения прикорма в 74,7% случаев — это 4–6-й месяц первого года жизни. В качестве первого прикорма чаще используются фруктовые и овощные продукты, далее вводят злаковые продукты (каши) и мясные консервы. Эти же виды продуктов имеют самые высокие показатели по содержанию тяжелых металлов (свинец, кадмий, мышьяк, ртуть).

Ключевые слова: химическая контаминация, токсичные элементы, детское питание, структура питания, грудное вскармливание, продукты прикорма

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Breastfeeding period, breast milk substitution and introducing complementary foods are the major issues of the infant development. The extent to which these processes would be chemically safe for the child is reflected in the extent of the favorable effects on the child health. The optimized and balanced child nutrition since birth would make it possible to reduce the risk of disease and increase the percentage of healthy children [1–6]. In the early XX century the majority of infants were breastfed (according to the WHO, 70–80%),

however, in the early XXI century the majority of infants are bottle-fed, and the breastfeeding rate has reduced to 30–50%. The Decade of Childhood project has been announced in the Russian Federation (2018–2027): one of the priorities of the national policy is wide promotion and support of breastfeeding. Transferring the child to bottle feeding results in the altered metabolism, immune status, and, therefore, the increased risk of allergy, gastrointestinal disorders, and alimentary-dependent diseases [7–9]. The presence of chemical contaminants, such

Table 1. Levels of baby food heavy metal contamination, average values for 2012–2017, Russian Federation

№	Group of food products	Average concentration, mg/kg M ± m
1	Food products for complementary feeding: foods made of fruit and vegetables, canned fruits and vegetables	0.0213 +/- 0.0021
2	Cereal food	0.0199 +/- 0.0012
2a	Instant cereal mixes	0.0195 +/- 0.0014
2b	Cereal mixes, groats and flour that require cooking	0.0178 +/- 0.0020
2c	Instant baby biscuits	0.0367 +/- 0.0073
3	Canned meat, fish and plant food	0.0195 +/- 0.0019
3a	Canned meat and meat with vegetables	0.0194 +/- 0.0021
3b	Canned fish and fish with vegetables	0.0210 +/- 0.0043
4	Cottage cheese and curd products	0.0124 +/- 0.0011
5	Dairy products	0.0098 +/- 0.001
5a	Dairy products (except for milk formulas)	0.0105 +/- 0.0022
5b	Adapted and partially adapted milk formulas	0.0094 +/- 0.001
6	Liquid fermented dairy products	0.0076 +/- 0.0005

as heavy metal (lead, cadmium, arsenic, mercury) salts, even in the concentrations not exceeding the maximum permissible levels, affect the health of children [10–16]. The study was aimed to assess food patterns in infants: define the percentage of the breastfed and bottle-fed babies, assess the terms of introducing complementary foods during the first year of live, evaluate chemical contamination of the products for bottle feeding/supplementary feeding, and complementary foods.

METHODS

The socio-hygienic study (questionnaire survey of 600 respondents) was conducted. The research object and the number of observations were as follows: a total of 500 mothers in health-care institutions of Moscow and 100 mothers in health-care institutions of Shakhty (Rostov region) were interviewed. Healthcare institutions to be included were selected randomly based on a survey. Examination was carried out only with the consent of the interviewed person. The questionnaire survey was voluntary and anonymous. The study did not endanger the subjects and infringe their rights in accordance with the principles of biomedical ethics approved by the Declaration of Helsinki of the World Medical Association (2000). Each of the respondents was invited to answer 39 questions. The total number of survey units was 23,400. Studying food patterns in infants was the subject of the study. Questions were clustered as follows: type of feeding, breastfeeding duration, initiation of complementary feeding and the type of consumed food products, quantity, introduction and types of complementary foods. We also assessed the indicators of the heavy metal (lead, cadmium, arsenic, mercury) chemical contamination of baby food obtained in the Russian Federation in 2012–2017. The data provided by the Federal Information Fund for Social and Hygienic Monitoring were analyzed (form 18, Information on the Sanitary Conditions in the Subjects of the Russian Federation).

Statistical processing involving the use of parametric methods was performed in the constructed databases. The average concentrations (and their errors) of toxic elements in the contaminated samples of baby food obtained in the Russian Federation in the years 2012–2017 were calculated. Student's t-test was used for evaluation of significant differences. We compared the data on baby food contamination with the data

on food products used for bottle feeding and foods most commonly used for complementary feeding.

RESULTS

It has been found that 37.3% of infants are breastfed, 62.7% of infants are bottle-fed or supplemented. A total of 7.8% of infants are exclusively bottle-fed from birth. At six months, 44.3% of infants are exclusively breastfed. In Moscow bottle feeding prevails (30.5% of infants are breastfed, 69.5% of infants are bottle-fed or supplemented). In Shakhty (Rostov region), breastfeeding prevails (51.2% of infants are breastfed, 48.8% of infants are bottle-fed or supplemented). In bottle-fed infants, 59.4% of respondents use only the imported adapted milk formulas, and 15.9% of respondents use the domestically-produced foods. In the remainder of cases (24.7%) both imported and domestically-produced adapted milk formulas are used. It has been shown that in 74.7% of cases mothers start introducing complementary foods at 4–6 months of age (as is recommended by pediatricians). However, in 14.5% of cases complementary foods are introduced to infants under four months of age, and in 10.8% of cases these are introduced to infants older than six months. More than a third of mothers (33.9%) introduce fruit as a complementary food. In second place are the fruit and vegetable complementary foods (21.3%), in third place are cereal mixes (16.3%), in fourth place is vegetable puree (11.3%), which is followed by cottage cheese (2.9%), fermented dairy products (2.3%) and dairy products (1.4%). The remaining 10.6% of respondents have noted that they have introduced food products of two groups simultaneously: fruit and cereal mixes, vegetables and cereal mixes, fruit and fermented dairy products.

According to 28.4% of mothers, vegetables are the most common second complementary foods to be introduced. In second place are cereal mixes (22%), and in third place are fruit and vegetable food products noted by 21.8% of mothers. Canned meat and meat with vegetables are the most common third complementary foods (46.3%). In second place are cereal mixes (cereal food) (27%), and in third place are dairy and fermented dairy products noted by 10.5% of mothers. Based on the data acquired in 2012–2017, provided by the Federal Information Fund for Social and Hygienic Monitoring of the Russian Federation, the average concentrations of 9,566 baby

Table 2. The baby food average portion size, g (M ± m)

Group of food products	Average portion size, g (M ± m)			
	1–3 months	4–6 months	7–9 months	10–12 months
Canned meat, fish Food products for complementary feeding: foods made of fruit and vegetables, canned fruits and vegetables	–	98.3 ± 3.8	137.1 ± 5.4	218.2 ± 6.6
Cereal food	–	61.3 ± 2.3	142.6 ± 7.5	207.7 ± 6.8
Instant cereal mixes	–	51.5 ± 2.1	103.8 ± 6.8	119.5 ± 3.3
Cereal mixes, groats and flour that require cooking	–	–	25.7 ± 3.8	66.8 ± 3.5
Instant baby biscuits	–	9.8 ± 1.1	13.1 ± 1.1	21.4 ± 3.3
Canned meat, fish and plant food	–	–	32.3 ± 5.6	53.4 ± 8.5
Canned meat and meat with vegetables	–	–	32.3 ± 5.6	40.5 ± 7.3
Canned fish and fish with vegetables	–	–	–	12.9 ± 2.8
Cottage cheese and curd products	–	–	36.4 ± 2.3	48.5 ± 4.1
Dairy products	758.5 ± 13.8	807.4 ± 18.4	730.5 ± 20.5	643.1 ± 26.2
Dairy products (except for milk formulas)	–	–	–	115.7 ± 8.1
Adapted and partially adapted milk formulas	758.5 ± 13.8	807.4 ± 18.4	730.5 ± 20.5	527.4 ± 29.7
Liquid fermented dairy products	–	–	119.6 ± 10.7	226.3 ± 14.1

food samples contaminated with heavy metals (lead, cadmium, arsenic, mercury) were analyzed (Table 1).

The maximum concentrations of toxic elements were found in the fruit and vegetable complementary foods (0.0213 ± 0.0021 mg/kg M ± m), instant cereal mixes (0.0195 ± 0.0014 mg/kg M ± m), canned meat and meat with vegetables (0.0194 ± 0.0021 mg/kg M ± m). Adapted and partially adapted milk formulas had lower concentrations of toxic elements (0.0094 ± 0.001 mg/kg M ± m). In the majority of cases, the listed above domestically-produced food products had higher levels of heavy metal contamination compared to imported products based on the concentrations in the studied samples.

We assessed food patterns based on the average amounts of basic food products consumed by the bottle-fed/supplemented infants (Table 2).

The average contamination levels of the adapted and partially adapted milk formulas are 1.5–2.3 lower than the average concentrations in complementary foods. However, it is these products that are used as a main food product (as an only food product in infants under 3–4 of age) for bottle-fed infants. Therefore, regular consumption of these products can result in the significant chemical load on the child's body. At the same time, we have to keep in mind that it is fruit and vegetable food products that are used as first complementary foods starting from the fourth month of life (on average). Cereal mixes (cereal foods) are the most common second complementary foods, after which meat products are introduced, including canned baby food. Despite the lowest concentrations of heavy metals, fermented dairy products rank second in the amount of food taken in the second half of the first year.

DISCUSSION

The findings are generally consistent with the results obtained by Rosstat, UNICEF, and the regions of the Russian Federation, being no more than 15% lower. According to Rosstat, in 2017, 43.2% of infants aged 3–6 months and 40.4% of infants aged 6–12 months were breastfed [17–19]. According to UNICEF, in 2018 41% of infants consumed breast milk only during the first six months of life. The higher the economic health, the lower is the rate of breastfeeding [20]. The minimum age at which complementary foods could be first introduced is four months. The optimum age of introducing first complementary foods to

a healthy baby is 5–6 months or the age of eruption of first incisors. According to the World Health Assembly resolutions No. 54.2 dated May 18, 2002 and No. 59.13 dated May 4, 2006, in the exclusively breastfed children, first complementary foods should be introduced at the age of six months. Currently, introduction of such complementary foods as vegetable puree or cereal mixes is preferable. It is recommended to introduce meat starting from the age of six months, while in the past it was recommended to introduce meat at the age of seven months or later. It is best to introduce fruit puree during the second half of the first year, and not to use it as a first complementary food. It is recommended to introduce fish not earlier than at the age of eight months [17–19]. When studying children in St. Petersburg, the age of the first complementary food introduction was defined, 5–5.5 months [21]. Similar data were obtained by the authors when performing a questionnaire survey in various regions of the Russian Federation (Astrakhan region, Republic of Bashkortostan, Republic of Tatarstan, Udmurt Republic) [22–24].

Food products, including baby food, have been assessed in various regions of the Russian Federation (Arkhangelsk region, Primorsky Krai, Orenburg region, Saratov region). The priority contaminants (heavy metals) have been found in such food products as dairy products, fruit and vegetable products, meat items, which confirms the results of our analysis of baby food contamination [25–30].

CONCLUSION

The issue of breastfeeding remains relevant due to the fact that only 37.3% of infants consume breast milk in the first year of life. Preventive work in maternity clinics and women's consultation clinics in the form of information kits, leaflets and short booklets, and volunteer work with puerperants would make it possible to increase the number of breastfed babies. This is fully in line with the goal of increasing the abundance of the exclusively breastfed children under six months of age to 50%, stated by both Russian Government within the framework of the Decade of Childhood project and the world community (WHO).

The issues of the complementary food introduction age (a quarter of mothers introduce complementary foods before or after the optimum age) and the type of first complementary

food remain relevant: mothers most often introduce fruit-based products as first complementary foods, while pediatricians recommend to start with vegetable foods or cereal mixes.

Fruit and vegetable complementary foods in the form of the ready for use canned puree, which are most often used as first complementary foods by mothers, are the main contributors to heavy metal contamination. However, such dairy products as the adapted and partially adapted milk formulas play a significant part in the baby food heavy metal contamination

due to high consumption as an alternative or supplement to breastfeeding.

The findings dictate the need to apply the measures to improve breastfeeding rate and reduce consumption of the ready to use baby food contaminated with heavy metals in favor of increasing consumption of the self-cooked baby food in infants. Such measures and recommendations would contribute to maintaining the child's health, optimum growth, development, and functional state, as well as to prevention of child morbidity.

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THE EXPERIENCE OF HEALTH-CENTRIC CAREER COUNSELING FOR SCHOOLCHILDREN IN A PEDIATRIC CLINIC

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The article reviews the issues of career counseling for adolescents with health problems. Goal. Show the possibilities and share the experience of providing career advice with focus on health to adolescents with health problems in the settings of primary health care establishments. Patients and methods. Nine hundred forty schoolchildren were counseled in the career advice room. The participants were divided into 3 groups: group 1 — participants with disabilities since early childhood, group 2 — children with chronic diseases, group 3 — children at risk of developing chronic diseases. The inclusion criteria were: status of a schoolchild, signed and submitted informed consent form, lack of exposure to occupational hazards. The conducted study does not endanger the participants and complies with the biomedical ethics requirements. Statistica 10.0 software was used for statistical processing of the data collected. Based on the results of this work and review of the relevant publications, authors of the study suggest a structure of the health-centric career advice service. Conclusions Career advice that factors in health aspects is an important link in medical and psychological rehabilitation aimed at helping the teenager to adapt to current socio-economic conditions and realize his/her physical and intellectual capabilities.

Keywords: health-centric career counseling, adolescents, health status

Author contribution: Ganuzin VM — research supervision, collection of material, article authoring; Maskova GS — literature analysis, statistical processing.

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ОПЫТ ВРАЧЕБНОЙ ПРОФЕССИОНАЛЬНОЙ КОНСУЛЬТАЦИИ ШКОЛЬНИКОВ В УСЛОВИЯХ ДЕТСКОЙ ПОЛИКЛИНИКИ

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В статье рассматриваются вопросы организации врачебной профессиональной консультации подростков с отклонениями в состоянии здоровья. Цель — показать возможности и поделиться опытом проведения врачебной профессиональной консультации подросткам с отклонениями в состоянии здоровья в первичном звене здравоохранения. В кабинете профессиональной консультации было осмотрено 940 школьников, которые были разделены на три группы: первая — инвалиды-детства, вторая — дети с хроническими заболеваниями, третья — дети с риском развития хронических заболеваний. Критерии включения — школьник, наличие подписанного информированного согласия, отсутствие контакта с вредными производственными факторами с условиями труда. Проведенное исследование не подвергает опасности участников и соответствует требованиям биомедицинской этики. Статистическая обработка проведена с использованием Statistica 10.0. На основе проведенного исследования и литературных данных предлагается структура организации службы врачебной профессиональной консультации. Врачебная профессиональная консультация является важным звеном в медико-психологической реабилитации, позволяющей подростку адаптироваться к современным социально-экономическим условиям и реализовать свои физические и интеллектуальные возможности.

Ключевые слова: врачебная профессиональная консультация, подростки, состояние здоровья

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Continued improvement of the occupational guidance services provided to the youth is a task important on the level of the entire nation. The choice of profession made by the young person, his/her socialization during the transition from school to a vocational education establishment and further employment are often influenced by the state of health of this person, the level of development of medical and psychological career guidance structures and the choice of educational establishments and employers in the region of residence [1, 2].

Currently, the health-centric career guidance service (HCCGS) for adolescents with chronic diseases and childhood disabilities has certain shortcomings. The training in areas related to HCCGS that students receive in higher education

establishments is limited. Pediatricians often lack sufficient medical, hygienic, psychological, technical and legal knowledge required to provide qualified assistance to adolescents with health problems. They cannot competently provide career guidance from the point of view of health. The problem is further exacerbated by the lack of modern publications supporting HCCGS activities, materials that would collate professions and diseases, like the earlier developed and published Lists of medical contraindications for admission to educational establishments.

An important task is to include adolescents at risk of chronic diseases into the HCCGS audience. In our opinion, this task has not yet been addressed. Giving career advice to such

adolescents, it is necessary to predict individual resistance to the effects of adverse occupational factors. Far from all young people working in adverse conditions develop occupational pathologies and subsequent disabilities. Under the influence of adverse occupational and environmental macro- and microclimatic factors, even healthy adolescents that run high risk of chronic diseases can develop such pathologies. In addition to general examination, it is recommended test the young people from this group for gene polymorphisms causing development of various pathologies [3–10].

GOAL. Show the possibilities and share the experience of provision of HCCGS in the pediatric clinic setting.

PATIENTS AND METHODS

Nine hundred forty schoolchildren were counseled in the HCCGS room. We divided the children into 3 groups: group 1 — participants with disabilities since early childhood, group 2 — children with chronic diseases, group 3 — children at risk of developing chronic diseases. Before the counseling session, most schoolchildren knew nothing about occupational hazards and working conditions associated with the profession they have chosen [11].

As for the methods supporting HCCGS, we relied on the federal protocol ROUSHUMZ-5-2014 and the HCCGS Guidelines prepared by the Methodological Union of the medical and pharmaceutical education establishments of Russia [11].

The inclusion criteria were: status of a schoolchild, signed and submitted informed consent form, lack of exposure to occupational hazards. The conducted study does not endanger the participants and complies with the biomedical ethics requirements. Statistica 10.0 software was used for statistical processing of the data collected.

RESULTS

All young people that came to the HCCGS room for counseling received profession recommendations and suggestions of educational establishments that offer relevant training. The process of counseling included several stages.

The first stage was in grades 4–8, the second — in grades 9 and 11. Each participating young person had a “Health-Centric Career Guidance Card” registered for him/her [11].

Each examined person was recommended a number of professions and specialties that accord with his/her state of health. In addition, we identified the occupational hazards that can contribute to the deterioration of health in the context of the pathology.

Group one was the hardest to give health-centric career advice to, since the diseases its members had often took severe forms and frequently progressed into exacerbations. The circle of professions recommended to this group was very narrow.

In the second group of schoolchildren, 50.0% had 2–4 chronic diseases: digestive system disorders — 23.9%, urinary system diseases — 13.2%, impaired eyesight — 12.8%, nervous system disorders — 10.3%, diseases of the respiratory organs, including bronchial asthma — 8.4%, musculoskeletal system disorders — 6.6%, malfunctioning ENT organs — 6.6%, cardiovascular system diseases — 5.6%, skin diseases — 4.3%, endocrine system disorders — 3.5%, etc.

As an example, we shall more closely consider the peculiarities of provision of HCCGS to adolescents with ENT problems. Of the 62 schoolchildren with such problems, 26 had chronic tonsillitis, 23 — hearing loss of varying degrees, 13 — chronic sinusitis.

The need for health-centric advice for young people with ENT problems is supported by the multitude of occupational hazards that further exacerbate these problems.

In cases of chronic rhinitis, pharyngitis, tonsillitis, sinusitis, the following aspects are taken into account: general condition of the teenager, condition of the nasal and pharyngeal mucosa, tonsils, teeth, gums, the size and nature of regional lymph nodes, state of the cardiovascular and respiratory systems (including as established by functional tests), ECG, results of endoscopic and microbiological examination of the nasopharynx, ultrasound, X-ray, computed tomography (if indicated) of the paranasal sinuses, hematological parameters.

These teenagers are not recommended to work in adverse meteorological conditions, in conditions of increased dustiness, with toxic, irritating substances and gases. In case of smell disorders, the jobs advised against are those associated with the danger of sudden poisoning with chemicals in the pharmaceutical and fragrance industries.

In cases of chronic otitis, auditory neuropathy with mild hearing loss, the following aspects are taken into account: presence and localization of headache, condition of the tympanic membrane, auditory and vestibular function (as registered with tympanogram and audiogram tests) and the vestibular apparatus, hematological parameters, X-ray and computed tomography (if indicated) of the temporal bones, audiologist examination results.

As an example, we shall consider a conclusion issued following a health-centric career guidance session with I., a 17-year-old student of the 11th grade of a secondary school.

Diagnosis: bilateral hearing loss, neurosensory, degrees I–II, hereditary.

Hearing loss was diagnosed 6 years ago. Audiologist established that he perceives whispered speech from a distance of 3 meters. The grades at school are “good” and “excellent”. He prefers exact sciences and likes to design. The future profession is a yet undecided matter.

His father is a watch repairman. Hearing loss can be traced in three generations on the father's side. His mother is healthy, she works as a merchandiser. The HCCGS session was the first one even for the boy.

The young man is advised against jobs that requires good hearing, as well as those associated with intense production-related noise and vibration, neurotoxic substances, adverse weather conditions.

The professions recommended to the child, accounting for the state of his health, inclinations and academic performance (and the fact that the HCCGS session was the first one) were as follows: mechanical and electronic watch repairman, photographic/videographic equipment repairman, instrumentation and automation installer, household appliances repairer, optician, online merchant, webmaster.

The recommended universities and college curricula are electronic control of electrical systems, food industry machines and systems, optical instruments and spectroscopy, precision mechanics, automation and telemechanics, industrial electronics, semiconductor devices, software for computers (IT technologies) and automated control systems (ACS), ACS design and operation, economics, accounting.

DISCUSSION

This study suggests that the HCCGS should be provided mainly by a pediatrician in close cooperation with a psychologist. They should be tasked with provision of career advice from the viewpoint of health to adolescents from the high risk groups,

those having functional deviations and a number of chronic diseases. In the process of solving these tasks the pediatrician should contact his polyclinic peers specializing in other areas of medicine.

To improve the quality of HCCGS provided to adolescents and youth, it is necessary to organize a number of activities at federal level. We added some of these activities in the resolution of the 2021 VII National Congress on School and University Medicine:

We suggest extending staff schedules of the Children's Health Centers with the position of a pediatrician trained in the areas related to HCCGS, who will work with adolescents with chronic diseases and those at risk of developing such [2, 5].

Another initiative is to establish a city (inter-district) HCCGS office that can help teenagers with more complex pathologies and young people with disabilities acquired in early childhood. This office can be set up in one of the city's pediatric clinics or the Children's Health Center. The duties of the employees of the city HCCGS office should include advisory and supervisory functions, as well as the introduction of methodological advancements in the primary health care. In addition, they should have access to the employment system/database, know the demand for this or that profession, and provide socio-psychological and legal assistance to adolescents [1, 2, 5, 9, 10].

Staffing schedules of regional youth career guidance and psychological support centers, which currently help with

psychological aspects of career counseling, should be extended with a medical doctor position. This initiative should be aligned with the Ministry of Health and the Ministry of Education; the doctor, currently not available at such centers, will give health-centric career advice to adolescents with chronic diseases and disabilities. Considering the great scientific and practical potential of the regional youth career guidance centers, adding a medical doctor to their schedules would have solved the problems of training primary care doctors and psychologists in the areas enabling high quality HCCGS provision, aided the development of the new methods of career guidance at the intersection of medical, psychological, pedagogical, social and legal sciences and allowed their introduction into practice on the level of regions.

CONCLUSION

In the current socio-economic conditions, health-centric career advice given by a medical doctor to adolescents and youth is a task important for the state, since its solution contributes to the effective replenishment of labor resources and allows young people select an educational establishment and a recommended professions that factors in the specifics of their health. Our experience in this field allows us to give recommendations on how to improve the structure of the HCCGS at various levels of medical care for children and young people.

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RISK FACTORS OF ATOPIC DERMATITIS IN CHILDREN AND THE MEANS FOR INDIVIDUAL PROGNOSIS

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Despite considerable progress in prevention and treatment of atopic dermatitis made in recent years, the issue remains topical, since in recent decades a significant increase in the prevalence of atopic disorders is observed all over the world. The increased incidence of atopic dermatitis results from the human body exposure to the wide range of factors, as well as from the factors' specificity and mutual activation. Atopic dermatitis is a multifactorial disorder associated with genetic predisposition to atopy, realized under the influence of environmental factors. The risk factors of pediatric atopic dermatitis are divided into endogenous and exogenous factors, which are also affected by genetic susceptibility. It is worth paying attention to the fact that the factors are enhanced by triggers, which both directly and indirectly influence the body in children and adolescents. A combination of multiple factors plays a key role in chronic pediatric atopic dermatitis. Also do not forget about the impact of sanitation, hygiene, environmental factors, urbanization of the area of residence, and the presence of industrial enterprises in the residential area on the health of children and adolescents. Atopic dermatitis has a negative impact on the quality of life of children and their families. There is a clear need for further research. Currently, monitoring the effects of atopic dermatitis becomes relevant, it is aimed at addressing the issues of prevention. For its part, timely identification of the risk factors and concomitant disorders are of inestimable value for the course of the disorder.

Keywords: hygiene, children and adolescents, atopic dermatitis, genetic factors, prognosis

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ФАКТОРЫ РИСКА ВОЗНИКНОВЕНИЯ АТОПИЧЕСКОГО ДЕРМАТИТА У ДЕТЕЙ И ПУТИ ПЕРСОНАЛЬНОГО ПРОГНОЗИРОВАНИЯ

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Несмотря на значительный прогресс, достигнутый за последние годы в профилактике и лечении атопического дерматита, эта проблема не утратила своей злободневности, так как во всем мире в последние десятилетия отмечается значительный рост атопических заболеваний. Увеличение заболеваемости атопическим дерматитом вызвано воздействием обширного комплекса факторов на организм человека, их спецификой и взаимоактивацией. Атопический дерматит относится к многофакторной патологии с наследственной предрасположенностью к атопии, осуществляемой под влиянием факторов внешней среды. Факторы риска развития атопического дерматита у детей подразделяют на эндогенные и экзогенные факторы, на которые также влияет генетическая предрасположенность. Стоит обратить внимание на то что факторы усугубляются действием триггеров, которые как на прямую, так и косвенно воздействуют на детский и подростковый организм. При течении хронического атопического дерматита у детей ключевую роль играет совокупность множества факторов. Не стоит забывать о влиянии санитарно-гигиенических и экологических факторов на состояние здоровья детей и подростков, урбанизации местности их проживания и промышленных предприятий на ней локализованных. Атопический дерматит негативно влияет на качество жизни пациентов и их семей, существует явная необходимость проведения дальнейших исследований. На сегодняшний день мониторинг воздействия атопического дерматита приобретает значимость и направлено на решение вопросов профилактической направленности. В свою очередь, своевременное выявление факторов риска его развития, а также сопутствующей патологии имеет неоспоримое важное значение в течении данной патологии.

Ключевые слова: гигиена, дети и подростки, атопический дерматит, наследственность, прогнозирование

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

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In recent decades, atopic dermatitis has been classified as a socially significant disease, the so-called "disease of civilization" [1, 2, 3]. Risk factors, directly related to lifestyle and habitat, play a vital part in the atopic dermatitis development and progression [4, 5, 6].

Atopic dermatitis is a multifactorial disorder associated with genetic predisposition to atopy, realized under the influence of environmental factors [7, 8, 9, 10].

Children have some risk factors for atopic dermatitis, which are divided into endogenous (genetic factors, atopy, skin hyperreactivity) and exogenous (food, household, pollen, epidermal, fungal, bacterial, and vaccine-associated factors, as well as tobacco smoke, pollutants, xenobiotics, etc.) factors [11]. It is worth paying attention to the fact that the triggers could be enhanced by such factors as climate, geographical factors, malnutrition, non-compliance with personal hygiene practices, viral infections, and psychological stress, which is confirmed by research data [12].

Currently, genetic predisposition in patients with atopic dermatitis is not in dispute [13, 14, 15, 16]. According to the research [17], 53.4% of children had a family history of atopic dermatitis. Moreover, in 9 patients, allergic diseases were diagnosed in both patients (14.3%). According to other reports, predisposition to allergy was observed in 82% of cases [18]. I. M. Shevchenko et al. (2015) believe that it's allergy in mother's history that increases the risk of atopic dermatitis in children in their first year of life ($\chi^2 = 24.04$, $p = 0.000001$), TORCH infections ($\chi^2 = 9.93$, $p = 0.001$) [19].

The combination of socio-hygienic, biomedical, environmental and hygienic factors plays a key role in the development and persistence of chronic atopic dermatitis [20, 21, 22].

In recent years, the impact of environmental factors on the pediatric allergic diseases was investigated and proven [23, 24]. The relationship between the degree of air pollution and the prevalence of allergy was detected [25, 26]. It's been proven that higher incidence of atopic dermatitis is found in children who live in urban areas, especially in the environmentally damaged regions [27].

In scientific literature, the researchers focus on the impact of antenatal and neonatal risk factors on the development of atopic dermatitis in children [28, 29, 30].

Factors constituting the primary entities of atopic dermatitis, such as alimentary factors, infection, preventive vaccination, taking medications, genetic factors, fetal diseases, have been specified [31, 32]. It's been proven that caesarean delivery results in higher likelihood of early-onset atopic dermatitis compared to normal delivery [33]. Furthermore, complicated pregnancy is observed in 96.7% of mothers of the surveyed children with atopic dermatitis [34].

METHODS

The review of 67 papers addressing the course of atopic dermatitis in children and adolescents was the research method. Assessing the data on the risk factors and disease development enables complete and detailed specification of the preventive medical and recreational guidelines for both individuals and groups.

RESULTS

The impact of biomedical and socio-hygienic risk factors on the development of allergy in children was assessed [35, 36]. Factors related to inadequate sanitation, poor hygiene and

unfavorable environmental conditions in the child's residential space, such as occupational hazards, maternal smoking cessation, toxicosis of the first or second half of pregnancy, delivery complications, breastfeeding duration, have a prominent effect [37, 38].

The impact of sanitation, hygiene and environmental factors, such as the amount of living space per household member and passive smoking, on children's health was assessed. In that connection, the disappointing trend was revealed, i. e. the increase in the number of smoking mothers by 2.5 times over the past decade [39, 40].

The data on the impact of parental occupational factors on children's health were studied; high prevalence of allergic diseases in children of employees working at the chemical and petrochemical enterprises was revealed [41].

The impact of multiple factors on the development of fungal infections in children with atopic dermatitis was studied; the degree of influence and magnitude were assessed for risk factors affecting the children at various stages of life starting with intrauterine development [42, 43]. The study [44] emphasizes that the development of cutaneous mycoses is interrelated with the atopic dermatitis severity and the extent of the lesion. Such symptoms of atopic dermatitis as dry skin, itching, erythema, peeling/oozing, edema/papules, excoriation, lichenification, and sleep disorder positively correlate with the development of cutaneous mycosis.

Information is provided on the degree of the risk factors influence on the development of atopic dermatitis combined with respiratory allergy in children [45, 46].

Forecasting, which is currently widely used in many fields of research, also finds its use in medicine [47, 48, 49, 50]. Predicting the course of various disorders is a topical issue in medicine due to the possibility of disease prevention by targeting various stages of the disease and managing their development in the right direction. In their papers, researchers show the feasibility of using mathematical methods for individual prediction of pediatric allergic diseases.

The prognosis of respiratory and cutaneous manifestations of allergy in children with early-onset exudative diathesis was defined. The method for early prediction of allergic reactions based on the family history and the course of intrauterine development was developed in order to identify the groups at high risk. The method for prediction of pediatric allergic diseases was tested in the context of identifying the allergy clinical form.

A model was developed enabling individual prediction of the risk of atopic dermatitis in children based on the combination of maternal and children's risk; the measures for eradication or reduction of unfavorable social, hygienic and other factors, contributing to the disorder, were recommended. The method for prediction of the extended immune parameters in children with allergic dermatoses was also proposed.

The diagnosis of gnoseological indicators, such as medical history, clinical and laboratory data, and immune parameters, is essential for the prediction of the atopic dermatitis course in the newborn and first year babies with food allergies.

The method for prediction of early-onset atopic dermatitis based on the family history, associated with atopic dermatitis, has been identified, which could increase the efforts to develop the groups for primary disease prevention.

Mathematical model for individual prognosis of the development and progression of pediatric allergic disorders was developed based on assessing the strength and hierarchy of influences for various group of factors [50]. Stages of the prevalence of allergic diseases were predicted based on the planned alterations in air

pollution: namely, the annual increase in the prevalence of atopic dermatitis could reach 0.4–0.9% of cases.

The use of mathematical forecasting of immune parameters in older children with atopic dermatitis, and software developed based on the research results and calculations are recognized by scientists as a creative way to predict the impairments in patients with this disorder.

The use of mathematical models to define the risk of the atopic dermatitis symptom emergence in children of various age and predicting the sustained remission are beneficial. The authors have defined the adverse factors, such as diffuse and extensive forms of atopic dermatitis, concomitant skin diseases, early disease onset, affecting the duration of the recurrent disease.

Mathematical model for prediction of the pediatric atopic dermatitis course is recommended. The authors emphasize that the use of the logistic regression equation developed based on 16 predictor variables, for which the significance levels were within 5% (Wald test), facilitates identification of children at risk of atopic dermatitis in the population. Alternative study performed by the same researchers reports the use of mathematical model to predict the risk of bronchial asthma in children with this disorder. The logistic regression equation includes 7 predictor variables (age; intrauterine infection; pneumonia, acute obstructive bronchitis, and chronic adenoiditis in children above the age of two; paternal and maternal (mother's relatives) history of allergy).

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DISCUSSION

Many authors point out that studying the factors contributing to allergic reactivity and the use of those in combination with forecasting are primary points for minimization of the disorder.

CONCLUSIONS

Regardless of multiple studies and reviews focused on studying the role of potential risk factors in the development and progression of atopic dermatitis, we have found no reports of the comprehensive studies of the impact of risk factors on the emergence of the atopic dermatitis complicated forms aimed at developing predictive models. Such studies are essential, these would make it possible to develop individual predictive models of the course of atopic dermatitis complicated by bacterial and fungal infections. This aspect would enable the development of the recovery program and the number of preventive measures for the groups with atopic dermatitis at high risk of complications.

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NEW DIGITAL OPPORTUNITIES IN DIAGNOSIS AND PREVENTION OF STUDENTS' MENTAL HEALTH

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The article deals with new digital opportunities in diagnosis and prevention of health and well-being of students that also create principally new conditions for getting education. Use of digital traces, big data, machine learning and computer modelling in diagnosis results in obtaining important data about mental health of students to examine their behavior, physical activity, emotional condition and a wide specter of personal traits in detail. Quantitative methods combined with big data and artificial intelligence (AI) technologies are utilized to anticipate certain neurological and mental diseases. They allow to overcome limitations of traditional research methods and expand the opportunities of modern education by changing the educational process based on the analysis results and adapting them to the student's current state and development. When digital technologies are moderately used under certain conditions, they (chat-bots, applications and other online resources) can be utilized as preventive activities, estimating one's health, improving social and psychological well-being and interactions by transforming the educational process.

Key words: students, digital environment, diagnosis, prevention, health, well-being

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НОВЫЕ ВОЗМОЖНОСТИ ЦИФРОВЫХ ТЕХНОЛОГИЙ В ДИАГНОСТИКЕ И ПРОФИЛАКТИКЕ ПСИХИЧЕСКОГО ЗДОРОВЬЯ ОБУЧАЮЩИХСЯ

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В статье раскрываются новые возможности цифровых технологий в вопросах диагностики и профилактики здоровья и благополучия обучающихся, которые также создают принципиально новые условия для получения образования. Использование в диагностике методов цифровых следов, больших данных, машинного обучения и компьютерного моделирования позволяет получить важные сведения о психическом здоровье обучающихся для детального изучения поведения, физической активности, эмоционального состояния, широкого спектра личностных характеристик. Количественные методы в сочетании с технологиями больших данных и искусственного интеллекта используются для прогнозирования определенных неврологических и психических расстройств, которые позволяют преодолевать ограничения традиционных исследовательских методов и расширять возможности современного образования, меняя сам процесс обучения по результатам такого анализа и адаптировать их под текущее состояние и развитие обучающегося. При умеренном использовании цифровых технологий в определенных условиях они (чат-боты, приложения и другие онлайн-ресурсы) могут использоваться в качестве профилактических мероприятий, помогая оценивать свое состояние здоровья, повышать социально-психологическое благополучие и взаимоотношения, трансформируя процесс обучения.

Ключевые слова: обучающиеся, цифровая среда диагностика, профилактика, здоровье, благополучие

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Development of digitalization and active implementation of digital technologies into the daily life occurs in any sphere, including medicine, education, economics, production, transportation, construction, etc., expanding the opportunities of education, communication, implementation of brand-new scientific developments of AI that result in global transformation of the reality.

A modern generation widely uses the opportunities of the Internet, navigator, smart house, and interactive helpers such as the simplest mobile applications like distance recorders, calorie calculators or gadgets used to determine the condition of a system, electronic medical record, convenient IT-navigation system and telemedicine.

Such new developments as digital medical cards, IT management of personnel and time of appointment, etc. constitute a comfortable environment. Development of telemedicine enables distant consultation with medical experts, whereas the individual approach using the brand-new scientific developments becomes increasingly human-oriented.

Digitalization of education acquires importance due to the steady growth of mental health disorders in children and adolescents. They are primarily represented by depressive

and anxiety disorders that are the most frequently occurring manifestations of mental disturbances in a younger generation. According to the results of a number of trials, the prevalence of depressive symptoms varies from 7.5% to 11% among those aged 18 years, and the upward trend is observed [1, 2].

The data dependent pathology and emotional stress are on the rise. They can also be risk factors for diseases (mental, cardiovascular, gastrointestinal diseases, etc.) and new pathologies such as a computer syndrome, various addictions (pathological dependence), etc. [3].

Inevitable informatization, digitalization of Russian education and creation of high-tech educational environment make the issue of diagnosis, prevention and health-saving technologies more pressing. This is how the negative effect of the factors on the mental health and social-psychological well-being of students is reduced.

MATERIALS AND METHODS

The science data presented in Russian and foreign trials using RSCI- and PUBMED-based digital technologies that concern

the issues of diagnosis and prevention of mental health and social and psychological well-being of students were analyzed following the principles of scientific objectivity and complexity.

DISCUSSION OF RESULTS

Owing to modern technologies, researchers come across new opportunities. Distribution of digital technologies resulted in occurrence of such a new scientific area as 'computational social science' [4].

Due to the use of digital traces, big data, methods of machine education and computer modeling, computational social sciences overcome the limitations of traditional research methods. The digital traces, the vast amount of which are left by people, can be used to study their owners' behavior in detail. For instance, fitness bands and mobile phones trace where we move, measure our physical activity and sleep patterns; social networks and telephone conversations can be used to examine social interactions. Data about social interactions can be obtained using mobile device sensors [5] or through the history of interactions, presenting new sources of data for the research. New methods also allow to conduct researches on a large scale. The opportunity was not previously available.

For instance, examination of the effect produced by the news feed on the emotional state of users included a sample of 700,000 thousand people [6]; researches of a similar scale were conducted on a sample of VKontakte users [7]. The largest experiment was carried out on the platform of one of the social networks and included 61 million people [8]. A large sample enables to find effects that are less strong, but more significant for a human well-being. This is especially important when examining a human emotional well-being influenced by many factors. However, their effect in small samples is difficult to prove. Due to a larger coverage, participants can be distributed into groups of different age and gender, examine the effect of the same factors on those educated depending on various indicators, etc.

Machine learning methods permit to restore various characteristics using digital traces (prediction of such demographic indicators as gender, nationality, income, etc.) according to tweets [9], photos in the profile [10], user's posts [11]. A wide specter of personal traits (from temperament to the level of intelligence) can be predicted based on how users behave in social networks, including academic progress [12, 13].

Moreover, digital traces can be used to predict depression effectively: based on certain social networks, depression can be predicted three months before the official diagnosis, and the predictive accuracy is comparable with a standard screening interview [14].

We can compose an individual human profile using the artificial intelligence (AI), and Internet resources can be used to collect data about one's mental health. AI can analyze such data as age, gender, ethnicity, blood group, weight, body mass index, and chronic diseases that constitute a higher risk for a human's health [15, 16].

Digital platforms can serve as environment for instant distribution of emotions and allow to study collective reactions to terror attacks [6] or celebrity suicides [17], which is important to take into account due to possible imitations [18]. The researchers are currently using quantitative methods to predict certain mental health problems such as depression, suicidality and anxiety [19].

Digital safety technologies including control and observance of hygienic conditions based on sanitary rules and standards of educational institutions can help solve health promoting school issues [20].

In accordance with the National Strategy for the Development of Artificial Intelligence over the period extending up to the year 2030 (Presidential Decree of the Russian Federation dated 10.10.2019 No. 490), fundamental research to create conditions for human life improvement is developed due to an increased level of education, healthcare, including preventive examinations, prediction of disease occurrence and progress, etc. New methods of optimization of mental and educational activity occur on the basis of technologies of cognitive cyber physical systems, artificial intelligence, distribution, perception and storage of data preserving mental, and social and psychological well-being of those educated [3].

According to the 'balanced approach' hypothesis, moderate use of digital technologies can positively affect physical and mental health, and social and psychological well-being of children, adolescents and young population in the high-tech sphere [21].

The factors producing a negative influence on well-being of those educated in high-tech environment include effects of electromagnetic fields, screen light, peculiarities of visual data presentation, ways and mode of operation (multitasking), etc. [22].

The role of information hygiene and development of optimal levels of visual information, light output, sound, criteria of data relevance and complexity, epidemiology of risk groups and incidence of information overload has been increasing [3].

It is well-known that a part of those educated needs long-distance learning due to health reasons (health limitations and disability), as they can't visit educational institutions on a constant basis.

The main value of long-distance learning for people with health limitations is that long-distance learning is frequently the only way to implement their potential and be successful in life just like their healthy peers. Students educated long-distance, including those with health limitations and disability, are not limited by space or time, they work where they want, when they want and as fast as they want without any overstressing.

Every teacher takes into account a student's opportunities and can determine how long it takes for the student to understand the program. When the program is completed, knowledge is always tested. Clearly, long-distance learning is a great advantage for students with health limitations. The learning process can be adapted to their needs. The students can interact with virtual teachers and peers without inconvenience, constraints or feeling disabled. Thus, the people with limited health capacities are integrated into the society owing to telecommunication and information technologies.

Long-distance E-learning can be extremely effective due to the possibility to analyze the students' data and alter the learning process based on the analysis results [23]. In this case, distance-learning of students, including people with health limitations, is the basis for the new paradigm of the educational process. It is not the content of educational material, subjects, forms and methods of education, but rather the student's personality, individuality, self-actualization during the educational process that occupy a central position. The personal approach is associated with educational individualization as it takes into account personal, psychophysiological and cognitive abilities, values and individual needs of every student [24].

It is also important to pay careful attention to those with hampered adaptation to use of distance educational technologies and formation of competencies associated with wellness and adherence to healthy lifestyle in students [25, 26].

Under certain conditions, a moderate use of digital technologies can promote formation of good habits associated

with a healthy way of life, nutrition, sleeping and physical activity. Examples of the use include different chat bots, applications and other online resources that estimate somebody's health and improve the social and psychological well-being and interrelations in the younger generation [27, 28].

An element of such preventive technologies can include the use of digital means improving well-being of the students in an unfavorable or vulnerable condition of health or a social situation. This is because online communities and social networks provide support and assist in coping with difficult life situations, emotions and stress [17, 28].

A set of different preventive activities must be primarily aimed at prevention of any negative effect and/or elimination of risk factors associated with the use of digital and information and communication technologies in high-tech educational environment that result in visual, locomotor and digestive diseases. It is necessary to reduce a stress factor and its consequences, and hypodynamia resulting in the development of mental health in students. Increasing popularity of social networks attracts the younger generation and promotes their active use [29]. Social networks enable students to develop and support relations by chatting with friends who are off-line using messengers, E-mail, etc. Internet offers great chances to make new friends, urges young people to unite in groups with similar ideas and interests. Online communication is important for development of identity, self-confidence, stable positive self-estimation and self-understanding [30, 31].

Examination of digital technologies requires a differentiated approach with a need in big data. Information from social media can be used here as well. For instance, online activity helps predict health-related issues.

It is shown [32] that social online integration is associated with a reduced mortality due to cardiovascular diseases, drug overdose and suicide. Big data analysis allows to predict depression using posts from social networks [33, 34, 35]. This offers great opportunities. Thus, it is now possible to search for factors of risk and protection in relation to depression and other

diseases in large samples. However, the opportunity couldn't be previously utilized by investigators.

CONCLUSION

Active development of global networks and digital technologies resulted in principally new conditions for getting education using the corresponding methods. Big data add new quality to the process.

Long-distance learning can be more effective when the content is expanded, and new scenarios are created. The use of AI technologies enables significant complementation and expansion of modern educational opportunities, including for people with health limitations. They include the following activities: to collect and analyze data about the students and their activity, analyze their digital traces, i. e., alter the process of education based on the analysis results and adapt to their current condition and development. The shortest way from a digital trace to transformation of the educational process is paved by AI technologies.

Students with health limitations acquire equal educational opportunities owing to transition to multi-media and AI technologies in learning.

Digital technologies can be used during such preventive activities as consultation and educational activities, monitoring of mental health problems, physical and social-psychological well-being, cognitive and other psychophysiological functions, examination of the effect produced by information technologies and peculiarities of education in a high-tech environment.

Based on the analyzed data of scientific literature it has been shown that additional detailed and focused trials of health dynamics need to be conducted to examine the influence of digitalization on mental health and well-being of students, paying special attention to differentiation of sampling and analysis of subjects' activity, as the trials require large samples, and big data obtained from social networks and other sources, and weighted income are considered perspective.

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