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PATTERNS OF INFLUENCE OF ELECTRONIC DEVICES ON LIFESTYLE AND HEALTH OF YOUNG ADULTS

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High demand for electronic devices used both for educational purposes and during leisure time among the representatives of younger generation is reported. Inadequate development of skills related to the safe use of electronic devices results in impaired daily routine and eating pattern, impairs the quality and duration of sleep, contributes to the development of internet addiction, determines the risk of health problems in users, and provides the basis for the development of prevention programs to be used at the population, group, and individual levels. The paper summarizes the data on the influence of electronic devices on the lifestyle and health of young adults. The review of scientific papers published in the international and Russian databases (E-Library, PubMed, Cyberleninka) in 2019–2023 is provided. The accumulated knowledge about the adverse effects of electronic devices on health will make it possible to use the findings to search for effective preventive measures and plan further scientific research.

Keywords: electronic devices, mobile electronic devices, smartphones, tablets, health problems, lifestyle

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ЗАКОНОМЕРНОСТИ ВЛИЯНИЯ ЭЛЕКТРОННЫХ УСТРОЙСТВ НА ОБРАЗ ЖИЗНИ И ЗДОРОВЬЕ МОЛОДОГО ПОКОЛЕНИЯ

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Отмечают высокую востребованность электронных устройств, используемых как в образовательных целях, так и во время досуга, среди представителей молодого поколения. Недостаточная сформированность навыков безопасного применения электронных устройств приводит к нарушению режима дня и питания, ухудшает качество и продолжительность сна, способствует развитию интернет-зависимости, определяет риск нарушения здоровья пользователей и является основанием для разработки программ профилактики как на популяционном, групповом, так и на индивидуальном уровне. В статье обобщены сведения о влиянии электронных устройств на образ жизни и здоровье молодого поколения. Представлен обзор научных статей, опубликованных в международных и российских базах данных (E-Library, PubMed, Cyberleninka) в 2019–2023 гг. Накопленные сведения о негативном влиянии на здоровье электронных устройств позволяют использовать полученные данные для поиска эффективных мер профилактики, планирования дальнейших научных исследований.

Ключевые слова: электронные устройства, мобильные электронные устройства, смартфоны, планшеты, нарушение здоровья, образ жизни

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In today's society, electronic devices (EDs) represent an integral part of daily life, constitute the basis and prospects of the development of multiple industry sectors and spheres of activity. EDs having a significant impact on lifestyle not only contribute to rearrangement of social communications, but also create additional health risk. Young adults constitute a specific group of users using EDs both for educational purposes and during leisure time, having limited experience of offline communication, and vigorously drawn into the space of Internet from an early age [1, 2].

The distance learning ensuring varying contributions to the aggregate training program for students studying at the general, professional, and secondary educational institutions represents the most vivid example of the ED introduction into the educational system.

Scientific literature provides data on the impact of distance learning technologies on the health and lifestyle of schoolchildren

and students, describes the risk factors of health problems related to noncompliance with the rules for safe use of EDs during training and leisure activities, shows the relationship between health problems and the conditions and mode of using EDs [3–6].

The analysis of findings can provide the scientific basis for the development of preventive measures aimed to reduce health risks in the younger generation; it will make it possible to identify relevant directions for further research. Our aim was to summarize the acquired knowledge about the influence of EDs on the lifestyle and health of young adults.

The review of scientific papers published in the international and Russian databases (E-Library, PubMed, Cyberleninka) in 2019–2023 was conducted.

The majority of papers are focused in assessing the features of lifestyle and health of individuals using EDs. This research area is complex due to multifactorial effects of EDs.

The ED type (stationary, mobile) and model can be considered the risk factors of health problems, along with the duration and frequency of using ED, type of activity (using mobile telephony, social media, visiting websites, watching videos, screen reading, gaming). Working conditions (luminance level, workplace ergonomics, presence of background noise, using headphones, etc.) are additional risk factors that are not directly related to EDs. The user's personal preferences (place and time of operation, applications and ED settings used, etc.), awareness of the rules for safe use, and the development of useful skills have a significant effect. All the above create a hard-to-predict model for determination of the health risk associated with the use of EDs [7–12].

Numerous studies are focused on assessing the impact of using EDs on the emergence of eye disorders and their prevalence among young adults.

Deterioration of vision in students attending educational institutions throughout 20 years is observed. A significant decrease in visual acuity ($p \leq 0.05$) is observed in today's schoolchildren during their middle grades; the decrease in the reserve of relative accommodation is observed in the first-years just starting their systematic school training. This suggests depletion of adaptation. The structure of myopia and its prevalence among students have been studied [13–16].

The ED technical characteristics, specifically the features of use affecting visual perception of information from the screen, that result in eye fatigue, development of functional impairment and eye disorders, have been identified [17–18].

Information has been obtained about the significant effect ($p \leq 0.05$) of the conditions and mode of using mobile EDs (MEDs) on the development of computer vision syndrome (CVS): use at night, less than 40 min before sleep, with local lighting, at a distance less than 30 cm from the eye. It has been shown that the time on ED, insufficient illuminance level, simultaneous use of EDs (two or more), use of ED in an inappropriate location (in transport), as well as noncompliance with the principles of eye care, specifically working without interruptions for rest and eye exercise, inadequate working posture (sitting in a chair, lying), lack of the day “free from smartphone” during the week, have a significant effect on the emergence of functional eye disorders ($p \leq 0.05$) [19].

The correlation ($p \leq 0.05$) between the visual acuity decrease in students and the duration of ED use (total daily and continuous use) has been revealed [20–21].

The duration of continuous MED use significantly increases with the child's age to reach its maximum in his/her student days and exceeds the hygienic standard set for the use of tablet [22] 2-fold in primary school students, 3-fold in high school students, almost 5-fold in senior school students, and 7-fold in university students. The duration of ED use causes untimely organization of breaks for rest and eye exercises, impaired food intake regime, determines the level of physical activity, contributes to the later bedtime, reduced sleep duration, etc. [23].

The online engagement of the youth is a serious problem. Students spend more than 4 h per day on social media, and every second student uses three social media or more. The frequency of browsing social media exceeds 20 times per day in every third student. The lack of access to social media causes stress in every seventh student. Spending large amounts of time on social media and the prolonged lack of access to social media result in the development of psycho-emotional disorders that can be manifested by sleep disorders, increased irritability, and the development of addiction. The relationship between the development of internet addiction and the time

on social media exceeding 2 h per day has been demonstrated from the perspective of evidence-based medicine [24–26].

The problem of safe ED use is related to low population awareness of the health risks emerging when using EDs. Only 70% of senior school students, 75% of university students, 80% of parents and teachers adequately estimate or overestimate the risk associated with the ED use. Furthermore, not all of them are aware of the rules for safe use of ED and put these rules into practice [27–31].

The wrong skills of using EDs pose potential health risks. For example, musculoskeletal dysfunction is associated with the prolonged static posture maintained when using smartphones and tablets. The data has been acquired that suggest the relationship between using the ED for two or more hours per day and obesity [32].

Spectral composition of the light emitted by smartphones is recognized as disturbing the process of melatonin secretion, which results in difficulty falling asleep, decreases sleep duration, causes nocturnal awakenings, worsens the overall quality of sleep [33].

Moreover, the light emitted by the ED screens alters accommodation, affects pupil diameter and cognitive functions, changes the sleep-wake pattern, and has a potential toxic effect caused by lipofuscin accumulation on the retina [34].

Multiple reports contain the results of studying the effects of electromagnetic waves on the users' health. However, the emergence of new MED models and data transmission technologies (wired, wireless), improvement of the mobile network generations (3G, 4G, 5G), increase in the number of transmitter units, placement of these units in the zone that is most close to users (in educational institutions, residential areas) determine the need for further research focused on the effects of electromagnetic waves emitted by the new-generation EDs on health. Thus, there is currently no consensus on the health effects of 5G mobile network [1, 34].

Assessment of the effects of non-ionizing, non-thermal electromagnetic waves on the body allowed the researchers to draw a conclusion about their effects on the homeostasis, endocrine and reproductive functions, fetal development and embryo survival, sperm quality [1, 35].

The researchers face the challenge of differentiation between the degree of the health effects of electromagnetic fields created by MEDs on the one hand and the nature of the browsed content, conditions and mode of using MED on the other hand [35–36].

The analysis of the characteristics of user's communication with MED (screen time, call duration, evening use) is conducted [37].

The researchers suggest the need for multifactorial analysis of the effects of using MEDs on cognitive performance and the ability to navigate in space as performance indicators of different brain hemispheres [38].

The regulatory and methodological documents that are in force in Russia (p. 3.5.3 of SanPiN 2.4.3648-20) prohibit the use of MEDs for educational purposes [39]. In November 2023, the State Duma accepted amendments to the Federal Law dated 29 December 2012 № 273-FZ “On Education in the Russian Federation” prohibiting the use of mobile phones at school, including during breaks [40]. A similar initiative is being implemented by the Government of Sweden through preparation of the bill on the prohibition of using MEDs by students at school during both lessons and breaks [41].

According to the methodological guidelines on ensuring sanitary and epidemiological requirements in the implementation of educational programs involving the use of e-learning and distance learning technologies approved by the Chief State Sanitary Physician of the Russian Federation on 29 August 2023 (MR

2.4.0330-23), it is recommended to use wired data transmission systems for connection of peripheral devices. It is not recommended to use a wireless data transmission system [42].

CONCLUSION

Thus, the acquired knowledge about the negative effects of electronic devices (EDs) on lifestyle, daily routine, sleep quality,

and health of the younger generation makes it possible to use the data obtained to search for effective preventive measures. These should be considered when developing the individual, group and population prevention programs. A special place in prevention programs should be given to hygienic training of the youth aimed at developing the beliefs and skills of safe ED use that are so in demand in the leisure and professional activities of modern humans.

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ESTIMATION AND ANALYSIS OF SMOKING, THE HARMFUL HABIT OF MEDICAL STUDENTS

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In modern society, smoking is one of the most common harmful habits. The issue of smoking among medical students and the ways to address it are particularly relevant. The study was aimed to identify the priority factors contributing to smoking as the main harmful habit. We performed a cross-sectional study of 254 students using the tailored questionnaire, D. Horn test, and Fagerstrom test. The data obtained were processed and analyzed using the mathematical statistics methods. The findings have shown that 68.4% of students are smokers. The majority of students report negative health effects of smoking: 45% of students complain of cough, 38% complain of mucus, 52% complain of the decrease in physical endurance. Furthermore, low motivation for smoking cessation has been revealed in the majority of respondents. Vaping turned out to be the smoking type most popular among students, and the majority of respondents believe that it is harmless. The identified predominant types of smoking behavior ("support", "craving") suggest emotional stress. The correlation between the students' anxious emotional state and the frequency of smoking has been found ($r = 0.79$). Learning problems and emotional stress are the priority factors contributing to smoking as the main harmful habit of students. Thus, the issue of smoking should be considered both in medical-biological and socio-psychological aspects. It is important to shape health-saving behavior in students through hygienic training and education.

Keywords: smoking, health, students, electronic cigarettes, healthy lifestyle, prevention

Author contribution: the authors made equal contributions to preparation of paper.

Compliance with ethical standards: the study was compliant with the principles of biomedical ethics. The written informed consent was obtained from all study participants.

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ОЦЕНКА И АНАЛИЗ КУРЕНИЯ — ВРЕДНОЙ ПРИВЫЧКИ СТУДЕНТОВ МЕДИЦИНСКОГО ВУЗА

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В современном обществе курение является одной из наиболее распространенных вредных привычек. Особенно актуальны проблема курения среди студентов медицинского вуза и пути ее решения. Целью исследования было выявить приоритетные факторы, способствующие формированию курения как основной вредной привычки. Проведено одномоментное исследование 254 учащихся с применением специально разработанной анкеты, анкеты Д. Хорна и теста Фагерстрема. Полученный материал обработали и проанализировали, применив методы математической статистики. Результаты исследования показали, что курят 68,4% учащихся. Большинство студентов отмечают отрицательное влияние курения на здоровье: 45% студентов жалуются на кашель, 38% — на мокроту, 52% — на ухудшение физической выносливости. При этом у большинства респондентов выявлен низкий уровень мотивации к отказу от курения. Самым популярным среди студентов видом курения оказался вейпинг, при этом большинство опрошенных считают его безвредным. Выявленные преобладающие типы курительного поведения («поддержка», «жажда») свидетельствуют об эмоциональном напряжении. Обнаружена корреляционная связь между тревожным эмоциональным состоянием учащихся и частотой курения сигарет ($r = 0,79$). Приоритетными факторами, способствующими формированию курения как основной вредной привычки студентов, являются проблемы с учебной и эмоциональное напряжение. Таким образом, рассматривать проблему курения необходимо как в медико-биологическом, так и в социально-психологическом аспекте. Важно формировать у студентов здоровьесберегающее поведение посредством гигиенического обучения и воспитания.

Ключевые слова: курение, здоровье, студенты, электронные сигареты, здоровый образ жизни, профилактика

Вклад авторов: все авторы сделали эквивалентный вклад в подготовку публикации.

Соблюдение этических стандартов: проведенное исследование соответствовало требованиям биомедицинской этики. Письменное добровольное информированное согласие было получено от каждого участника исследования.

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Speaking of healthy lifestyle as a societal norm, Vladimir Putin, the President of the Russian Federation, emphasized that health should be the center of the healthcare system. At the same time, insufficient knowledge about the healthy lifestyle can lead to the spread of harmful habits, causing irreparable harm to health. Smoking remains a harmful habit that is most prevalent among students. Sociologists note that almost every second young adult in Russia smokes. The age of nicotine use initiation is 14.2 years in males and 14.6 years in females [1]. About 68% of adolescents have tried smoking at least once. There is a steady upward trend of the number of smoking students from the first year to the last one. Males twice more often become smokers, than females [1–6].

Not only the number of smokers, but also the rate of smoking-related diseases grows every year. The highly toxic, carcinogenic tobacco smoke increases the risk of the diseases affecting all organs and systems of the human body, determining the extraordinary damage of using tobacco products [7–10].

The use of e-cigarettes, vapes becomes more and more popular among the youth, which raises concerns of various healthcare system structures and the public due to potential harmful health effects. Many young adults believe that vaping is less harmful than conventional cigarette smoking, as well as more fashionable and socially acceptable. However, e-cigarettes have a more prominent negative effect on the health status than

conventional cigarettes. The sequelae of using e-cigarettes, vapes are still poorly understood. However, we know that a couple of cigarettes contains more than 30 harmful substances, including diacetyl causing the deadly “popcorn lung”. More than 70% flavorings for vapes contain diacetyl. Bronchiolitis obliterans resulting in the scar formation and narrowing of bronchioli is developed after inhaling this substance with fruity smell. The other toxic substance contained in the vaping fluid, propylene glycol, has cumulative properties. It causes allergy, impairs the kidney and liver function. When heated, propylene glycol and glycerin yield acrolein and formaldehyde having irritant, allergenic, mutagenic and carcinogenic properties. The vape flavorings also cause allergic diseases of the upper respiratory tract and bronchial asthma.

The researchers have not yet managed to substantiate the harm of vaping to human health. Some authors argue that vaping has a harmful effect on the body [11], the other, in contrast, report weaker effects on the body compared to tobacco smoking [12, 13]. The lack of rationale for harmful effects of vaping can result in psychological vape addiction that is developed extremely fast by the youth.

The prevalence of smoking among students, popularity of using e-cigarettes, vapes, and hookahs, especially among future doctors, constitute a serious medical and social problem. Young adults fail to consider the consequences of smoking, which, in turn, dictates the need for hygienic training and education, promotion of health-saving behavior [14–17].

Education of the negative attitude to smoking, shaping healthy lifestyle in students are priority components of the system of education in the medical university and an important direction of professional training of physicians, whose responsibilities include preventive work with the population, particularly prevention of deviant behavior among young adults [18–23].

Smoking is a harmful habit, which can and should be influenced as early as possible, in young adulthood, since smoking cessation can reduce the risk of a number of serious medical conditions.

The study was aimed to identify the priority factors contributing to smoking as the main harmful habit of students.

METHODS

The cross-sectional study performed in the fall semester (November 2023) involved students of the Burdenko Voronezh State Medical University. A total of 254 people were enrolled (151 females and 103 males). We performed anonymous polling of the 2nd-year medical students, whose average age was 19.1 ± 0.3 years. The tailored questionnaire contained questions regarding motivation for smoking, frequency of using cigarettes, knowledge about harmful effects of smoking. The D. Horn test was used to determine the type of the students' smoking behavior (“stimulus”, “fiddle”, “relaxation”, “support”, “craving” or “reflex”). The Fagerstrom test was used to estimate the nicotine addiction degree.

To determine prioritisation and gender-related differences in smoking, the group of students was divided into two samples (males and females). The required sample size had not been previously defined.

The data acquired were processed and analyzed using the mathematical statistics methods. Statistical analysis of the results was performed using the MyOffice 2022 software package (New Cloud Technologies; Russia). Comparison of sample means was performed using the Student's *t*-test for independent samples with subsequent determination

of statistical significance (*p*-value). The correlation was considered to be significant at $p \leq 0.05$. The correlation between the respondents' psychophysiological indicators and the prevalence of smoking was determined using the Pearson correlation coefficient (*r*).

RESULTS

The results of anonymous polling have shown that 68.4% of surveyed students smoke, among them 78.4% smoke regularly. Furthermore, at the time of the questionnaire survey, the number of cigarettes consumed by one respondent was 12.3 ± 0.4 cigarettes per day, while a year ago the students consumed on average 10.3 ± 0.4 cigarettes per day, i.e. the smoking intensity increased by their 2nd year.

The age of smoking initiation in students was 13 ± 1.2 years. The students started smoking due to the following reasons: “friends were smokers” — 21%, “to cope with stress/due to learning problems” — 73%, “to look older” — 17%, “out of curiosity” — 12%.

The prevalence of smoking was 71% in male students and 59% in female students.

The analysis of the students' health status subjective assessment has shown that students who smoke more often complain of cough (45.2%), mucus (38.3%), vertigo (33.8%), fatigue (12.3%). The majority of students (87.5%) have noted that in general smoking has a negative impact on their health.

Students believe that the most significant negative health effects of smoking are as follows: the decrease in physical endurance that also manifests itself when participating in sports, dancing (52.5%); slower recovery after exercise and aesthetic defects (yellow teeth and skin) (68.1%). Shortness of breath and chest pain following physical exertion have been reported in 76.5% of students who smoke.

Today, vaping becomes more and more popular among students. The questionnaire survey results have shown that 78.3% of students who smoke use vapes, and only 16.3% note that this smoking type presents a health risk. However, e-cigarettes have a more prominent negative health effect than conventional cigarettes [11]. According to the findings, 83.7% of respondents believe that vapes are less harmful than conventional cigarettes. The main factors contributing to the increase in the prevalence of vaping among students are as follows: possibility of smoking indoors, no tobacco smell, lower consumption of conventional cigarettes, fashion.

Furthermore, hookah smoking has become widespread among students, which can be considered as one of the conditions contributing to shaping harmful habits. According to the study results, about 36% of surveyed students smoke hookah, but the smoking rates of males and females are different. Regular hookah smoking means inhaling significantly more smoke compared to the cigarette smoking. The surveyed students' opinion about the issue is incorrect. They believe that hookah is less dangerous than cigarettes and that it is easy to stop smoking hookah.

The reasons why young adults smoke hookah vary. They mostly smoke for fun (57.1%), to relax (74.3%) or simply out of curiosity (12.5 %) and for company (18.2%).

The survey of students who smoke made it possible to determine their smoking behavior type. The study revealed several types of smoking behavior. The “stimulus” type was found in 19.1% of surveyed students. Smokers with this type had a high degree of psychological addiction to cigarettes. The second type (“fiddle”), when a person smoked very little, for company, in social situations, was found in about 8.7%

of respondents. The “relaxation” type was typical for about 13.8% of surveyed students. About 53.5% demonstrated the “support” type associated with the situations of anxiety, emotional stress, feeling uncomfortable. They smoked to stop the rage, overcome shyness, gather the courage, sort things out. Young adults view smoking as a means for reducing emotional stress. The “craving” type is found in 3.6% of respondents. This smoking type is associated with physical addiction to tobacco. About 1.3% of surveyed students are not aware of the reasons for their smoking and often do not notice the fact of smoking. The sixth type, “reflex”, is typical for these students.

The “support” smoking behavior is typical for more than a half of surveyed males and females. Furthermore, the “fiddle” and “relaxation” behavior is reported in girls, while the “craving” and “stimulus” types are reported in boys.

Determination of the degree of nicotine addiction among students who smoked revealed medium degree of nicotine addiction in 27.2% of respondents; 61.6% had low degree and 11.3% of students had high degree of nicotine addiction. The highest degree of nicotine addiction was reported in males. The students having a high degree of nicotine addiction noted increased irritability, absent-mindedness, general apathy during the long breaks between using cigarettes.

The students' nicotine addiction was significantly correlated to the age of smoking initiation. Furthermore, the younger was the age of smoking initiation, the stronger was the nicotine addiction ($r = 0.63$).

Moreover, we found a correlation between the students' anxious emotional state and the frequency of smoking cigarettes ($r = 0.79$).

The Fagerstrom test results showed low motivation for smoking cessation in 80.4% of students.

DISCUSSION

The findings are consistent with the results reported by other researchers. Thus, a number of researchers highlight smoking among young adults as a risk factor of pulmonary and cardiovascular disorders, attaching great importance to prevention of the spread of smoking across students and to the overall health culture [18, 21]. The other researchers note that it is necessary to carry out information and preventive work, talking about the dangers of smoking, provide support and assistance to those who want to get rid of this habit, as well as to create conditions for a healthy lifestyle and prevention of nicotine addiction in order to reduce harmful effects of smoking on medical students [8, 17, 19].

According to the results of selective social surveys, the prevalence of smoking among schoolchildren is 20–40%. The prevalence of smoking in Russia varies depending on the region [6, 22].

It has been shown that noncompliance with a healthy lifestyle, tobacco smoking contribute to the increase in young adult morbidity and determine the need to search for new ways to address the issue [23].

According to a number of researchers, the factors contributing to involvement in smoking include communication with smokers, low hygienic culture, lack of desire for learning

and poor academic success, personality and psychological traits, insufficient awareness of the effects of smoking, poor financial situation. Women's smoking differs from men's smoking in that it is less intense, has a later onset, and is more influenced by the degree of financial security [2].

Vaping has become extremely popular among young adults. Respondents believe that the main reason is that this type of smoking is harmless. However, e-cigarettes, vaping can have a more harmful effect on the body, which is confirmed by the data provided by the Center for Hygienic Education of the Population of Rospotrebnadzor.

CONCLUSIONS

Smoking is a significant risk factor for the health of student youth. The results of the study show that smoking as a harmful habit is found in 68.4% of students. The majority of students note that in general smoking adversely affects their health, 45% complain of cough, 38% of mucus, 52% report decreased physical endurance. However, low motivation for smoking cessation is reported in 80.4% of respondents.

The most popular type of smoking has been determined, which is vaping (78.4% of students who smoke; the majority of them believe that this smoking type is harmless). High degree of nicotine addiction has been revealed in 11.3% of respondents, and the degree is significantly correlated to the age of smoking initiation ($r = 0.63$).

It has been found that stress and learning problems represent the common causes of smoking initiation (73%). We have revealed a correlation between the students' anxious emotional state and the frequency of smoking cigarettes ($r = 0.79$). The identified predominant types of smoking behavior (“support”, “craving”) indicate the students' emotional stress and maladaptation.

The priority factors contributing to smoking as a harmful habit include learning problems and emotional stress.

Thus, the issue of smoking should be considered both in medical-biological and socio-psychological aspects. Quitting harmful habits and taking care of health should become parts of the young specialist's image, qualitative characteristics of any professional, especially the future physicians. It is necessary to create an education and training system for physicians and students in terms of combating nicotine addiction and other harmful habits, form a proactive approach to the issue.

The amount of work on medical prevention, hygienic education, training and formation of a healthy lifestyle among young adults in educational organizations needs to be increased. The hygienic training of students should be organized considering the existing risk factors.

Conducting debates, competitions, seminars, festivals, clubs, scientific and educational student events of various formats, discussion and dialogue, support and mutual understanding represent the important aspects of shaping a professional worldview of the physician, who will take care about his/her own health and the health of patients. It is necessary to introduce specialized health-preserving and health-shaping courses at all levels of professional medical education.

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COMPARATIVE ANALYSIS OF THE CYTOGENETIC STATUS OF PREGNANT WOMEN RESIDING IN THE TERRITORIES OF RADIOACTIVE, CHEMICAL AND COMBINED CONTAMINATION

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Anthropogenic impact on the biosphere has become one of the major factors dictating the conditions of our existence on the Earth. The study was aimed to perform comparative analysis of the rate of cytogenetic alterations, indicators of proliferation and destruction of the nucleus in the vaginal epithelium reflecting the reproductive health status of pregnant women aged 26–33 years living in conditions of radioactive, chemical and combined contamination of the territories of Bryansk Region. Cytogenetic status of 80 pregnant women divided into four groups, 20 individuals per group, was assessed using the micronucleus test. The rate of cytogenetic alterations, indicators of proliferation and destruction of the nucleus in the vaginal epithelium of pregnant women living in the environmentally disadvantaged territories was 1.9–4.9 times higher ($p < 0.001$) compared to that in women living in the environmentally safe (control) districts. The combined effects of radioactive and chemical contamination resulted in the significantly higher rate (increase from 12.8 to 81.4%) of cells with micronuclei, nuclear protrusions, binucleated cells, as well as cells with karyopyknosis and karyolysis compared to the effect of only one pollution factor. The findings are likely to show synergy of the effects of radiation and chemical factors on the cytogenetic status of pregnant women.

Keywords: pregnant women, cytogenetic alterations, vaginal epithelium, micronucleus test, chemical pollution, radioactive contamination, combined contamination, Chernobyl disaster, Bryansk region

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Compliance with ethical standards: the informed consent to collection of biomaterial during screening and clinical data processing was obtained from all patients.

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СРАВНИТЕЛЬНЫЙ АНАЛИЗ ЦИТОГЕНЕТИЧЕСКОГО СТАТУСА БЕРЕМЕННЫХ ЖЕНЩИН, ПРОЖИВАЮЩИХ НА ТЕРРИТОРИЯХ РАДИАЦИОННОГО, ХИМИЧЕСКОГО И СОЧЕТАННОГО ЗАГРЯЗНЕНИЯ

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Техногенное загрязнение биосферы различной природы стало одним из значимых факторов, диктующим нам условия существования на Земле. Целью настоящего исследования было провести сравнительный анализ частоты цитогенетических нарушений, показателей пролиферации и деструкции ядра во влагалищном эпителии, отражающий состояние репродуктивного здоровья беременных женщин 26–33 лет, проживающих в условиях радиационного, химического и сочетанного загрязнения территорий Брянской области. Цитогенетический статус 80 беременных женщин, разделенных на четыре группы по 20 человек, исследовали с помощью микроядерного теста. Частота цитогенетических нарушений, показателей пролиферации и деструкции ядра во влагалищном эпителии беременных женщин, проживающих на экологически неблагоприятных территориях, в 1,9–4,9 раза выше ($p < 0,001$), чем у проживающих в экологически благополучных (контрольных) районах. Сочетанное влияние радиоактивного и химического загрязнения стало причиной значимо высокой частоты (увеличение с 12,8 до 81,4%) клеток с микроядрами, протрузий, двуядерных клеток, клеток с двойным ядром, а также клеток с кариопикнозом и кариолизисом у беременных женщин по сравнению с влиянием только одного фактора загрязнения. Полученные результаты, по всей вероятности, указывают на синергетический характер действия радиационного и химического факторов на цитогенетический статус беременных женщин.

Ключевые слова: беременные женщины, цитогенетические нарушения, влагалищный эпителий, микроядерный тест, химическое загрязнение, радиоактивное загрязнение, сочетанное загрязнение, Чернобыльская катастрофа, Брянская область

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Соблюдение этических стандартов: информированное добровольное согласие на взятие биоматериала в процессе скрининга и обработку клинических данных было получено от каждой пациентки.

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Numerous pollutants of various nature constantly worsen the environmental situation, causing irreparable harm to public health [1–3].

Anthropogenic impact on the biosphere has become one of the major factors dictating the conditions of our existence on the Earth. Serious radiation accidents and disasters of the late 20th and early 21st centuries (Kyshtym, Windscale, Leningrad, Three Mile Island, Saint-Laurent-des-Eaux, Chernobyl, Fukushima) brought large amounts of anthropogenic radionuclides into the biosphere [3, 4–6].

As a result of the Chernobyl disaster that happened 37 years ago, large territories, where more than 5 million people lived, were contaminated [5]. The radioactive contamination density to the greater extent determined by cesium-137 (¹³⁷Cs) and strontium-90 (⁹⁰Sr) will remain radiologically significant for many decades [7].

Today, 309,000 people reside in the radioactively contaminated territories of the Bryansk region [8].

Radioecological monitoring of the Bryansk Region shows that the density of soil contamination with ¹³⁷Cs and ⁹⁰Sr in the South–Western territories (SWT) exceeds the permissible exposure limits (criteria for classifying territories as radioactively contaminated areas) [9], and the cumulative effective radiation doses of the population vary from several mSv to hundreds of mSv 37 years after the accident [10].

The environmental situation in the Bryansk region is also complicated by chemical pollution of the environment due to the work of industrial enterprises and the growing number of vehicles. According to official figures, in recent years, an increase in emissions of air pollutants, mostly of carbon monoxide (CO) and volatile organic compounds (VOCs) has been reported in the Bryansk region [11]. Such environmental situation causes deterioration of public health and makes the issue of environmental pollution a priority for the healthcare system of the region. Furthermore, it is important to note that in some territories of the Bryansk Region population is exposed to the combined effects of radioactive and chemical pollution, which leads to the massive increase in morbidity rate [12].

The described unfavorable environmental conditions in the Bryansk Region lead to the increase in the number of mutagenic factors. These can pose a real threat reflected in the increase of the population burden and the changing rate of mutation [13]. It was found that the index of cytogenetic alteration in residents of large cities is 2.0–2.4 times higher than that in rural population [14], however, pregnant women still represent the group that is most susceptible to the effects of adverse environmental factors [15–19]. According to the literature data, air pollutants (phenol, formaldehyde, heavy metals) [15–18], radioactive contamination [19, 20] not only lead to the increase in the incidence of various somatic disorders among pregnant women and worse pregnancy course, but also can cause embryo- and fetotoxicity.

The micronucleus test, that has proven itself as a reliable and simple instrument for assessment of cytogenetic disorders, has been long used for cytogenetic monitoring [21, 22]. This is explained by the fact that the method represents a universal biomarker that is reliable in terms of measuring genotoxic, mutagenic, and teratogenic environmental factors [21–23]. The capabilities of the micronucleus test can be used much more widely, since these allow one to assess not only micronuclei, but also the broad spectrum of the nucleus conditions in the exfoliative cells based on the cytogenetic alterations, indicators of proliferation and destruction of the nucleus [23, 24].

Thus, the study of the cytogenetic status of pregnant women living in the territories with various levels of radioactive

and chemical contamination of the environment is very important not only for theoretical hygiene of the environment and medical ecology, but also for practical healthcare.

The study was aimed to perform comparative analysis of the rate of cytogenetic alterations, indicators of proliferation and destruction of the nucleus in the vaginal epithelium of pregnant women living in the conditions of radioactive, chemical and combined contamination in the territories of the Bryansk Region.

METHODS

Cytogenetic status of pregnant women was assessed using the micronucleus test [21–25] applied to the vaginal epithelial cells at the Bryansk City Hospital No. 1 between August and November 2023.

The study involved three groups of pregnant women living in various environmental conditions (in the territories of chemical, radioactive, and combined contamination) and the control group (women living in the ecologically safe territories). A total of 20 women aged 26–33 years with the same gestational age (27–33 weeks) and with no chronic somatic disorders or complications of pregnancy were included in each group. The non-inclusion criteria were as follows: pregnant woman's age over 35 years, various complications of pregnancy. A total of 80 women were surveyed.

The vaginal epithelium samples were obtained using the Cervex-Brush cell sampling device (Simurg; Russia) and placed in the test tube filled with specific medium, and the buccal epithelium samples were obtained using the sterile wooden spatula and applied to the slide; these were fixed in air for 2 min. The cytological vaginal epithelium preparations were produced by precipitation. All the preparations were subjected to Quik staining. The samples containing at least 2500–3000 cells were selected for analysis. Data calculation was performed per 1000 cells (the final results were expressed in ppm, ‰). A total of about 220,000 cells were assessed. Microscopy examination was performed using the Nikon Eclipse light microscope (Nikon; Japan) with 1000× magnification.

The smears were used to count cytogenetic alterations (cells with micronuclei and nuclear protrusions of various types; indicators of proliferation (binucleate cells, cells with a double nucleus, cells with more than two nuclei); indicators of destruction of the nucleus (cells with karyopyknosis, karyorrhexis and karyolysis) [23–25].

The districts and towns of the Bryansk Region were divided into four groups based on the levels of chemical and radioactive contamination. The group of environmentally safe territories included Karachevsky, Navlinsky, Kletnyansky, and Dubrovsky districts, while the group of chemically contaminated territories included the city of Bryansk and the town of Dyatkovo. The group of radioactively contaminated territories consisted of Krasnogorsky and Zlynkovsky districts, while the territories with combined radioactive and chemical contamination included the town of Novozybkov and the town of Klinty.

The levels of the ⁹⁰Sr and ¹³⁷Cs radioactive contamination of the territories were determined based on the data [9], the average accumulated effective doses — based on the data [26], the levels of chemical contamination — based on the data of the Rostekhnadzor reports on the stationary source emissions 2-TP (air) for the decade (2010–2019) [8]. We identified the main air pollutants: carbon monoxide (CO), nitrogen oxides (NO_x), sulfur dioxide (SO₂), and VOCs (including formaldehyde, benzene, benzo[a]pyrene, styrene, pyridine, vinyl chloride, acrolein, and phenol). Chemical emissions into atmospheric air (tons/year) were recalculated for the area of the district (km²) to be expressed in g/m² [8].

Table 1. Levels of chemical and radioactive contamination of the environment in the studied groups of towns and districts of the Bryansk Region (2010–2019)

№	Towns and districts of Bryansk Region	Major air pollutants					Radioactive contamination density, kBq/m ²	
		Total	Of those:				¹³⁷ Cs	⁹⁰ Sr
			VOCs	NO _x	SO ₂	CO		
Gross gaseous pollutant emissions per area of the district, g/m ²								
Environmentally safe territories (control)								
1	Dubrovsky District	45	12	8	1	24	6.4	0.4
	Navliinsky District	57	26	7	1	23	16.7	1.2
	Kletnyansky District	68	51	4	2	11	4.7	0.4
	Karachevsky District	122	44	25	0	53	12.3	0.7
	Mean value	73	33	44	1	27.8	10	0.7
Chemically contaminated territories								
2	Dyatkovsky District	6553	365	3809	198	2181	34	1
	City of Bryansk	30462	7671	8230	2019	12542	7.8	5.2
	Mean value	18508	4018	6020	1109	7362	20.9	3.1
Radioactively contaminated territories								
3	Krasnogorsky District	13	2	3	1	7	268.7	8.2
	Zlynkovsky District	16	6	3	0	7	365.3	14.3
	Mean value	14.5	4	3	0.5	7	317	11.3
Territories with combined radioactive and chemical contamination								
4	Town of Novozybkov	281	94	33	0	154	404.3	8.6
	Town of Klintsty	441	151	133	7	150	173.3	2.6
	Mean value	361	123	83	3.5	152	288.8	5.6

Statistical analysis of the data obtained was performed using the MyOffice software package (New Cloud Technologies; Russia). The sample mean (M) and standard error of the mean were used (m). The data distribution was tested for normality using the Shapiro–Wilk test. It was found that in the majority of cases the distribution of the indicators of cytogenetic alterations, proliferation, and destruction of the nucleus was non-normal, so the Mann–Whitney U test was used to verify statistical significance of differences; the differences were considered significant at $p < 0.001 - p < 0.05$.

RESULTS

The levels of air pollution with CO, SO₂, NO_x and VOCs in four groups of districts differ by hundreds and even thousands of times (Table 1). In the environmentally safe territories, the maximum gross gaseous pollutant emission value per area of the district (g/m²) is 122 g/m², while in the chemically contaminated territories, the total emission value reaches its maximum — 30,462 g/m². In the radioactively contaminated territories, the total gaseous pollutant emission value is extremely low — 13–16 g/m². In the territories with combined contamination, the gaseous pollutant emission value is 281–441 g/m², which is 22–27 times higher compared to the values reported for the radioactively contaminated districts (Table 1).

The levels of CO pollution in the chemically contaminated territories vary between 2181 and 12,542 g/m², the levels of SO₂ pollution vary between 198 and 2019 g/m², the levels of NO_x are 3809–8230 g/m², and the levels of VOC pollution are 365–7671 g/m². In the radioactively contaminated territories, the values are minimal and show minor fluctuation — from 0 for SO₂ to 7 g/m² for CO, while in the territories with combined contamination, the values vary between 0 for SO₂ and 154 g/m² for CO; in the control districts these vary between 0 and 53 g/m² (Table 1).

The ¹³⁷Cs radioactive contamination density in the environmentally safe districts varies between 4.7 and 16.7 kBq/m², while in the chemically contaminated territories it varies between 7.8 and 34.0 kBq/m². In the radioactively contaminated territories, the average ¹³⁷Cs contamination density is 31.7 times higher than in the safe territories (317.0 and 10.0 kBq/m²) and 15.2 higher than in the chemically contaminated territories (317.0 and 20.9 kBq/m²), which exceeds the permissible values being the criteria for classifying territories as radioactively contaminated areas (37.0 kBq/m²) [9]. In the territories with combined contamination, the average ¹³⁷Cs contamination level is 288.8 kBq/m², which is slightly lower compared to the values of the radioactively contaminated territories (–8,9%), but 28.8-fold exceeds the values of the control districts and 13.8-fold exceeds the values of the chemically contaminated ones (Table 1).

The ⁹⁰Sr radioactive contamination density in the towns and districts of the Bryansk Region varies between 0.4 and 14.3 kBq/m² to reach its maximum in the radioactively contaminated territories (14.3 kBq/m²) and territories with combined contamination (8.6 kBq/m²), which exceeds the permissible values (5.6 kBq/m²) [9] (Table 1).

The values of the average annual effective dose (AAED90) from the Chernobyl component in the group of environmentally safe and chemically contaminated territories do not exceed 0.1 mSv per year, while in the group of territories with radioactive and combined contamination AAED90 is on average 1.1 mSv per year [26].

Table 2 provides comparative analysis of the cytogenetic alterations, indicators of proliferation and destruction of the nucleus in the vaginal epithelium of pregnant women aged 28–33 years living in various environmental conditions (chemical, radioactive, and combined contamination of the environment) and in the environmentally safe territories. The Figure presents microphotographs of the cytogenetic alterations, indicators

Table 2. Comparative analysis of the cytogenetic alterations, indicators of proliferation and destruction of the nucleus in the vaginal epithelium of pregnant women aged 28–33 years living in various environmental conditions (per 1000 cells, ‰)

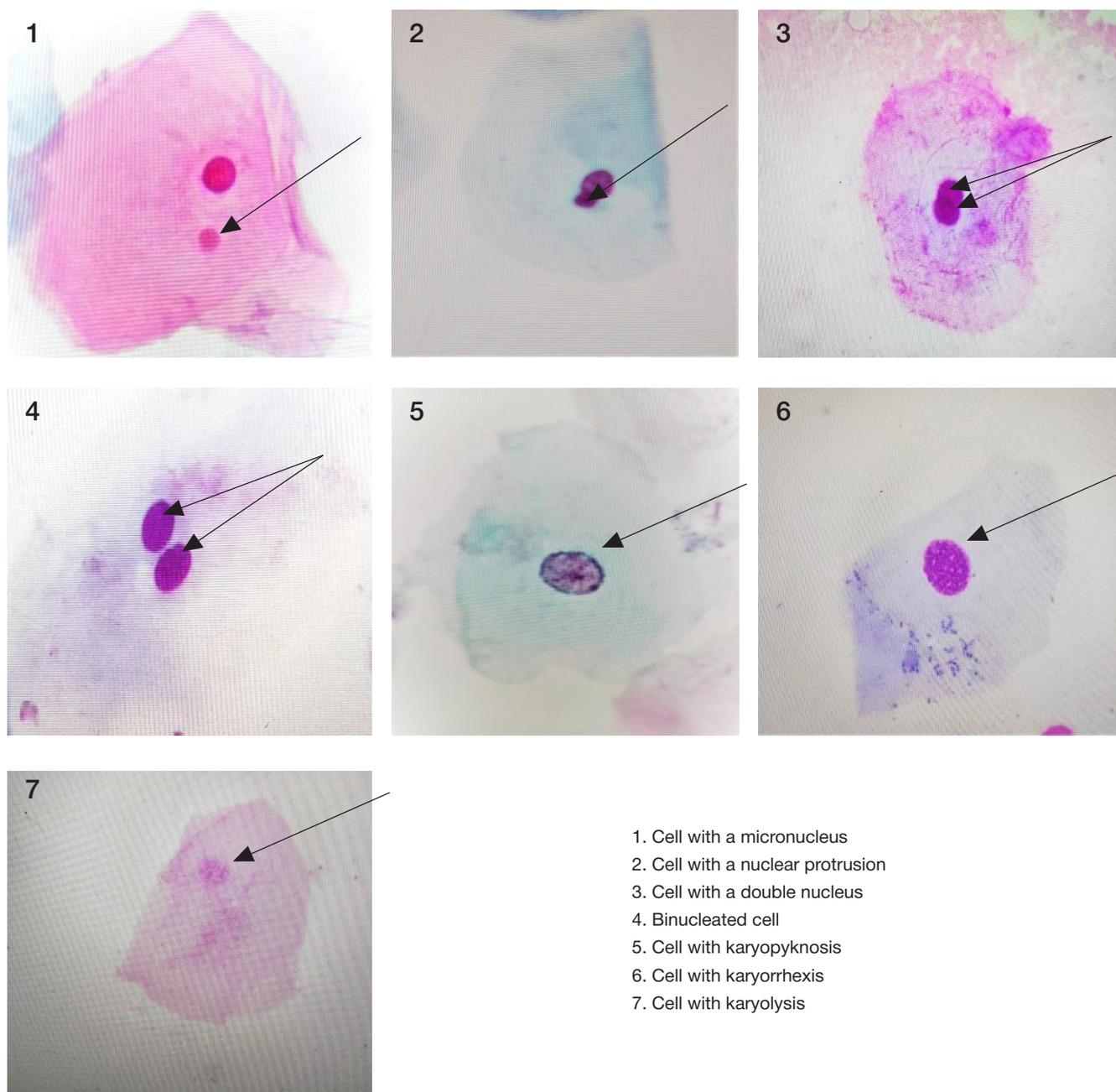
Studied indicator of the vaginal epithelium, ‰	Studied territories	Environmentally safe territories (control)	Chemically contaminated territories	Radioactively contaminated territories	Territories with combined contamination	Significance of intergroup differences based on the Mann–Whitney U test: p_1 (I–II), p_2 (I–III), p_3 (I–IV), p_4 (II–III), p_5 (II–IV), p_6 (III–IV).
		I (n = 20)	II (n = 20)	III (n = 20)	IV (n = 20)	
Cytogenetic alterations						
Cells with micronuclei		1.6 ± 0.15	5.9 ± 0.31	6.8 ± 0.35	7.9 ± 0.32	$p_1^{***}; p_2^{***}; p_3^{***}; p_4^{n/d}; p_5^{***}; p_6^*$
Various types of nuclear protrusions		3.8 ± 0.27	6.9 ± 0.33	8.8 ± 0.44	10.6 ± 0.43	$p_1^{***}; p_2^{***}; p_3^{***}; p_4^{**}; p_5^{***}; p_6^{**}$
Indicators of proliferation						
Binucleated cells		1.2 ± 0.22	2.7 ± 0.22	3.5 ± 0.25	4.9 ± 0.43	$p_1^{***}; p_2^{***}; p_3^{***}; p_4^*; p_5^{***}; p_6^*$
Cells with a double nucleus		0.9 ± 0.16	2.1 ± 0.22	2.4 ± 0.28	3.2 ± 0.21	$p_1^{***}; p_2^{***}; p_3^{***}; p_4^{n/d}; p_5^{**}; p_6^*$
Cells with two or more nuclei		0.4 ± 0.13	0.9 ± 0.20	1.1 ± 0.20	1.5 ± 0.24	$p_1^{n/d}; p_2^{**}; p_3^{***}; p_4^{n/d}; p_5^{n/d}; p_6^{n/d}$
Indicators of destruction of the nucleus						
Karyopyknosis		3.6 ± 0.35	6.4 ± 0.37	7.9 ± 0.33	9.9 ± 0.34	$p_1^{***}; p_2^{***}; p_3^{***}; p_4^{**}; p_5^{***}; p_6^{***}$
Karyorrhexis		4.8 ± 0.41	6.4 ± 0.30	7.7 ± 0.36	8.4 ± 0.29	$p_1^{**}; p_2^{***}; p_3^{***}; p_4^*; p_5^{***}; p_6^{n/d}$
Karyolysis		4.5 ± 0.32	7.8 ± 0.35	9.4 ± 0.27	10.6 ± 0.48	$p_1^{***}; p_2^{***}; p_3^{***}; p_4^{**}; p_5^{***}; p_6^*$

Note: * — the differences are considered significant at $p < 0.05$; ** — the differences are considered significant at $p < 0.01$; *** — the differences are considered significant at $p < 0.001$; n/d — the differences are considered non-significant at $p > 0.05$.

of proliferation and destruction of the nucleus in the vaginal epithelium of pregnant women aged 28–33 years.

The analysis of data provided in Table 2 has shown that the rate of cytogenetic alterations based on the number of cells with micronuclei and various types of nuclear protrusions in the vaginal epithelium is significantly increased ($p < 0.001$) in the environmentally disadvantaged territories compared to environmentally safe ones. Thus, the number of cells with micronuclei and nuclear protrusions of various types in the environmentally safe territories (control) is $1.6 \pm 0.15\%$ and $3.8 \pm 0.27\%$, in the group of chemically contaminated territories it is 3.7 and 1.9 times higher ($5.9 \pm 0.31\%$ and $6.9 \pm 0.33\%$), in the group of radioactively contaminated territories it is 4.3 and 2.3 times higher ($6.8 \pm 0.35\%$ and $8.8 \pm 0.44\%$), and in the group of territories with combined contamination the indicators are increased 4.9- and 2.8-fold ($7.9 \pm 0.32\%$ and $10.6 \pm 0.43\%$). It should be noted that the combined effects of radioactive and chemical contamination in appropriate districts resulted in the significantly higher rate of cells with micronuclei in pregnant women compared to that reported for the districts, where there was only one pollution factor (chemically contaminated territories: +33.9%, $p < 0.001$; radioactively contaminated territories: +16.2%, $p < 0.05$) (Table 2). The number of cells with various types of nuclear protrusions was also significantly higher in the territories with combined radioactive and chemical contamination (chemically contaminated territories: +53.6%, $p < 0.001$; radioactively contaminated territories: +20.5%, $p < 0.01$). Furthermore, it was found that the number of cells with nuclear protrusions of various types was significantly higher in the radioactively contaminated territories compared to the chemically contaminated territories (+27.5%, $p < 0.01$), while the increase in the rate of cells with micronuclei was non-significant (+15.2%, $p > 0.05$) (Table 2).

The pattern of proliferation indicators is virtually identical to the pattern of the rate of cells with cytogenetic alterations (Table 2). Thus, the rate of binucleated cells and cell with the double nucleus in pregnant women living in the control districts is $1.2 \pm 0.22\%$ and $0.9 \pm 0.16\%$, in the group of chemically contaminated districts it is 2.3 times higher ($2.7 \pm 0.22\%$ and $2.1 \pm 0.22\%$), in the group of radioactively contaminated districts it is 2.9 and 2.7 times higher ($3.5 \pm 0.25\%$ and $2.4 \pm 0.28\%$), and in the group of districts with combined contamination the values are increased 4.1- and 3.6-fold ($4.9 \pm 0.43\%$ and $3.2 \pm 0.21\%$). The combined effects of radioactive and chemical contamination in appropriate territories resulted in the increased rate of binucleated cells relative to the territories, where there was only one pollution factor (chemically contaminated territories: +81.4%, $p < 0.001$; radioactively contaminated territories: +40.0%, $p < 0.05$). The rate of cells with the double nucleus was also significantly higher in the territories with combined contamination (chemically contaminated territories: +52.4%, $p < 0.01$; radioactively contaminated territories: +33.3%, $p < 0.05$). The rate of binucleated cells was significantly higher in the radioactively contaminated territories compared to the chemically contaminated ones (+29.6%, $p < 0.05$), while the increase in the rate of cells with double nuclei was non-significant (+11.4%, $p > 0.05$). Significant differences in the number of cells with two or more nuclei from controls was reported for pregnant women living in the radioactively contaminated districts (+2.8-fold, $p < 0.01$) and districts with combined contamination (+3.8-fold, $p < 0.001$). In other cases no significant patterns were revealed ($p > 0.05$), along with the persistent upward trend of the rate of cells with two or more nuclei in the districts with chemical contamination (+22.5%), radioactive and chemical (+22.2%), radioactive and combined (+36.3%), chemical and combined (+66.7%)



1. Cell with a micronucleus
2. Cell with a nuclear protrusion
3. Cell with a double nucleus
4. Binucleated cell
5. Cell with karyopyknosis
6. Cell with karyorrhexis
7. Cell with karyolysis

Fig. Microphotographs of the cytogenetic alterations, indicators of proliferation and destruction of the nucleus in the vaginal epithelium of pregnant women aged 28–33 years (Quik stain, 1000× magnification)

contamination relative to the environmentally safe districts (Table 2).

The indicators of destruction of the nucleus fully reflect the overall patterns of the rate of cytogenetic alterations and the indicators of proliferation (Table 2). The rates of cells with karyopyknosis, karyorrhexis and karyolysis in the environmentally safe areas are $3.6 \pm 0.35\%$, $4.8 \pm 0.41\%$ and $4.5 \pm 0.32\%$, in the group of chemically contaminated territories these are 1.8, 1.3 and 1.7 times higher ($6.4 \pm 0.37\%$, $6.4 \pm 0.30\%$ and $7.8 \pm 0.35\%$), in the group of radioactively contaminated territories — these are 2.2, 1.6 and 2.1 times higher ($7.9 \pm 0.35\%$, $7.7 \pm 0.36\%$ and $9.4 \pm 0.27\%$), and in the group of territories with combined contamination the indicators reach their maximum and are increased 2.8-, 1.8- and 2.4-fold ($9.9 \pm 0.34\%$, $8.4 \pm 0.29\%$ and $10.6 \pm 0.48\%$). The combined effects of radioactive and chemical contamination in appropriate districts resulted in the increased rate of cells with karyopyknosis

in pregnant women relative to the districts, where there was only one pollution factor (chemically contaminated territories: +54.7%, $p < 0.001$; radioactively contaminated territories: +25.3%, $p < 0.001$). The number of cells with karyolysis was also significantly higher in the territories with combined contamination (chemically contaminated territories: +35.9%, $p < 0.001$; radioactively contaminated territories: +12.8%, $p < 0.05$). The number of cells with karyorrhexis was significantly higher in the territories with combined contamination compared to the chemically contaminated territories (+31.3%, $p < 0.001$) and higher compared to the radioactively contaminated territories, but the difference was non-significant (+9.1%, $p > 0.05$). It should be noted that the rate of cells with karyopyknosis, karyorrhexis and karyolysis is significantly higher in the radioactively contaminated districts than in the chemically contaminated ones (+23.4%, $p < 0.01$; +20.3%, $p < 0.05$; +20.5%, $p < 0.01$) (Table 2).

DISCUSSION

Comparative analysis of the cytogenetic status of pregnant women living in various environmental conditions revealed similar factor-dependent responses to the studied environmental exposures. The fact, that the studied samples belong to the territories showing many-fold differences in the chemical and radiation load, suggests that the identified differences in cytogenetic alterations, indicators of proliferation and destruction of the nucleus, reflect the effects of the chemical, radiation, and combined environmental factors.

The rate of cells with micronuclei in pregnant women living in the Bryansk Region attracts attention. Since, in accordance with the international data (HUMNxl project), the average rate of cells with micronuclei in controls is 1.1‰ [21], the indicator reported for the territories of the Bryansk Region is increased 1.45-fold relative to the control territories and 5.4–7.2-fold relative to the environmentally disadvantaged territories to reach its maximum in the territories with the combined radioactive and chemical contamination (7.9‰).

Both the differences and similarity of the data obtained by cytogenetic monitoring of exfoliative cells should be noted. Thus, according to [23], the rate of micronuclei in the urothelial, buccal and nasal cells of the control group varies between 0.24 and 0.35‰, which is significantly lower compared to both our results obtained for the control districts of the Bryansk Region (1.6‰) and international standards (1.1‰) [21]. The values of the rate of binucleated cells in the vaginal epithelium of pregnant women living in the control districts we have obtained (1.20‰) are similar to the data on the rate of binucleated cells in the urothelium of the controls (1.21‰) [23], however, the reported number of cells with karyopyknosis and karyolysis [23] is significantly higher compared to our results.

The study [25] showed that the total rate of cells with destruction of the nucleus (karyopyknosis, karyorrhesis and karyolysis) reached its maximum in the puerperas with abnormalities of the fetus living in the conditions of combined radioactive and chemical contamination.

When assessing the data obtained, it is necessary to emphasize the need to implement the complex hygienic monitoring of the environment based on the levels of chemical, radioactive and combined contamination reported over a long period, since the impact of single factors is always summed up and transformed in real-world conditions (the phenomenon of synergy) [12, 24, 25, 27].

In the reported study, the combined effects of radioactive and chemical contamination resulted in the significantly higher rates of cytogenetic alterations, indicators of proliferation and destruction of the nucleus in pregnant women living in the environmentally disadvantaged territories compared to women living in the districts where there was only one pollution factor. The findings are likely to show synergy of the effects of the radiation and chemical factors.

CONCLUSIONS

1. The rates of cytogenetic alterations, indicators of proliferation and destruction of the nucleus in pregnant women living in the environmentally disadvantaged territories are 1.9–4.9 times higher ($p < 0.001$) compared to that in women living in the environmentally safe (control) districts.

2. The number of cells with nuclear protrusions, binucleated cells, cells with karyopyknosis, karyorrhesis and karyolysis is significantly higher in the radioactively contaminated territories compared to the chemically contaminated ones (increase from 20.5 to 29.6%), which suggests the greater effect of the radiation factor resulting from the Chernobyl disaster on the cytogenetic status of pregnant women relative to the chemical factor.

3. The combined effects of radioactive and chemical contamination resulted in the significantly higher rates of cells with micronuclei (increase from 16.2 to 33.9%), nuclear protrusions (increase from 20.5 and 53.6%), binucleated cells (increase from 40.0 to 81.4%), cells with the double nucleus (increase from 33.3 to 52.4%), as well as cells with karyopyknosis (increase from 25.3 to 54.7%) and karyolysis (increase from 12.8 to 35.9%) in pregnant women living in the environmentally disadvantaged territories compared to that in women living in the districts where there was only one pollution factor. The findings are likely to show synergy of the effects of the radiation and chemical factors on the cytogenetic status of pregnant women.

4. In the towns and districts of the Bryansk Region, the average rate of cells with micronuclei in the environmentally safe territories 1.45-fold exceeds the international standards (HUMNxl project) and in environmentally unfavorable areas 5.4–7.2 times, reaching maximum values in the territories of combined radioactive and chemical contamination (7.9‰).

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ASSESSMENT OF PHYSICAL DEVELOPMENT AND LIFESTYLE IN JUNIOR MEDICAL STUDENTS

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Preserving the health of student youth is one of the state's priority tasks. The relevance of the issue results from the students' health deterioration. The study was aimed to assess physical development in students of the medical higher educational institution considering their lifestyle. We performed comparative assessment of physical development in 940 first-year students of the Pacific State Medical University. The source of information was primary medical documentation (form No. 025-CZ/u). Polling was used to assess the students' lifestyle. The CHAID algorithm for decision trees was used in 2021 to estimate the effects of lifestyle on the indicators of physical development in students. It was found that the students' body length decreased over 20 years. The chest circumference of students increased ($p = 0.001$). The right and left hand grip strength decreased ($p < 0.001$). A significant increase in the vital capacity was reported in males only ($p = 0.007$). We revealed the increase in the number of students with disharmonious physical development (by 9.4% in males and 15.3% in females) due to overweight, along with reduction of body weight by 12.5% in males. The risk factors of disharmonious physical development with the highest impact factor in males were as follows: the lack of vegetables in the diet and the use of social media and computer games during free time. In females, the risk factors were as follows: daily consumption of cereals, pasta, and bread and living apart from parents. The findings make it possible to estimate the risk factors of disharmonious physical development and determine the priority directions for the development of preventive measures for preservation of students' health.

Keywords: students, health, physical development, lifestyle, risk factors

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Author contribution: Trankovskaya LV— editing and preparation of the final version of the article; Shestera AA — research procedure, data acquisition, analysis and interpretation; Kaerova EV — study planning and management; Nagirnaya LN — manuscript draft writing.

Compliance with ethical standards the study was performed in accordance with the Declaration of Helsinki of the World Medical Association and approved by the interdisciplinary Ethics Committee of the Pacific State Medical University (protocol № 7 dated 27 March 2023). All subject submitted the informed consent to participation in the study.

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ОЦЕНКА ФИЗИЧЕСКОГО РАЗВИТИЯ И ОБРАЗА ЖИЗНИ СТУДЕНТОВ МЛАДШИХ КУРСОВ МЕДИЦИНСКОГО ВУЗА

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Сохранение здоровья студенческой молодежи является одной из приоритетных задач государства. Актуальность этой проблемы обусловлена ухудшением состояния здоровья студентов. Целью исследования было оценить физическое развитие обучающихся в образовательной организации высшего образования медицинской направленности с учетом их образа жизни. Проведена сравнительная оценка физического развития 940 студентов 1-го курса ФГБОУ ВО ТГМУ Минздрава России. Источником информации послужила первичная медицинская документация (форма № 025-Ц(З/у)). Методом опроса был изучен образ жизни учащихся. Для исследования влияния образа жизни на показатели физического развития студентов в 2021 г. использовали метод построения деревьев классификации (CHAID). Установлено, что за 20 лет произошло уменьшение длины тела студентов. Размеры окружности грудной клетки учащихся увеличились ($p = 0,001$). Сила правой и левой кистей уменьшилась ($p < 0,001$). Жизненная емкость легких значительно увеличилась лишь у юношей ($p = 0,007$). Выявлены увеличение числа студентов с дисгармоничным физическим развитием (у юношей на 9,4%, у девушек на 15,3%) за счет избыточной массы тела и снижение массы тела у юношей на 12,5%. Факторами риска дисгармоничного физического развития с наибольшим индексом влияния у юношей стали недостаток овощей в рационе и использование социальных сетей и компьютерных игр в свободное от учебы время. У девушек такими факторами стали ежедневное включение в рацион круп, макаронных изделий, хлеба и проживание отдельно от родителей. Полученные данные позволяют оценить факторы риска дисгармоничного физического развития и определить приоритетные направления разработки профилактических мер для сохранения здоровья учащихся.

Ключевые слова: студенты, здоровье, физическое развитие, образ жизни, факторы риска

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Соблюдение этических стандартов: исследование проведено в соответствии с Хельсинкской декларацией Всемирной медицинской ассоциации и одобрено междисциплинарным комитетом по этике ФГБОУ ВО ТГМУ Минздрава России (протокол № 7 от 27 марта 2023 г.). Все участники подписали добровольное информированное согласие на участие в исследовании.

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Preserving the health of student youth is one of the state's priority tasks. The relevance of the issue results from the continuing deterioration of students' health [1–3]. According to the data provided by the Ministry of Health of the Russian Federation and the Federal Service for the Oversight of Consumer Protection and Welfare, only 14% students in our country are considered to be generally healthy. Functional disorders are reported in 50%, and 40% have chronic diseases [4]. There has been a yearly increase in the number of students included in the special physical training group due to their health status. In some higher education institutions, the rate of such students is as high as 50% of the whole student body [5]. The students' health status attracts attention of both Russian and foreign scientists [6–10]. It is students who represent a specific social group at high risk due to health status that is characterized by definite age range (17–25 years), specific lifestyle, intense rhythm of learning resulting from high mental load, processing of information under time pressure, extensive use of smartphones, computers and other devices [11, 12]. At the same time, the lifestyle, the basics of intellectual and moral development, the students' health status are shaped against this specific "background" [6].

Junior students have certain biological features inherent to young adulthood (males aged 17–21 years, females aged 16–20 years), when the development of the body is not fully completed. At the same time, extreme lability of the nervous and emotional processes, tension of adaptive compensatory processes persist, some alterations occur in the CNS [13]. It is young adulthood, when many disorders typical for adults (arterial hypertension, diabetes mellitus, etc.) emerge, manifestation of mental disorders with atypical symptoms leading to diagnostic difficulties that reduce professional suitability, likelihood of military service and future parenting takes place. That is why this ontogeny period is considered to be the most significant in terms of studying certain morphological criteria for the diagnosis of norm and disorder [6, 14].

It is well known that physical development is the most important indicator of health owing to the environmental factor

exposure and the internal state of the human body [15, 16]. In this regard, the aggregated data on the state of students' physical development are the object of preventive medicine allowing one to predict the development of the population, make certain managerial decisions.

The study was aimed to assess physical development in students of the medical higher education institution considering their lifestyle.

METHODS

The source of information was primary medical documentation (form No. 025-CZ/u) of 940 first-year students of the Pacific State Medical University. Among them 277 individuals (44.0% males and 56.0% females) were first-year students in 2001 and 663 individuals (31.2% males and 68.8% females) were first-years in 2021. We assessed physical development using the regional regression scales based on the following indicators: body length (BL), body weight (BW), chest circumference (CC), right and left hand grip dynamometry (HHD), and vital capacity of the lungs (VC) [17].

In 2021, polling was used to assess the features of lifestyle formation in students.

In 2021, the CHAID algorithm for decision trees was used to assess the lifestyle factors affecting the students' physical development. Furthermore, the indices were calculated showing the extent, to which the probability of disharmonious physical development in certain group (node) was higher or lower compared to the average value for the whole sample. The index exceeding 100% suggested that the risk of disharmonious physical development in the group was higher relative to the average value for the whole sample [18].

Statistical data analysis was performed using the StatTech 3.0.7 software package ("Stattech"; Russia). When the distribution was normal, the data were described using the mean (M) and error of the mean (m). Statistical significance of differences in the quantitative parameters in the groups was assessed using the Student's *t*-test; the significance level was 0.05.

Table 1. Assessment of the average values of physical development indicators in males ($M \pm m$)

Indicators of physical development	Year of observation/number of individuals		<i>p</i>
	2001/122	2021/207	
Body length, cm	179.8 ± 0.7	178.0 ± 0.5	0.05*
Body weight, kg	68.6 ± 1.2	70.8 ± 1.0	0.07
Chest circumference, cm	91.0 ± 0.6	95.1 ± 0.7	0.001*
Right hand grip dynamometry, kg	44.8 ± 0.6	40.9 ± 0.5	0.001*
Left hand grip dynamometry, kg	30.7 ± 0.5	28.3 ± 0.5	0.001*
Vital capacity, mL	2458.2 ± 44.5	2738.8 ± 35.0	0.007*

Note: * — significant differences ($p < 0.05$).

Table 2. Assessment of the average values of physical development indicators in females ($M \pm m$)

Indicators of physical development	Year of observation/number of individuals		<i>p</i>
	2001/155	2021/456	
Body length, cm	166.7 ± 0.5	164.8 ± 0.3	0.01*
Body weight, kg	58.6 ± 0.7	58.5 ± 0.5	0.23
Chest circumference, cm	83.9 ± 0.5	89.0 ± 0.4	0.001*
Right hand grip dynamometry, kg	29.1 ± 0.3	26.5 ± 0.2	0.01*
Left hand grip dynamometry, kg	28.2 ± 0.4	24.9 ± 0.2	< 0.001*
Vital capacity, mL	2794.2 ± 39.5	2828.9 ± 25.0	0.16

Note: * — significant differences ($p < 0.05$).

Table 3. Assessment of the harmony of physical development in males

Physical development assessment	Assessment criterion	Year of observation/number of individuals			
		2001/122		2021/207	
		Abs.	%	Abs.	%
Harmonious	$M \pm 1\sigma R$	88	72.1	104	50.2
Disharmonious due to		34	27.9	103	49.8
underweight	body weight below $M - 1,1\sigma R$	13	10.7	48	23.2
overweight	body weight over $M + 1,1\sigma R$	21	17.2	55	26.6

Table 4. Assessment of the harmony of physical development in females

Physical development assessment	Assessment criterion	Year of observation/number of individuals			
		2001/155		2021/456	
		Abs.	%	Abs.	%
Harmonious	$M \pm 1\sigma R$	118	76.1	273	59.9
Disharmonious due to		37	23.9	183	40.1
underweight	body weight below $M - 1,1\sigma R$	16	43.2	51	27.9
overweight	body weight over $M + 1,1\sigma R$	21	56.8	132	72.1

RESULTS

It was found that multidirectional changes in the indicators of medical students' physical development took place in 20 years. In males, BL, right and left hand grip strength decreased significantly, while CC and VC significantly increased. Furthermore, BW increased, but the differences were non-significant (Table 1).

In females, BL, right and left hand grip strength decreased significantly, CC significantly increased, BW remained almost the same, VC showed non-significant changes (Table 2).

Assessment of the harmony of physical development using the regional regression scales showed that the number of young males with harmonious physical development decreased by 21.9% over 20 years. The rate of underweight increased 2.2-fold and the rate of overweight increased 1.5-fold (Table 3).

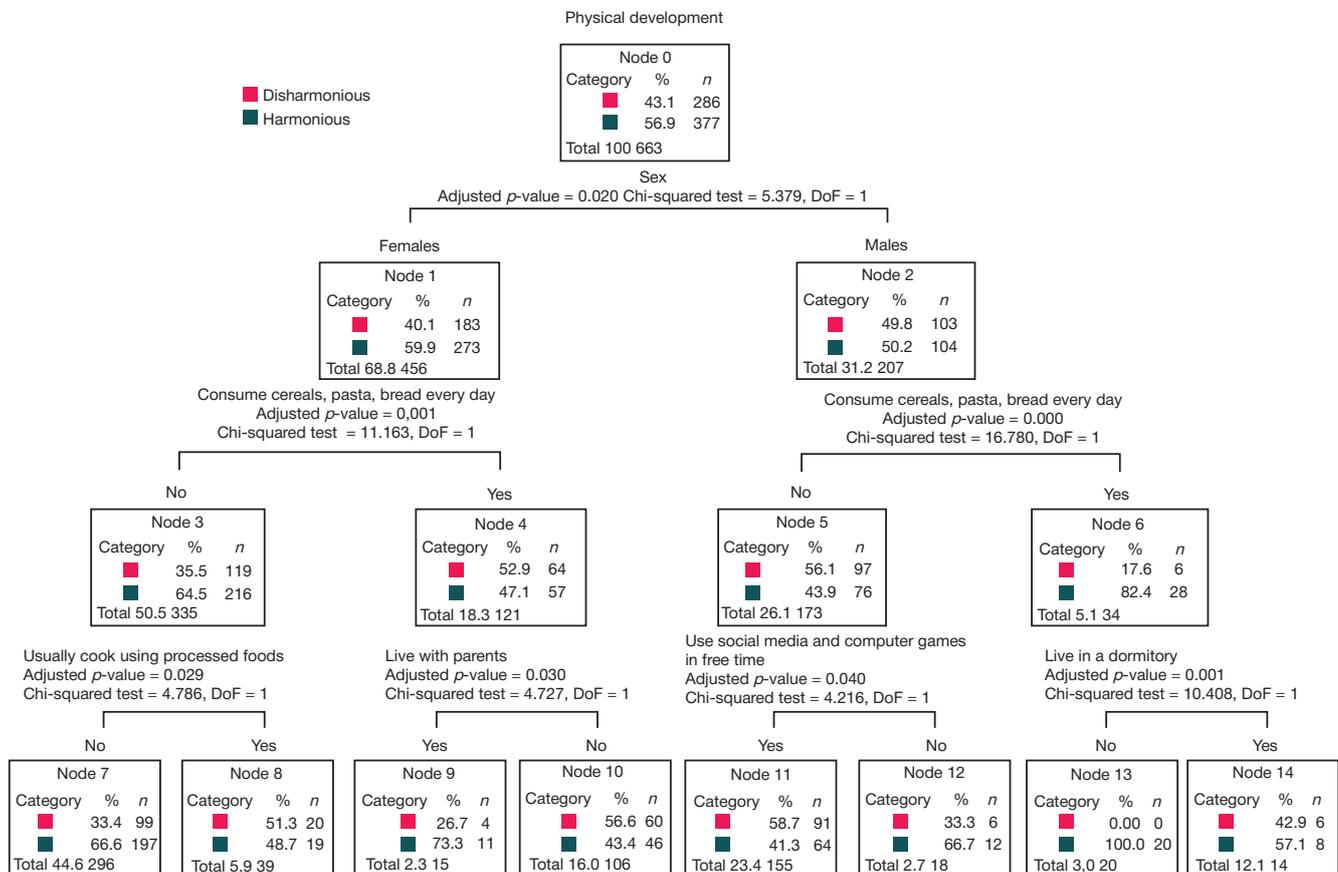


Fig. The most significant risk factors in students with different physical development scores depending on their lifestyle

Table 5. Characteristics of the classification tree terminal nodes

Number of the node	Risk factor values	Total number of students in the overall structure of the node		Share of students with the outcome relative to the total number for the node		Response (share of observations in the target category for the node in the overall number of observations for the node)		Impact factor of the node
		Abs.	%	Abs.	%	%		
11	Sex (males)	155	23.4	91	58.7	136.1		
	Consume vegetables every day (no)							
10	Use social media and computer games in free time (yes)	106	16	60	56.6	131.2		
	Sex (females)							
8	Consume cereals, pasta, bread every day (yes)	39	5.9	20	51.3	118.9		
	Live with parents (no)							
14	Consume cereals, pasta, bread every day (no)	14	2.1	6	42.9	99.4		
	Usually cook using processed foods (yes)							
7	Sex (males)	296	44.6	99	33.4	77.5		
	Consume vegetables every day (yes)							
12	Live in a dormitory (yes)	18	2.7	6	33.3	77.3		
	Consume cereals, pasta, bread every day (no)							
9	Usually cook using processed foods (no)	15	2.3	4	26.7	61.8		
	Sex (females)							
13	Consume cereals, pasta, bread every day (no)	20	3	0	0	0		
	Live with parents (yes)							
	Sex (males)							
	Consume vegetables every day (yes)							
	Live in a dormitory (no)							

The number of females, whose physical development was considered harmonious, decreased by 16.2%. Excess body weight was the main cause of disharmony. The number of overweight female students reported in 2021 was 1.3 times higher than that reported in 2001 (Table 4).

The most significant risk factors of the lifestyle of today's students associated with disharmonious physical development were determined using the CHAID algorithm for decision trees (Fig.).

As a result of the analysis, the three-level classification tree that included 14 nodes was constructed. The impact factors of the nodes with the risk factors triggering disharmonious physical development were determined.

The detailed description of the classification tree terminal nodes is provided in Table 5. Nodes 11 and 10 are considered to have the most adverse effect. The 11th node includes such characteristics, as male sex, lack of daily consumption of vegetables and excess use of gadgets (impact factor 136.1%). The 10th node includes such factors, as female sex, excess consumption of carbohydrate foods, and living apart from the family (131.2%). The table also contains nodes with the risk factors having a less significant effect on physical development.

The findings showed that the longitudinal growth acceleration in students of the Pacific State Medical University slowed down in the early 21st century. In 2021, a significant

decrease in BL of young males ($p = 0.05$) and females ($p = 0.01$) relative to the indicators reported in 2001 was observed. Changes in the students' BW were non-significant. The students' CC increased on average by 4 cm ($p = 0.001$). The changes in physiometric indicators predictably lead to the changes in functional capabilities. There was a significant decrease in the students' right and left hand grip strength ($p < 0.001$). VC increased significantly in males ($p = 0.007$).

Assessment of the individual physical development level has shown that more than a half of subjects have harmonious physical development. Despite this fact, the number of students with disharmonious physical development due to overweight increased by 9.4% in males and 15.3% in females over 20 years.

The classification tree construction method has made it possible to identify the risk factors affecting the students' physical development indicators. The risk factors of disharmonious physical development in males with the highest impact factor were the lack of vegetables in the diet and the use of social media and computer games in free time (136.1%). In females, the risk factors included daily consumption of cereals, pasta, bread and living apart from parents (131.2%).

DISCUSSION

The earlier research results indicate multidirectional dynamics of the modern students' physical development indicators. If in some regions of the country a decrease in anthropometric indicators is reported, then in other territories their increase is recorded [19, 20]. The majority of students have harmonious physical development. However, there is still a rather large share of students with disharmonious and sharply disharmonious physical development [21]. Thus, disharmonious physical development has been reported in 17% and sharply disharmonious physical development has been reported in 9% of students of the Pirogov Russian National Research Medical University [22]. The same results were obtained for medical students from Kyrgyzstan: disharmonious and sharply

disharmonious physical development was reported in 18.8% and 1.6% of males, 15.7% and 7.3% of females [23]. At the same time, our study has shown that 43.1% of subjects have deviations. The findings have made it possible to identify the major risk factors affecting physical development of students of the Pacific State Medical University.

It is well-known that nutrition is an important factor of shaping the students' physical development and one of the characteristics of their lifestyle [24]. A number of studies have shown that the medical students' nutrition is usually non-compliant with the physiological standards and unbalanced. Furthermore, the eating pattern is disturbed [11, 25]. Similar results were obtained in our study. It was found that the lack of vegetables in the diet and daily consumption of carbohydrate foods were the risk factors of disharmonious physical development in students.

Excess computerization of the modern students' life poses a significant health risk [26]. Scientific research has proven the adverse effects of the use of electronic devices on the emergence of deviations in physical development [10, 11]. This fact was also confirmed by our study. For example, it was found that 41.3% of young males with disharmonious physical development spent most of their time in social media and played computer games. Furthermore, it was shown that the students' place of residence and sex had a significant impact on their health.

The study conducted suggests that it is necessary to further monitor the indicators of physical development. The need for development and timely update of the modern standards for physical development assessment is still relevant for both schoolchildren and student youth.

CONCLUSIONS

Thus, regular monitoring of the students' physical development makes it possible to determine the priority directions of the development of complex and targeted preventive measures for health preservation and improvement, as has been implemented based on the study results.

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INTERPLAY OF THE INDICATORS OF PHYSICAL DEVELOPMENT AND PSYCHOLOGICAL STATUS IN THE YOUNG ADULT MEDICAL STUDENTS

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Currently, there is increasing number of overweight people all over the world. The increase in the incidence of depression among the population, especially among adolescents and young adults, has been reported. The study was aimed to determine the relationship between excess body weight and severity of depression in the young adult students taught at the initial courses in the medical university. The study involved 230 junior medical students (163 females and 67 males) having no chronic disorders. Body mass index (BMI) was determined in the subjects. The depression severity was defined using the Beck Depression Inventory. The analysis showed that the average BMI was 3.0 ± 3.9 AU in males and 22.0 ± 4.3 AU in females. The share of underweight male subjects was 7.5%, while the share of underweight females was 10.5%; 28.3% of males and 13.5% of female subjects had excess body weight and obesity of varying severity. No signs of depression were found in 66.0% of males and 61.0% of females. We revealed no significant correlation between BMI and depression.

Keywords: students, body mass index, depression, mental health, Beck Depression Inventory

Author contribution: Chevzhik YuV — study concept and design, data acquisition, data analysis, interpretation of the results; Milushkina OYu — manuscript editing, data analysis and literature review; Shemyakov SE — manuscript editing, data analysis; Skoblina NA — editing, participation in data interpretation; Samokhina AO — literature data acquisition.

Compliance with ethical standards: the study was approved by the local Ethics Committee of the Pirogov Russian National Research Medical University (protocol № 213 dated 13 December 2021) and conducted in accordance with the Declaration of Helsinki of the World Medical Association. The written informed consent was obtained from all subjects.

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ВЗАИМОСВЯЗЬ ПОКАЗАТЕЛЕЙ ФИЗИЧЕСКОГО РАЗВИТИЯ И ПСИХОЛОГИЧЕСКОГО СОСТОЯНИЯ СТУДЕНТОВ-МЕДИКОВ ЮНОШЕСКОГО ВОЗРАСТА

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Сейчас в мире растет число людей с избыточной массой тела. Установлено увеличение частоты депрессивных состояний среди населения, в особенности у подростков и людей юношеского возраста. Целью исследования было определить взаимосвязь избыточной массы тела и степени депрессии у студентов юношеского возраста, обучающихся на начальных курсах медицинского вуза. В исследовании приняли участие 230 студентов-медиков начальных курсов (163 девушки и 67 юношей) без хронических заболеваний. У обследуемых определяли индекс массы тела (ИМТ). Степень депрессии определяли с помощью шкалы депрессии Бека. В результате анализа установлено, что средние показатели ИМТ у юношей равны $23,0 \pm 3,9$ у. е., а у девушек — $22,0 \pm 4,3$ у. е. Количество обследованных юношей с дефицитом массы тела составило 7,5%, а количество девушек — 10,5%; 28,3% обследованных юношей и 13,5% девушек имели избыточную массу и ожирение разной степени. У 66,0% юношей и 61,0% девушек отсутствовали признаки депрессии. Статистически значимой связи между ИМТ и депрессией обнаружено не было.

Ключевые слова: студенты, индекс массы тела, депрессия, психическое здоровье, шкала депрессии Бека

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Соблюдение этических стандартов: исследование одобрено локальным этическим комитетом ФГАОУ ВО РНИМУ имени Н. И. Пирогова Минздрава России (протокол № 213 от 13 декабря 2021 г.) и проведено в соответствии с Хельсинкской декларацией Всемирной медицинской ассоциации. От всех участников было получено письменное информированное согласие.

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Medical universities are more and more often recognized as the institutions contributing to improving health and well-being, maximization of academic performance, career achievements and positive attitude towards health [1].

At the same time, there are concerns about the university students' mental health, as well as about other factors affecting academic success, such as the degree of overweight.

Obesity is one of the main risk factors of metabolic syndrome causing cardiovascular, endocrine, and other disorders. According to numerous studies, obese children often have persistent obesity later in life [2].

While childhood obesity and the related metabolic syndrome are recognized as pressing issues all over the world, there is still

a shortage of weight loss programs. It is estimated that in 2020 a total of 38.2 million children under the age of 5 years were overweight or had obesity [3, 4].

It has been shown that multidisciplinary approaches to weight loss involving a nutritionist, expert in physical exercise, and psychologist that are focused on changing the lifestyle, are the most effective [5–7].

Calculation of body mass index (BMI) is one of the rather simple and affordable methods to determine body weight. The method is suitable for estimation of optimal body weight that can be managed and maintained for a long time [8].

Many researchers believe that the individual's psychological status affects body weight both upward and downward [9].

Currently, the pandemic of novel coronavirus infection (COVID-19) is also considered to be associated with both poor mental health and overweight, especially in obese individuals [10, 11].

Stress tolerance represents one of the mental health factors [12]. Stimulation of the stress-related metabolic and neurobiological alterations coordinates the brain responses in order to provide behavioral adaptation. The long-term stress exposure can result in adverse physiological and behavioral changes, such as depression, metabolic syndrome, etc. [13].

In young adulthood (18–21 years), when the final growth and stabilization of the major body parameters take place, the degree of the individual's physical and mental health is determined in order to predict further personality and performance [14].

Medical students, both in the Russian Federation and abroad, go through a lot of stress during training. Malnutrition, harmful habits, low physical activity, and inadequate daily routine increase the risk of obesity and, consequently, metabolic syndrome; these also lead to persistent depression. The long-term stress exposure can be detrimental to the effectiveness of the training material perception and analysis, which leads to the decrease in academic performance and possible expulsion from the university [15–17].

There are also differences in manifestations of depression between males and females. Women usually complain of the feelings of anxiety, hopelessness, emptiness, helplessness, as well as of tearfulness, body weight changes, and pain in different parts of the body. Thus, the features of depression in women represent the more severe disorders of the anxiety and depression spectrum, somatization and more prominent verbalization of complaints and experiences. In males, apathy and being emotionally distant, motor retardation and changes in behavioral responses predominate in the course of depression. Furthermore, males are more often prone to harmful habits and risky behavior. There is an opinion that the gender-related differences associated with depression manifest themselves not in the subjective experience of depression, but in the behavioral expression of this experience [18].

It is necessary to take a holistic approach to the health of young people, not only by creating favorable social and hygienic environment, but also by contributing to shaping a healthy lifestyle, especially in future doctors. In this regard, assessment of students aimed to reveal excess body weight and obesity using BMI can help adequate adjustment of body weight to normal. Furthermore, it is necessary to control the depression severity in today's young adults. Depression represents one of the leading mental disorders all over the world [19]. According to the WHO, in 2017 depression was found in about 34 million people; the experts predict further growth of this indicator [20].

The Depression Inventory by A. Beck represents one of the screening methods for depression allowing one to quickly determine the depression severity at the pre-medical stage and refer the individual to psychologist, if necessary [21].

The study was aimed to determine the relationship between excess body weight and severity of depression in the young adult students taught at the initial courses in the medical university.

METHODS

We assessed 230 first-year and second-year students of the Pirogov Russian National Research Medical University (163 females and 67 males aged 18–21 years with no history of chronic

disorders), in whom we determined anthropometric indices (body length and weight) needed to calculate BMI (BMI = body weight (kg)/body length (m²)) at the laboratory of integrative anthropology and hygienic assessment of the Department of Human Anatomy. Body length was measured using the GMP anthropometer (Switzerland) with the accuracy of up to 0.1 mm. Body weight was measured using the VMEN-150/200 medical digital floor scales (TVES; Russia) with the accuracy of ± 50 g.

The depression severity was determined using the Depression Inventory by A. Beck in the morning, outside stressful periods (surveys, modules, exams). The Inventory consists of 21 statements structured based on the types of psychopathological symptoms. Items 1–13 represent a cognitive/affective subscale (assessment of the individual's emotional state, him/herself, his/her beliefs and problems), while items 14–21 represent a somatization subscale (complaints of symptoms not verified clinically). When assessing the results, the total score below 9 suggests no symptoms of depression. The total score of 10–18 corresponds to mild depression considered as “episodes” in patients with somatic disorders or individuals with high levels of neuroticism, the score of 19–29 corresponds to moderate depression representing a critical level, the score of 30–63 corresponds to severe depression, when endogeneity cannot be excluded [22].

Statistical processing of the results was performed using the StatTech 3.0.7 software package (StatTech; Russia). The standard indices were calculated, along with the Spearman's correlation coefficient (*r*).

RESULTS

The analysis of BMI values in the entire group of students (Table 1) showed that the average BMI was 22.3 ± 4.2 AU, which was within the normal range. Furthermore, in the group of males BMI was 23.0 ± 3.9 AU, while in the group of females it was 22.0 ± 4.3 AU. The total number of students with healthy body weight (18.5–24.9 AU) was 167 (72.6%): 43 males (64.2%), 124 females (76.0%). The number of underweight students (< 18.5 AU) was 22 (9.6%): five males (7.5%) had minimal BMI values of about 15.2 AU, and 17 females (10.5%) had BMI of about 16.2 AU. The number of overweight students (25.0–29.99 AU) in the entire group was 29 (12.6%): 16 males (23.8%), 13 females (8.0%). Class 1 obesity (30.0–34.9 AU) was revealed in eight individuals (3.5%): two males (3.0%) and six females (3.7%). Class 2 obesity (35.0–39.9 AU) was revealed in only one girl (0.6%). Class 3 obesity (> 40.0 AU) was found in three individuals (1.3%): one male (1.5%) and two females (1.2%).

Table 2 shows that among males there were 19 individuals with excess body weight and obesity (28.3%), while among females there were 22 overweight or obese individuals (13.5%).

Assessment of the Beck Depression Inventory scores showed that the average score for the entire cohort of students was 9.2 ± 7.4 points; it was 8.3 ± 6.7 points in the group of males and 9.5 ± 7.7 points in the group of females. No symptoms of depression were revealed in 143 students (62.2%). In the group of young males no depression was found in 44 individuals (65.7%), while in the group of females there were 99 individuals (60.7%) with no depression.

Among 43 young males with healthy body weight, 16 had signs of depression (12 individuals with mild depression, four individuals with moderate depression). Among underweight males, there were two individuals with mild depression, while among overweight males there were one individual with mild and two individuals with moderate depression. One individual

Table 1. BMI (AU) in males and females

Students	Number of students	M ± σ
Males	67	23.0 ± 3.9
Females	163	22.0 ± 4.3
Total	230	22.3 ± 4.2

Table 2. Number of students with different BMI values

BMI criteria	Males (n = 67)	Females (n = 163)	Total (n = 230)
Underweight	5 (7.5%)	17 (10.5%)	22 (9.6%)
Healthy weight	43 (64.2%)	124 (76%)	167 (72.6%)
Overweight	16 (23.8%)	13 (8.0%)	29 (12.6%)
Class 1 obesity	2 (3.0%)	6 (3.7%)	8 (3.5%)
Class 2 obesity	–	1 (0.6%)	1 (0.4%)
Class 3 obesity	1 (1.5%)	2 (1.2%)	3 (1.3%)

with severe depression was found among students with class 1 obesity. Among students with class 3 obesity, only one individual had mild depression (Table 3). A total of 48 individuals with depression were identified in the group of young females with healthy weight: 34 individuals with mild, 10 with moderate and four with severe depression. Among underweight female students, five individuals had mild depression and one had moderate depression. In the group of overweight young females (13 individuals), four individuals had mild and two had moderate depression. Among six individuals with class 1 obesity, mild depression was found in two. Mild depression was determined in one female student with class 2 obesity; two individuals with class 3 obesity had mild-to-moderate depression (Table 4).

The correlation analysis revealed a negative correlation between BMI and Beck Depression Inventory scores in males: the correlation strength based on the Chaddock's scale was considered to be weak, and the relationship of traits was non-significant ($p = 0.08$). The determination coefficient ($r^2 = 0.04$) suggests that there is no correlation between the variables. In females, there is a positive weak (based on the Chaddock's scale) correlation between the studied traits; the relationship between the traits is non-significant ($p = 0.07$), and the determination coefficient ($r^2 = 0.02$) shows that the variables are not related.

DISCUSSION

According to some studies, obesity ensured protection against depression in males and at the same time was a predictor of depression in young females [23].

A number of researchers found that the risk of depression increased many-fold in males with BMI > 40, while in young females the risk was associated with even small body weight fluctuations [24].

A total of 1584 undergraduate students of the Nigerian University of Agriculture (mean age 21.8 ± 2.2 years) were

examined in order to assess the correlation between anxiety (Beck Anxiety Inventory) and BMI. It was found that the prevalence of high anxiety ($p > 0.05$) was the same for both sexes, regardless of BMI. Furthermore, all obese males had low anxiety. No significant correlation ($p > 0.05$) between the Beck Anxiety Inventory scores and the degree of obesity was revealed in both males and females [25].

The other group of researchers tested 50 patients aged 18–50 years with multiple sclerosis having excess weight or obesity (BMI ≥ 25 kg/m²) for the symptoms of depression (Beck Depression Inventory) and anxiety. No relationship between depression, BMI, waist circumference (WC) and the waist–hip ratio (WHR) was revealed. There was no correlation between the symptoms of anxiety, BMI, WC, and WHR. In contrast, assessment of body composition by dual-energy X-ray absorptiometry aimed to determine the total lean mass and the fat percentage revealed a significant correlation between the percentage of total fat and the depression and anxiety. Furthermore, there was a strong negative correlation between the lean mass and the depression and anxiety [26].

Assessment of the cohort of students (12,677 people) of Brazilian colleges and universities of different grades showed that the likelihood of depression was significantly higher in females and junior students compared to males and senior students [27].

Thus, it is necessary to further assess the relationship between the indicators of physical development and psychological status of the individual.

CONCLUSIONS

The average BMI of all subjects is 22.3 ± 4.2 AU, which is within normal range. The share of underweight young males is 7.5%, while that of underweight females is 10.5%. The share of subjects with excess body weight and obesity of varying severity is 28.3% among males and 13.5% among

Table 3. Number of males with different BMI (AU) and severity of depression according to the Beck Depression Inventory (points)

Body mass index	Number of students	No depression (< 9)	Mild depression (10–18)	Moderate depression (19–29)	Severe depression (30–63)
Normal body weight	43	27 (63.0%)	12 (28.0%)	4 (9.0%)	–
Underweight	5	3 (60.0%)	2 (40.0%)	–	–
Overweight	16	13 (81.3%)	1 (6.2%)	2 (12.5%)	–
Class 1 obesity	2	1 (50.0%)	–	–	1 (50.0%)
Class 3 obesity	1	–	1 (100%)	–	–
Total	67	44 (66.0%)	16 (24.0%)	6 (9.0%)	1 (1.0%)

Table 4. Number of females with different BMI (AU) and severity of depression according to the Beck Depression Inventory (points)

Body mass index	Number of students	No depression (< 9)	Mild depression (10–18)	Moderate depression (19–29)	Severe depression (30–63)
Normal body weight	124	76 (61.4%)	34 (27.4%)	10 (8.0%)	4 (3.2%)
Underweight	17	11 (65.0%)	5 (29.0%)	1 (6.0%)	–
Overweight	13	8 (61.0%)	4 (31.0%)	1 (8.0%)	–
Class 1 obesity	6	4 (67.0%)	2 (33.0%)	–	–
Class 2 obesity	1	–	1 (100%)	–	–
Class 3 obesity	2	–	1 (50.0%)	1 (50.0%)	–
Total	163	99 (61.0%)	47 (29.0%)	13 (8.0%)	4 (2.0%)

females. There are no signs of depression in 66.0% of males and 61.0% of females. Assessment of the relationship between BMI and the Beck Depression Inventory scores has revealed multidirectional correlations between traits: a negative

correlation has been found in males and a positive one has been found in females. Furthermore, the relationships are weak based on the Chaddock's scale; the correlations between traits are non-significant for both sexes.

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ORGANIZATIONAL MODEL FOR PREVENTION OF SMOKING AMONG YOUNG ADULTS IN VORONEZH: REGIONAL EXPERIENCE

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The issues of damage to health related to the spread of nicotine product consumption are global. At the initiative of the Department of Healthcare Management, Burdenko Voronezh State Medical University, the organizational model of medical measures to overcome nicotine dependence involving formation of the smoking cessation groups among young adults, management and enlightenment of the participants on the issues related to damage from nicotine dependence and free provision of the medicines facilitating smoking cessation was implemented. The study was aimed to assess the organizational model effectiveness based on the nicotine cessation rates of young adults. The model participants (42 individuals) were divided into three groups and provided free medicines: tablets containing cytosine in group 1, nicotine sprays in group 2, nicotine patches in group 3. The experiment was conducted for 30 days, during which three follow-up questionnaire surveys were performed. In the experiment, 31.7% of subjects stopped smoking completely, while the total positive effect bringing together those, who ceased smoking, and those, who reduced smoking, was 66.7%. Furthermore, the tablets containing cytosine turned out to be the most effective option. Thus, the study results obtained within the framework of the proposed organizational model can be considered useful in terms of further practical use. It can be recommended to include the model in the target program involving provision of medicines for treatment of nicotine dependence at the expense of the regional budget and attracted funds of enterprises and organizations.

Keywords: smoking prevention, nicotine addiction, youth environment, nicotine replacement therapy, organizational model

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Author contribution: Ulianov IA — direct management of the smoking cessation groups, applying for grant support for implementation, buying medicines and carrying out the actions aimed to involve volunteers in the experiment, contributing to the organizational model development; Nehaenko NE, Ostroushko NI — organizational model development, methodological advising, administrative support; Meremyanin LV — organizational model development, scientific advising; Ulianova AV — direct management of the smoking cessation groups, informational support of the experiment; Petrova TN — administrative support of the experiment, coaching; Sharapova YuA — organizational model development.

Compliance with ethical standards: the study was approved by the Ethics Committee of the Burdenko Voronezh State Medical University (protocol No. 5 dated 19 September 2023). The informed consent to study participation and the consent to personal data processing were submitted by all subjects.

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ОРГАНИЗАЦИОННАЯ МОДЕЛЬ ПРОФИЛАКТИКИ КУРЕНИЯ В МОЛОДЕЖНОЙ СРЕДЕ Г. ВОРОНЕЖА: РЕГИОНАЛЬНЫЙ ОПЫТ

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Проблемы причинения вреда здоровью, связанные с распространением употребления никотинсодержащих веществ, являются общемировыми. По инициативе кафедры управления в здравоохранении ВГМУ имени Н. Н. Бурденко реализована организационная модель медицинских мероприятий для преодоления никотиновой зависимости, заключающаяся в формировании групп отказа от курения среди молодежи, курации и просвещения участников в вопросах вреда никотиновой зависимости, а также в бесплатном предоставлении медикаментозных средств, облегчающих отказ от никотиновой зависимости. Целью работы было оценить эффективность организационной модели по показателям успешности отказа от употребления никотина среди молодых людей. Участников модели (42 человека) распределили по трем группам и снабдили бесплатными медикаментами: в 1-й группе это были таблетки на основе цитизина, во 2-й группе — никотиновые спреи, а в 3-й группе — никотиновые пластыри. Эксперимент продолжался 30 суток, в течение которых были проведены три контрольных анкетирования. В результате эксперимента 31,7% участников полностью отказались от курения, а общий положительный эффект, объединивший тех, кто отказался полностью, и тех, кто уменьшил объемы курения, составил 66,7%. При этом самым эффективным средством оказались таблетки на основе цитизина. Таким образом, результаты исследования, полученные в рамках предложенной организационной модели, можно признать полезными с точки зрения дальнейшего практического применения. Модель можно рекомендовать для включения в качестве мероприятия целевой программы, предусматривающей предоставление медикаментов для лечения никотиновой зависимости за счет средств областного бюджета и привлеченных средств предприятий и организаций.

Ключевые слова: профилактика курения, никотиновая зависимость, молодежная среда, никотинзаместительная терапия, организационная модель

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Вклад авторов: И. А. Ульянов — непосредственная курация групп отказа от курения, привлечение грантовой поддержки для реализации, закупка медикаментозных средств и проведение мероприятий для вовлечения добровольцев в эксперимент, участие в разработке организационной модели; Н. Е. Нехаенко, Н. И. Остроушко — разработка организационной модели, методологическое консультирование, административная поддержка; Л. В. Меремьянин — разработка организационной модели, научное консультирование; А. В. Ульянова — непосредственная курация групп отказа от курения, информационное сопровождение эксперимента; Т. Н. Петрова — административная поддержка эксперимента, организация просветительской работы; Ю. А. Шаропова — разработка организационной модели.

Соблюдение этических стандартов: исследование одобрено этическим комитетом ВГМУ имени Н. Н. Бурденко (протокол № 5 от 19 сентября 2023 г.). Все участники подписали добровольное информированное согласие на участие в исследовании и согласие на обработку персональных данных.

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The issues of damage to health related to the spread of tobacco smoking and nicotine product consumption are global [1–3]. Manufacture of such products is a very profitable business. That is why manufacturers are interested in expanding the market segment through the use of marketing schemes and the chemical mechanisms enhancing nicotine dependence. According to the World Health Organization (WHO), tobacco smoking results in 7 million deaths annually, among which more than 6 million cases occur in tobacco smokers and former tobacco smokers and more than 890,000 cases occur in non-smokers exposed to the second-hand tobacco smoke. The tobacco use poses a serious threat to the health of citizens of the Russian Federation (RF) and results in negative medical, demographic, and socioeconomic effects.

Nicotine that causes and maintains addiction is the main component of tobacco [4]. The 10th revision of the International Statistical Classification of Diseases and Related Health Problems (ICD-10) recognizes nicotine dependence resulting from tobacco use as a disease associated with behavioral disorder. Nicotine dependence is a factor contributing to the development of cardiovascular, pulmonary, gastrointestinal tract, nervous, endocrine, and reproductive disorders; all these are a real threat to smokers using not only conventional cigarettes, but also digital tobacco heating devices and vapes [5–7]. According to the data of the International Agency for Research on Cancer (IARC) for the year 2014, tobacco smoking increases the risk of many cancer types, such as lip, oral cavity, pharyngeal, esophageal, gastric, pancreatic, tracheal, bronchial, lung, bladder, kidney and urinary tract cancer, as well as acute myeloid leukemia.

The RF Government decree approved the concept for realization of the state policy on combating consumption of tobacco and other nicotine products [8]. According to the concept, the new options in the form of tobacco heating devices have become widespread along with conventional tobacco products. Thus, the monitoring data show that today the growth of consumption of such type of tobacco products, as digital nicotine delivery systems, is observed, including among children and adolescents. The rate of the use of such type of nicotine products among individuals aged 18–24 years is 19.1%, which is more than 10 times higher compared to other age groups. Furthermore, the monitoring data suggest that the RF residents are adequately informed about the harm from tobacco use (the majority of smoking respondents (76%) think that smoking causes harm to their health).

According to the polling data acquired by the Russian Public Opinion Research Center (VCIOM), 41% of the country's population were smokers in 2013, while in 2022 as many as 33% of the citizens suffered from nicotine dependence. Moreover, smokers predominate in the age group 25–59 years. However, many authors of scientific papers report growth of the rate of smoking in the youth environment (18–35 years), which is considered to be associated with the growing popularity of vapes and digital tobacco heating devices [9–11]. Thus, according to the scientific literature data, the number of young adult smokers in various regions varies between 25 and 40% [12–15]. For this reason, in the RF the ability of minors to purchase any nicotine products is being consistently limited, and since 2023, additional restrictions on distribution and advertising have come and continue to come into force; penalties for illegal trade of nicotine products are being tightened [16, 17]. Along with the legal and regulatory changes in the healthcare system structure, there are more and more health centers. The activity of such medical and preventive branches is focused on the early diagnosis of chronic disorders and promotion of healthy lifestyle [18, 19].

As for fight against smoking, specialists of the centers provide counseling and give recommendations on smoking cessation using psychotherapeutic methods and medicines [20]. However, to purchase such products, the smoker will have to spend a fairly large amount of money. This creates economic constraints and deters people, especially young adults, from starting treatment.

Considering the above factors, the measures for prevention of diseases in the population are implemented in the Voronezh Region within the framework of the Healthcare national project.

At the initiative of the Department of Healthcare Management at the Burdenko Voronezh State Medical University, including within the framework of the students' educational and research work, the organizational model of medical measures involving formation of the smoking cessation groups among young adults, management and enlightenment of the participants on the issues related to damage from nicotine dependence and free provision of the medicines facilitating combating nicotine addiction was developed.

The study was aimed to assess the organizational model effectiveness based on the nicotine cessation rates of young adults.

METHODS

To form experimental groups for modeling, we organized awareness-raising activities on the resources for the youth and 21 face-to-face actions. The information coverage was about 25,000 people; more than 400 people took part in the face-to-face events. In this phase of the project we conducted the public awareness campaign focused on the harm from various smoking options and smoking cessation methods. Young adults were also offered to join the smoking cessation groups.

Based on the results of the first phase, we formed three groups, 14 individuals per group. The groups included individuals aged 18–28 years, who expressed the desire to quit smoking and had moderate nicotine dependence based on the Fagerstrom Test (score 4 or higher). Furthermore, 41.2% of the experimental subjects used vapes, 23.5% used cigarettes, 11.8% used digital tobacco heating devices, and 23.5% used various combinations of the above. Among participants, 64.7% were males and 35.3% were females. In this regard, the groups were formed by stratification considering the smoking means and the nicotine dependence severity. We used tablets containing cytosine in group 1, nicotine sprays in group 2, nicotine patches in group 3.

The experiment was conducted for 30 days, during which the subjects were through three questionnaire surveys (on days 2, 15, and 30). The questionnaires designed by the authors contained questions about the current state of the member of the group: "Do you currently smoke?"; "Have the number of cigarettes smoked or the use of vape decreased?"; "What effect of the medicine used do you experience?"; "Do you experience any side effects of the medicines used?"; "Do you plan to start smoking again?"

Funding of the organizational model (purchase of medicines for further free provision, conducting educational events, installation of banners, and distribution of printed materials) was ensured by the grant of the Federal Agency for Youth Affairs. Medicines were selected based on their popularity and accessibility for purchase in May–June 2023.

The polling results were processed in the StatTech 3.1.8 program (StatTech; Russia) using Pearson's chi-squared (χ^2) test for independent samples and the Wilcoxon test for assessment of the process dynamics with the significance level below 0.05.

Table 1. The number of non-smokers in various phases of the experiment

	Day 2	Day 15	Day 30
Group 1	14	10*	7*
Group 2	14	5	4
Group 3	13	3*	2*
Total	41	16	13

Note: * — the differences between groups are considered significant at $p < 0.05$.

Table 2. The number of individuals, who have reduced consumption of nicotine products (individuals, who do not smoke at all or have reduced the dose) in various phases of the experiment

	Day 2	Day 15	Day 30
Group 1	14	14*	13*
Group 2	14	12	10
Group 3	14	7*	5*
Total	42	33	28

Note: * — the differences between groups are considered significant at $p < 0.05$.

RESULTS

The smoking cessation organizational model effectiveness was assessed based on the indicators reported at the time of follow-up polling. It should be noted that the most prominent effect of the nicotine dependence relief was observed on day 2. This is explained by the fact that the subjects were inspired by the beginning of the experiment, including the awareness-raising activities, and were particularly enthusiastic about fighting against nicotine dependence during the first days. However, some respondents reported the decrease in the desire to stop using nicotine, insufficient effect of medicines, impossibility to fight against the habit and the surrounding smokers. That is why part of the subjects resumed smoking by the last day of the experiment. Given the above, two parameters can be considered the measure of effectiveness in two groups: the number of non-smokers (those who ceased smoking) and the number of individuals, who have reduced the use of vapes/digital tobacco heating devices/cigarettes in the group.

Tables 1 and 2 show that during the experiment 31.7% of participants remained non-smokers by day 30 and the total positive effect bringing together those, who ceased smoking, and those, who reduced smoking, was 66.7%. Assessment of the overall process dynamics using the Wilcoxon test revealed a significant decrease in the number of non-smokers and the subjects, who reduced the dose of nicotine products used, by day 30.

The tablets containing cytosine, using which 50% of the subjects ceased smoking, were the most effective option in terms of smoking cessation, and the total effect was 92.9%. The second place by efficacy was occupied by the nicotine spray with 28.6% of individuals, who ceased smoking, and 71.4% total positive effect. The nicotine patch was the least effective, with 14.3% of individuals, who ceased smoking, and 35.7% positive effect. Significant differences in both parameters were reported for groups 1 and 3 only. It is necessary to increase the number of subjects in each group to reveal the differences between other medicines.

Assessment of the patients' sensations from using various options showed that only 4.7% of the study participants reported no physical effects of the proposed options. Others felt the relief of withdrawal syndrome, however, many of them failed to overcome nicotine dependence due to surrounding smokers and psychological attachment to the smoking process. Two subjects developed addiction to the nicotine spray that manifested itself in the larger and frequent need to use this option.

All the study participants, who remained non-smokers by the end of the experiment, responded negatively to the question: "Do you plan to start smoking again?" Furthermore, 78.5% of the subjects, who reduced the amount they smoked, responded that they would continue their fight against nicotine dependence after the end of the experiment.

DISCUSSION

The fight against nicotine dependence is a very complicated process. Not only drug therapy is important, but also personalized approach, support, and the sense of team. That is why the experiment involving free provision of medicines provided the basis for the organizational model consisting of the awareness-raising activities, support of the group curators, and the opportunity to consult physicians. It was important for us to not just distribute free medicines across young adults, but to support and consult them throughout the entire process of fighting against nicotine dependence. Furthermore, many individuals, who ceased smoking, reported the importance and effectiveness of such comprehensive approach.

The findings showed low effectiveness of using nicotine patches. According to a number of researchers, this is due to the fact that this option cannot compensate for the nicotine dependence psychological aspect [21]. The lack of ritual action in response to the emergence of the desire to smoke did not enable complete suppression of withdrawal syndrome, and the use of tablets and spray takes places at the time when the desire to smoke emerges and is associated with a certain sequence of actions, which to some extent compensates psychological addiction [22].

The subjects had no economic, administrative or other interest to distort information about the smoking cessation process. That is why the questionnaire survey data could be considered reliable enough.

CONCLUSIONS

The organizational model for prevention of smoking in the youth environment can be considered effective, since we have managed to achieve smoking cessation in 31.7% of the young adults taking part in the program through free provision of medicines, awareness-raising activities, follow-up and support of the members of the groups. The results of preventive activities and drug support obtained within the framework of the proposed model show signs of effectiveness and can be recommended

for further testing and subsequent practical application with the stage-by-stage scaling. Given the statistically significant data on the results of assessing the effectiveness of the use of medicines for drug support of combating nicotine dependence and the use of nicotine products, it is recommended to prepare information for the Ministry of Health of the Voronezh Region

substantiating the feasibility of scaling the measures to ensure expansion of the scope of drug therapy in individuals with nicotine dependence through inclusion of activities in the target program and funding outpatient treatment of individuals with nicotine dependence from the budget of the Voronezh Region.

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HYGIENIC ASSESSMENT OF WEATHER SENSITIVITY AND METEOTROPIC REACTIONS IN STUDENTS

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The issue of weather sensitivity and meteotropic reactions in various population groups depending on the age, place of residence, professional features, and health status is relevant and inadequately covered in scientific literature. The study was aimed to assess weather sensitivity and meteotropic reactions in medical university students of various age groups. Polling of 243 students aged 17–18 and 23–24 years was performed using a tailored questionnaire consisting of 16 questions allowing one to detect weather sensitivity and meteotropic reactions in the respondents. Analysis of the data acquired showed that 53.7% of female and 16.7% of male first-year students had weather sensitivity ($p < 0.001$). Furthermore, 47.0% of surveyed first-year students and 67.0% of 5–6th-year students complained of various intermittent meteotropic reactions. In first-year students, meteotropic reactions were most often manifested in the decreased performance (76.6%), headache (74.6%), fatigue (70.2%). The weather-sensitive 5–6th-year students more often complained of the bouts of headaches (72.9%), decreased performance (66.7%), sleep disorders (31.2%), and muscle pain (49.6%). Meteotropic reactions occurred in 47.0–67.0% of the surveyed students of various age groups. Thus, when weather sensitivity is detected in students during the medical check-up, further prevention of the meteotropic reaction exacerbations should be tailored based on the medical weather forecasting.

Keywords: students, weather sensitivity, meteotropic reactions, diagnostics

Author contribution: Ganuzin VM — questionnaire survey, processing and describing the study results, manuscript formatting; Baraboshin AT — questionnaire survey, processing of the study results; Serkova OV — literature review, describing the study results, editing and formatting the finished paper.

Compliance with ethical standards: anonymous polling did not violate human rights or endanger the respondents, it was compliant with the principles of biomedical ethics.

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ГИГИЕНИЧЕСКАЯ ОЦЕНКА МЕТЕОЗАВИСИМОСТИ И МЕТЕОТРОПНЫХ РЕАКЦИЙ У СТУДЕНТОВ

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Проблема метеозависимости и метеотропных реакций среди различных слоев населения в зависимости от возраста, места проживания, профессиональных особенностей и состояния здоровья актуальна и недостаточно раскрыта в научной литературе. Целью работы было изучить метеочувствительность и метеотропные реакции у студентов медицинского университета различных возрастных групп. Проведено анкетирование 243 студентов в возрасте 17–18 и 23–24 лет с помощью авторской анкеты из 16 вопросов, позволяющих выявить метеозависимость и метеотропные реакции у респондентов. Анализ полученных данных показал, что метеочувствительность имела место у 53,7% девушек и 16,7% юношей ($p < 0,001$), обучающихся на первом курсе. При этом 47,0% обследованных студентов-первокурсников и 67,0% студентов 5–6-го курсов жаловались на различные периодически возникающие метеотропные реакции. У студентов первого курса метеотропные реакции чаще проявлялись снижением работоспособности (76,6%), головными болями (74,6%), слабостью (70,2%). Метеозависимые студенты 5–6-го курсов чаще жаловались на приступы головных болей (72,9%), снижение работоспособности (66,7%), нарушения сна (31,2%) и мышечные боли (49,6%). Метеотропные реакции возникали у 47,0–67,0% обследованных студентов различных возрастных групп. Таким образом, во время диспансеризации студентов при выявлении у них метеочувствительности дальнейшую профилактику обострений метеотропных реакций следует строить с учетом медицинских прогнозов погоды.

Ключевые слова: студенты, метеочувствительность, метеотропные реакции, диагностика

Вклад авторов: В. М. Ганузин — проведение анкетирования, обработка и описание результатов исследования, оформление статьи; А. Т. Барабошин — проведение анкетирования, обработка результатов исследования; О. В. Серкова — работа с литературой, описание результатов, редактирование и оформление готовой статьи.

Соблюдение этических стандартов: анонимное анкетирование не ущемляло права человека, не подвергало опасности респондентов и соответствовало требованиям биомедицинской этики.

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The review of scientific literature about the impact of weather conditions on the human body has shown that there is a large group of people poorly tolerating various atmospheric disturbances. According to a number of researchers, weather-sensitive individuals respond differently to the same factors of influence. Like adults, children show weather sensitivity manifesting itself in various meteotropic reactions starting from the neonatal period [1–5]. The prevalence of meteotropic reactions depends on the age, geographic zone of residence, profession, anomalies of the constitution, certain chronic disorders.

Large contribution to investigation of the issues of weather sensitivity and meteotropic reactions in children and adolescents was made by Konstantin I. Grigoriev, Dr. Sci (Med.), Professor at the Department of Pediatrics and Children's Infectious Diseases, Pirogov Russian National Research Medical University. According to K.I. Grigoriev, weather sensitivity is the "ability of the body and autonomic regulation system to generate a physiological, pre-pathological or pathological response to the exposure to weather factors and/or decrease resistance to the changing meteorological or climatic conditions" [6, 7].

Table. Rates of meteotropic reactions in weather-sensitive students

Symptoms of meteotropic reactions	1 st -year students,%	5–6 th -year students,%
	<i>n</i> = 47	<i>n</i> = 96
Fatigue	70.2	51.1
Irritability	46.8	48.9
Decreased performance	76.6	66.7
Headache	74.6	72.9
Sleep disorder	12.8	31.2
Heart pain	10.6	14.6
Tachycardia	21.3	14.6
Shortness of breath	8.5	7.3
Nausea	14.9	11.4
Abdominal pain	10.6	6.4
Itchy skin	6.4	4.2
Skin rash	6.4	5.2
Muscle pain	28.8	49.6
Joint pain	38.3	37.5
Nosebleed	10.6	7.3
Exacerbation of chronic disorder	25.5	20.8

In our opinion, it is important to study the impact of weather conditions on the student youth in the context of today's socio-hygienic training and living conditions.

The study was aimed to detect weather sensitivity and meteotropic reactions in medical university students of various age groups.

METHODS

We performed polling of medical university (Yaroslavl State Medical University) students using the tailored questionnaire consisting of 16 questions allowing one to detect meteotropic reactions in the respondents. The respondents, who gave the consent to assessment, were divided into two groups. The first group included 100 first-year students aged 17–18 years, the second one included 143 5–6th-year students aged 23–24 years. Polling of first-year students was performed in September and October; polling of senior students was performed in the end of the academic year.

Statistical data processing was performed using the StatTech (StatTech; Russia) software package. The differences were considered significant at $p < 0.05$.

RESULTS

Analysis of the results showed that 53.7% of female and 16.7% of male first-year students had weather sensitivity ($p < 0.001$). Furthermore, 47.0% of surveyed first-year students and 67.0% of 5–6th-year students complained of various intermittent meteotropic reactions.

It is interesting to note that chronic disorders were more common among weather-sensitive students, than among those, who showed no weather sensitivity. Accordingly, chronic disorders were detected in 51.1% of weather-sensitive first-year students and 26.4% of students with no weather sensitivity. Among weather-sensitive senior students, chronic disorders were found in 50%, while among students with no weather sensitivity 28.2% had chronic disorders.

The rates of various meteotropic reactions found in the group of weather-sensitive students are provided in the Table.

The Table shows differences in the meteotropic reactions occurring in the groups of weather-sensitive first-year and 5–6th-year students. In first-year students, meteotropic reactions were most often manifested in the decreased performance (76.6% of cases), headache (74.6% of cases), fatigue (70.2% of cases). The weather-sensitive 5–6th-year students more often complained of the bouts of headaches (72.9%), decreased performance (66.7%), sleep disorders (31.2%), and muscle pain (49.6%).

Analysis of the data obtained showed that the rates of exacerbations of chronic disorders in weather-sensitive students were the same in both groups.

DISCUSSION

Our findings are in line with the studies of meteotropic reactions in schoolchildren and students performed by a number of domestic researchers. In the study [8], 58.9% of surveyed individuals were considered to be weather-sensitive. The study of weather sensitivity in the pedagogical university students aged 17–23 years showed that 29.3% of them suffered from weather sensitivity [9].

When assessing weather-sensitive patients, seasonal fluctuations of their hemodynamic parameters were revealed [10].

The study of meteotropic effects on the metabolic factors in the student's body proved that various climatic conditions of students' residence had an impact on the changes in the body's metabolic processes, including in the cardiovascular and respiratory systems [11].

Studies of the impact of meteorological factors on the development and course of disorders were conducted by a number of domestic researchers. Thus, predictors of meteotropic reactions in patients with arterial hypertension under conditions of the Extreme North were identified [12].

In 2020–2022, meteopathic reactions were assessed in children with bronchial asthma living in Moscow: 74.8% of children in this group were weather-sensitive. The authors proposed the normobaric hypoxic therapy that made it possible to reduce the patients' weather sensitivity and meteotropic reactions by 80.0% [13, 14].

The following pattern was identified when assessing the effects of weather sensitivity in patients with arterial hypertension: the authors found that meteopathic reactions occurring in patients were most often associated with sudden weather changes [15].

The literature review has shown that it is necessary to consider health status and ensure prevention of chronic disorders when providing career guidance to weather-sensitive adolescents, including those from the groups at risk of bronchial asthma and arterial hypertension [16–18].

In our opinion, meteotropic reactions and some categories of diathesis are characterized by identical reactions. Therefore, it is necessary to record individuals with certain types

of diathesis and to ensure timely preventive measures not allowing diathesis to realize into disease [19].

The analysis of the literature and original data suggests the need to detect weather sensitivity during medical check-ups of schoolchildren and students in order to prevent meteotropic reactions.

CONCLUSIONS

Meteotropic reactions occurred in 47.0–67.0% of the surveyed students of various age groups. Thus, in cases of detecting weather sensitivity in patients, further prevention of the meteoropic reaction exacerbations should be tailored considering medical weather forecasting.

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DYNAMIC CHANGES IN PHYSICAL DEVELOPMENT INDICATORS OF HIGH SCHOOL-AGE CHILDREN IN THE SAMARA REGION OVER A DECADE

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Physical development in adolescence is one of the key aspects of the modern society's well-being. Assessment of physical development in children and adolescents represents an essential component of the pediatric population health status estimation being a clear indicator of the impact of lifestyle, environment, and learning process on the child's body. The study was aimed to assess the dynamic changes of physical development indicators in the high school-age children in the Samara Region over a decade. The paper deals with the anthropometric data of physical development acquired in 2013 and 2023. A total of 476 children aged 14–16 years were examined (256 boys, 220 girls). Physical development assessment performed in the group of high school-age boys revealed significant changes. Boys of all ages examined in 2023 lagged behind their peers examined in 2013 in the number of individuals with harmonious physical development. Furthermore, a significantly greater number of children with disharmonious physical development due to excess body weight were revealed in 2023. The results yielded by assessing physical development in girls are slightly different: the today's 14-year-old schoolgirls lag behind girls examined in 2013 in the size of population with harmonious physical development. The body height comparative analysis results have shown that the today's schoolchildren do not lag behind their peers examined in 2013 in all gender-age groups ($p > 0.05$). A significant increase in the schoolchildrens' body weight relative to 2013 is likely to result from the quarantine measures related to the COVID-19 pandemic, which made children stay at home for longer and reduced their physical activity.

Keywords: hygiene of children and adolescents, physical development, dynamics, anthropometry

Author contribution: Trubetskaya SR, Gavryushin MYu — research initiators; Sazonova OV — academic advising; Hamtsova RV — processing of the results, manuscript editing; Tupikova DS — data acquisition, preparing the results; Frolova OV — literature review, manuscript writing.

Compliance with ethical standards: the study was approved by the Ethics Committee of the Samara State Medical University (protocol No. 9 dated 24 September 2022). The informed consent was obtained from all participants (their legal representatives).

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ДИНАМИКА ПОКАЗАТЕЛЕЙ ФИЗИЧЕСКОГО РАЗВИТИЯ У ДЕТЕЙ СТАРШЕГО ШКОЛЬНОГО ВОЗРАСТА В САМАРСКОЙ ОБЛАСТИ ЗА ДЕСЯТИЛЕТНИЙ ПЕРИОД

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Физическое развитие подростков является одним из ключевых аспектов благополучия современного общества. Изучение физического развития детей и подростков — неотъемлемая часть оценки состояния здоровья детской популяции, которая служит наглядным показателем влияния образа жизни, окружающей среды и образовательного процесса на организм ребенка. Целью исследования было проанализировать динамику показателей физического развития у детей старшего школьного возраста в Самарской области за десятилетний период. В статье рассмотрены антропометрические данные физического развития, полученные в 2013 и 2023 г. Были обследованы 476 детей в возрасте 14–16 лет (256 мальчиков, 220 девочек). Исследования физического развития в группе мальчиков старшего школьного возраста выявили значимые различия. Мальчики всех возрастов, обследованные в 2023 г., отстают от своих сверстников, обследованных в 2013 г., по количеству человек с гармоничным физическим развитием, при этом 2023 г. выявлено значимо больше детей с дисгармоничным физическим развитием за счет избыточной массы тела. Результаты анализа физического развития у девочек несколько отличаются: современные 14-летние школьницы отстают от обследованных в 2013 г. по наполняемости группы с гармоничным физическим развитием. Результаты проведенного сравнительного анализа длины тела продемонстрировали, что современные школьники во всех возрастно-половых группах не отстают от их сверстников, обследованных в 2013 г. ($p > 0,05$). Заметный рост массы тела у школьников по сравнению с 2013 г., вероятно, обусловлен карантинными мерами в связи с пандемией COVID-19, которые привели к увеличению времени, проводимого детьми дома, и снижению их физической активности.

Ключевые слова: гигиена детей и подростков, физическое развитие, динамика, антропометрия

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Comprehensive assessment of physical development in children and adolescents is a critically important component of the pediatric population health status estimation. This makes it possible to identify the effects of the lifestyle factors, environment, and learning process on the growing child's body [1, 2]. A considerable amount of scientific research on assessing physical development in children during various age periods

is carried out in order to monitor the pediatric population health status. The children's harmonious development, well-being, and social adaptation determine the future of our country [3, 4].

The physical development level is determined by the values of key anthropometric parameters (body height and weight), and the ratio of these parameters determines whether the child's development is harmonious. Furthermore, physiological

parameters that reflect the activity of body's structural components also play an important role in assessment of physical development [5, 6].

The results of large-scale studies confirm unfavorable trends in children and adolescent health. There is a decrease in the number of healthy children, along with the increase in the number of children with chronic disorders or disability [7]. The child's body continuously grows and develops; any deviations from normal can indicate health problems. Physical maturation follows biological patterns and reflects the general patterns of body's growth and development [8]. However, the long-term urbanization, transformation of the environment, changes in the population ethnic makeup, effects of the climatic and geographic conditions, lifestyle, as well as different quality of care provision also influence the processes of children's physical development.

The regional indicators of physical development used to assess the development of traits are based on the anthropometric assessment of homogenous groups of children. These indicators need to be continuously updated and adapted for each region of Russia. The regional standards of physical development for children and adolescents living in the Samara Region, which were updated in 2013, need to be revised. In this regard, it is relevant to assess dynamic changes in the main physical development indicators in this region considering the regional and temporal features.

The study was aimed to assess the dynamic changes of physical development indicators in the high school-age children in the Samara Region over a decade.

METHODS

The surveyed group included 476 children aged 14–16 years (256 boys, 220 girls), who attended secondary educational institutions in Samara and had no clinical manifestations of disorders; at the time of measurement they belonged to the health status groups 1 and 2. The surveyed children had been permanent residents of Samara for more than 5 years. The children belonging to the health status group 3 or higher, who did not attend general educational institutions or lived in Samara for less than 5 years, were excluded from the study. Body height and weight were measured using standard equipment: body height using a stadiometer (Tves; Russia) with an accuracy of up to 0.5 cm, body weight using the VEM-150-Massa-K scales (Massa-K; Russia) with an accuracy of up to 60 g. The anthropometric characteristics (body height and weight) were estimated using the regional regression scales for the Samara Region in the Anthro-prof software package "Program for Assessing Physical Development in Schoolchildren" [9, 10].

The data obtained were compared with similar physical development indicators obtained in the study conducted in 2013. The study involved 496 adolescents aged 14–16 years (263 boys and 231 girls), who attended secondary educational institutions in Samara [11].

Statistical processing of the results was performed using the StatTech 4.0 (StatTech; Russia) software package and MyOffice (New Cloud Technologies; Russia). Significance of differences between the values compared was determined using the chi-squared test (χ^2); Yates's correction was applied when necessary. The critical significance level was considered to be 0.05, when testing the statistical hypotheses. Student's t-test was used to estimate significance of differences between the mean values. The differences were considered significant at $p \leq 0.05$.

RESULTS

Estimation of children's physical development throughout two assessment periods revealed no children with disharmonious physical development due to abnormal body height.

Estimation of physical development in senior school-age boys revealed significant differences in boys aged 14 and 15 years relative to their peers examined in 2013. Thus, the share of 14-year-old children with harmonious physical development was 69.5% in 2013, while in 2023 it was 50% ($p = 0.024$). However, the share of children with disharmonious physical development due to excess body weight increased: it was 14.7% in 2013 and 31.5% in 2023 ($p \leq 0.05$). Furthermore, the percentage of children with disharmonious physical development due to underweight increased in 2013.

The share of 15-year-old boys with harmonious physical development was 72.5% in 2013 and 68.2% in 2023. The share of children with disharmonious physical development due to excess body weight was 8.7% in 2013, while in 2023 it was 16.6%. The differences between peers assessed in two different decades were significant ($p \leq 0.05$). Comparison of physical development in the 16-year-old boys assessed in 2013 and 2023 revealed no significant differences ($p > 0.05$). In 2013, the share of boys with harmonious physical development was 61%, while in 2023 it was as low as 38.2%. Furthermore, the percentage of adolescents with disharmonious physical development due to underweight increased in this age group: in 2013 it was 22.0%, and in 2023 it was 47.1%. Amidst this the percentage of overweight boys decreased: it was 17% in 2013 and dropped to 14.7% in 2023 (Table 1).

Such trend was also observed in girls. By the age of 16, the share of today's children with harmonious physical development becomes the same as the share of their peers examined in 2013. Assessment of 14-year-old girls revealed significant differences in the physical development estimation results ($p \leq 0.05$). The share of girls with harmonious physical development dropped to 37.5% in 2023, while in 2013 it constituted more than a half of the surveyed adolescents of the same age group (56.3%). In contrast, in 2023 the share of girls with disharmonious physical development due to excess body weight increased to 34.5%. In 2013 the value of this group was 23.1%. Despite the growing number of overweight girls, the prevalence of underweight among girls also increased relative to 2013 (to 28 and 20.6%, respectively). Physical development of the 15- and 16-year-old girls surveyed in 2023 did not differ from that reported in 2013. Harmonious physical development was reported in 51.2% of 16-year-old girls surveyed in 2013 and 61.8% of girls surveyed in 2023. No differences were also revealed in the OW and UW groups of both 15- and 16-year-old girls (Table 2).

Comparison of the mean values of major anthropometric traits of children surveyed in different decades revealed significant differences. According to the assessment results obtained in 2023, a significant increase in body height was revealed in the groups of 14- and 15-year-old-boys relative to their peers surveyed in 2013. Thus, body height of 14-year-old boys was 157.3 ± 0.64 cm in 2013 and 168.2 ± 1.8 cm in 2023 ($p < 0.01$). In 15-year-old boys, body height was 163.6 ± 0.77 cm in 2013 and 170.3 ± 1.1 cm in 2023 ($p < 0.01$.) There were no significant differences between the values of 16-year-old boys: 176.53 ± 0.93 cm in 2013, 176 ± 1.1 cm in 2023 ($p = 0.37$).

When comparing body height in girls surveyed in 2023, a significant increase in body height at the age of 14 and 15 years relative to the peers surveyed in 2013 was reported. Thus, body height of the 14-year-old girls was 147.3 ± 0.64 cm

Table 1. Physical development of boys aged 14–16 years

14 years					
Physical development	2023		2013		χ^2, p
	<i>n</i> = 80		<i>n</i> = 87		
	Abs.	%	Abs.	%	
H(N)PD	40	50	60	69.5	$\chi^2 = 7.544^*$ $p = 0.024^*$
UW	15	18.5	14	15.8	
OW	25	31.5	13	14.7	
15 years					
Physical development	2023		2013		χ^2, p
	<i>n</i> = 92		<i>n</i> = 89		
	Abs.	%	Abs.	%	
H(N)PD	56	68.2	65	72.5	$\chi^2 = 10.807^*$ $p = 0.005^*$
UW	12	15.2	17	18.8	
OW	24	16.6	7	8.7	
16 years					
Physical development	2023		2013		χ^2, p
	<i>n</i> = 84		<i>n</i> = 90		
	Abs.	%	Abs.	%	
H(N)PD	32	38.2	55	61	$\chi^2 = 0.294$ $p = 0.864$
UW	40	47.1	20	22	
OW	12	14.7	15	17	

Note: H(N)PD — harmonious (normal) physical development; UW — underweight; OW — overweight; * — significant results.

in 2013, and in 2023 it was 153.9 ± 1.1 cm ($p < 0.01$). Body height of the 15-year-old girls was 160.8 ± 1.1 in 2013 and 165.8 ± 0.77 cm in 2023 ($p < 0.01$). The values of 16-year-old girls were as follows: 2013 — 176.53 ± 0.93 cm, 2023 — 176.0 ± 1.1 cm ($p = 0.66$) (Fig. 1).

Physical development of the boys surveyed in 2023 was significantly different from that of girls ($p = 0.003$): the

percentage of underweight children among boys (15%) was significantly lower than among girls (30%) surveyed in 2023. However, boys with harmonious physical development showed no significant differences from their female peers ($p = 0.605$).

When comparing boys and girls surveyed in 2013, it was found that the share of boys with harmonious physical development (68%) was significantly higher ($p = 0.019$), than

Table 2. Physical development of girls aged 14–16 years

14 years					
Physical development	2023		2013		χ^2, p
	<i>n</i> = 78		<i>n</i> = 87		
	Abs.	%	Abs.	%	
H(N)PD	29	37.5	49	56.3	$\chi^2 = 6.098^*$ $p = 0.048^*$
UW	22	28	18	20.6	
OW	27	34.5	20	23.1	
15 years					
Physical development	2023		2013		χ^2, p
	<i>n</i> = 68		<i>n</i> = 68		
	Abs.	%	Abs.	%	
H(N)PD	24	31	33	48.5	$\chi^2 = 2.499$ $p = 0.287$
UW	24	31	20	29.4	
OW	20	38	15	32.1	
16 years					
Physical development	2023		2013		χ^2, p
	<i>n</i> = 74		<i>n</i> = 76		
	Abs.	%	Abs.	%	
H(N)PD	46	61.8	39	51.2	$\chi^2 = 2.354$ $p = 0.309$
UW	22	29.4	26	34.2	
OW	6	8.8	11	14.6	

Note: H(N)PD — harmonious (normal) physical development; UW — underweight; OW — overweight; * — significant results.

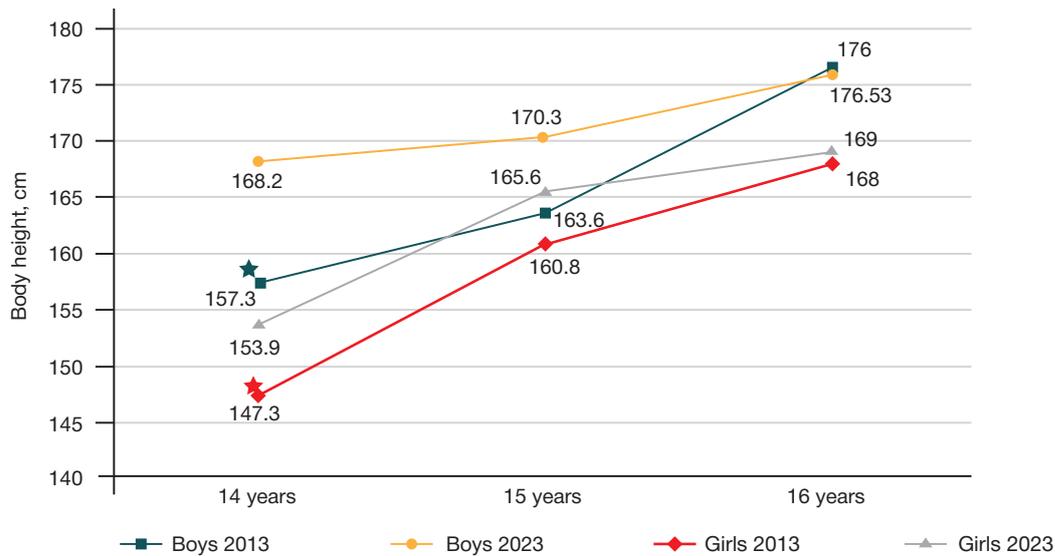


Fig. 1. Body height of boys and girls aged 14–16 years in Samara based on the body height assessment performed in 2013 and 2023

the share of girls (50%). Underweight and overweight boys were statistically the same as girls ($p = 0.103$).

Comparison of body weight in the high school-age boys showed that the 14-year-old schoolboys surveyed in 2013 significantly ($p = 0.044$) lagged behind their peers surveyed in 2023. Body weight values became the same by the age of 15 years. This could be due to the larger number of overweight children (Table 2). Thus, body weight of 14-year-old boys was 46 ± 4.08 kg in 2013, 50.3 ± 0.86 kg in 2023 ($p < 0.01$). The values of 15-year-old boys were as follows: 64.2 ± 0.4 kg in 2013, 62.2 ± 0.7 kg in 2023 ($p = 0.05$). Body weight of 16-year-old boys was 66.73 ± 0.3 kg in 2013 and 67.6 ± 1.2 kg in 2023 ($p = 0.05$) (Fig. 2).

A similar trend was observed when comparing body weight in girls. Thus, the 14-year-old girls surveyed in 2013 had significantly lower body weight ($p < 0.01$), than their peers surveyed in 2023. However, the body weight values obtained in 2013 and 2023 became the same by the age of 15 years.

Body weight of 14-year-old girls was 49.6 ± 1.8 kg in 2013 and 53.5 ± 0.7 kg in 2023 ($p = 0.045$). The values of 15-year-old girls were as follows: 54.27 ± 0.6 kg in 2013, 54.4 ± 1.1 kg in 2023 ($p = 0.91$). Body weight of 16-year-old schoolgirls was 54.6 ± 0.8 kg in 2013, 55.7 ± 1.3 kg in 2023 ($p = 0.47$) (Fig. 2).

DISCUSSION

Comparative analysis of the physical development assessment results has shown that children with harmonious physical development are significantly less common among today's schoolchildren of the Samara Region, than among their peers surveyed in 2013.

The study of the features of the indicator dynamics has revealed significant differences in the major anthropometric traits in each gender-age group. The lag in development of one anthropometric trait is not always associated with the corresponding trends of other developmental indicators in the same gender-age group. Significant differences in the number of underweight boys were revealed when comparing boys and girls. The observed decrease in the number of children with harmonious physical development resulting from the increase in the number of overweight boys and girls that was confirmed by significant differences in the average body height and weight can suggest specific features of sexual development in the discussed age groups [12, 13]. The change in the age of growth spurt was revealed when comparing the average anthropometric parameter values. In our opinion, which is in line with the other authors' opinions [14, 15], the change can result

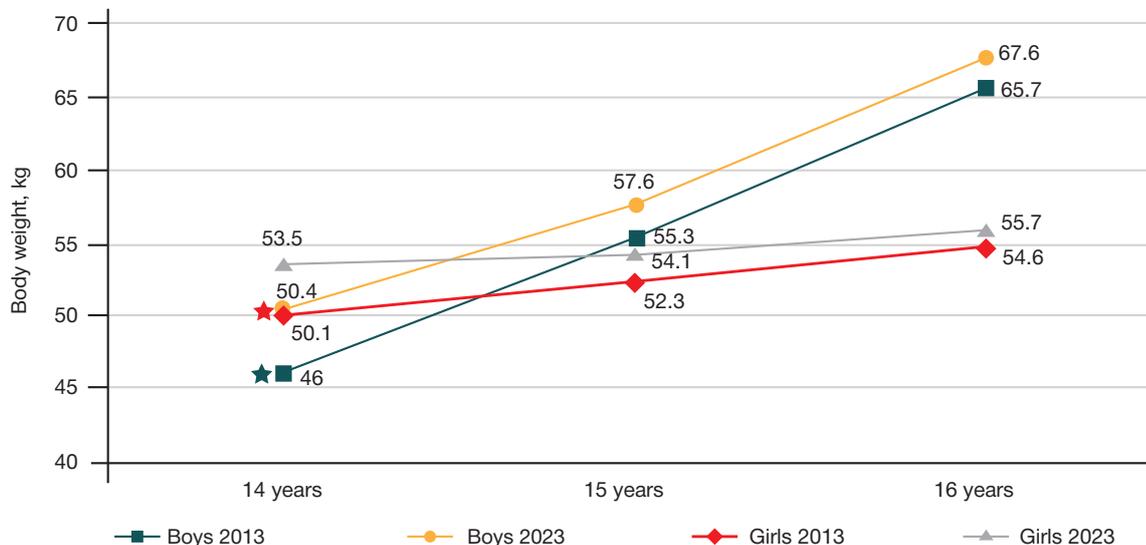


Fig. 2. Body weight of boys and girls aged 14–16 years in Samara based on the body height assessment performed in 2013 and 2023

from the features of the course of puberty and the impact of the altered diet, urbanization, and increased information load.

According to a number of researchers, the current trend is a significant increase in the number of children of this age group compliant with the basic principles of healthy lifestyle and actively involved in sports, which also has an effect on the anthropometric parameters. Thus, the authors note that body weight of the children engaged in swimming is significantly higher than body weight of their peers [16], while children engaged in tennis have body height that is significantly higher, than in children, who do not practice intense physical exercise [17].

A significant increase in the schoolchildren's body weight relative to the values reported in 2013 can be associated with the quarantine measures due to coronavirus infection (COVID-19): large amount of time spent at home, sedentary lifestyle, decreased physical activity [18].

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CONCLUSIONS

The identified differences in the anthropometric indicators of 14–16-year-old children acquired in different decades in Samara demonstrate the need for thorough investigation of the current features of physical development in the majority of children's age groups aimed to decide on the need to revise the regional standards of the physical development anthropometric traits. The features of the growth shift identified provide the context for the more thorough study of biological development in today's schoolchildren. Multiple studies suggest possible effects of the living conditions and lifestyle, including the amount of children's physical activity. In this regard, it seems necessary to assess the possibility to use the data of the children actively involved in sports and allocate the groups of children with various levels of physical activity for more thorough and reliable estimation of their physical development, when studying anthropometric indicators.

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