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ORIGINAL RESEARCH

4

Severity of borderline level eating disorders in student

Voitovich AA

Выраженность пограничного уровня расстройств пищевого поведения у студенческой молодежи

А. А. Войтович

OPINION

8

Development of a program for shaping healthy lifestyle and health improvement in student youth

Aminova OS, Tyatenkova NN

Разработка программы по формированию здорового образа жизни и оздоровлению студенческой молодежи

О. С. Аминова, Н. Н. Тятенкова

REVIEW

13

Hygienic aspects of human carcinogenic safety with respect to biological factors

Eliseev YuYu, Chekhonov SYu, Eliseeva YuV

Гигиенические аспекты решения проблемы обеспечения канцерогенной безопасности для человека факторов биологической природы

Ю. Ю. Елисеев, С. Ю. Чехомов, Ю. В. Елисеева

ORIGINAL RESEARCH

21

Hygienic features of the quality of drinking water from the regional center centralized water supply system based on organoleptic indicators

Gavrikova AA, Dementiev AA, Solovyov DA, Tsurgan AM, Paramonova VA, Korshunova EP, Sharov AA

Гигиенические особенности качества питьевой воды централизованной системы водоснабжения областного центра по органолептическим показателям

А. А. Гаврикова, А. А. Дементьев, Д. А. Соловьев, А. М. Цурган, В. А. Парамонова, Е. П. Коршунова, А. А. Шаров

ORIGINAL RESEARCH

27

Comparative assessment of the incidence of malignant neoplasms of the ovaries in women living in the environmentally disadvantaged areas (2000–2019)

Golovleva AA, Korsakov AV, Troshin VP, Milushkina OYu, Pivovarov YuP, Korolik VV, Lagerev DG

Сравнительная оценка заболеваемости злокачественными новообразованиями яичников женщин, проживающих на экологически неблагоприятных территориях (2000–2019 гг.)

А. А. Головлева, А. В. Корсаков, В. П. Трошин, О. Ю. Милушкина, Ю. П. Пивоваров, В. В. Королик, Д. Г. Лагерева

ORIGINAL RESEARCH

34

Sleep disorders in primary school children associated with use of various types of digital devices

Khramtsov PI, Kurgansky AM, Berezina NO, Chekalova SA, Antonova EV

Нарушения сна у младших школьников при использовании различных видов цифровых устройств

П. И. Храмцов, А. М. Курганский, Н. О. Березина, С. А. Чекалова, Е. В. Антонова

ORIGINAL RESEARCH

39

Comprehensive assessment of the nutritional status of figure skaters

Zadorozhnaya NA, Dubkova NV, Domozhilova AA, Petrochenko DE

Комплексный подход к оценке пищевого статуса фигуристов в современных условиях

Н. А. Задорожная, Н. В. Дубкова, А. А. Доможилова, Д. Е. Петроченко

ORIGINAL RESEARCH

44

Quality of life and lifestyle assessment in students of medical and humanitarian faculties of Voronezh universities

Fertikova TE, Komissarova OV, Sapina AE, Trofimova AS

Оценка качества и образа жизни студентов медицинских и гуманитарных специальностей вузов г. Воронежа

Т. Е. Фертикова, О. В. Комиссарова, А. Е. Сапина, А. С. Трофимова

SEVERITY OF BORDERLINE LEVEL EATING DISORDERS IN STUDENTS

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The relevance of the study results from high significance of nutrition and the growing interest of today's researchers in the phenomenon of orthorexia nervosa (ON) as an obsessive desire for healthy, proper diet. The study aimed to assess ON severity in students. The students' anthropometric measurements (body height, body weight), body mass index (Quetelet Index), ON severity based on the ORTO-15 questionnaire, features of the diet based on the Food Frequency Questionnaire were assessed, with subsequent statistical processing of the results. High prevalence of ON among both girls and young men (80.2% of the respondents) was shown. Furthermore, there were no differences in the ON phenomenon severity between young men and girls, and the relationship between the ON severity and the anthropometric measurements was non-significant ($p > 0.05$). Food selectivity associated with the phenomenon of ON was found in 3.3% of cases. Imbalanced diet was found in the majority of the respondents. The study has made it possible to conclude that the subjects constitute the group at risk of eating disorders. Further research is needed to accurately diagnose ON and reveal the relationship between ON and possible risk factors of this condition.

Keywords: orthorexia nervosa, nutrition, healthy lifestyle, BMI, students

Compliance with ethical standards: all students submitted the informed consent to participation in the study.

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ВЫРАЖЕННОСТЬ ПОГРАНИЧНОГО УРОВНЯ РАССТРОЙСТВ ПИЩЕВОГО ПОВЕДЕНИЯ У СТУДЕНЧЕСКОЙ МОЛОДЕЖИ

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Актуальность проведенного исследования обусловлена высокой значимостью питания и растущим интересом к феномену нервной орторексии (НО) как навязчивого стремления к здоровому и правильному питанию со стороны современных исследователей. Целью исследования было изучить выраженность НО у студенческой молодежи. У студентов изучали антропометрические показатели (рост, масса тела), индекс массы тела по формуле Кетле, выраженность явления НО по опроснику «ORTO-15», особенности организации питания по опроснику «Food Frequency Questionnaire» с последующей статистической обработкой результатов. Показана высокая распространенность НО как среди девушек, так и среди юношей (80,2% опрошенных). При этом выраженность феномена НО у юношей и девушек не различалась и не была значимо связана с антропометрическими показателями ($p > 0,05$). Избирательность в питании, сопровождающая явление НО, обнаружена в 3,3% случаев. Нарушение сбалансированности питания выявлено у большинства опрошенных. Проведенное исследование позволило сделать вывод, что обследованные лица составляют группу риска формирования расстройств пищевого поведения. Необходимы дальнейшие исследования с целью точной диагностики и выявления связи НО с возможными факторами риска развития данного состояния.

Ключевые слова: нервная орторексия, питание, здоровый образ жизни, ИМТ, студенты

Соблюдение этических стандартов: все студенты подписали добровольное информированное согласие на участие в исследовании.

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Nutrition is of particular importance throughout human life, since it is a life-supporting factor that determines health. That is why food safety is a priority of state policy in the field of healthy eating aimed to provide the population with rational nutrition [1]. Multiple studies confirm the key role of nutrition in shaping the healthy lifestyle and prevention of nutrition-related diseases [2–4]. However, the features of modern lifestyle related to the changing nature of psychological aspects of shaping healthy diet, inadequate physical activity, disturbed daily routine present certain difficulties with the healthy lifestyle organization that are also typical for students [5–7]. Furthermore, there is a trend towards excess human desire for consumption of food products related exclusively to healthy diet, without taking into account the body's need for fundamental substances and energy [8], which creates conditions for eating disorders. Currently, an obsessive desire for healthy, proper diet represents the eating disorder referred to as orthorexia nervosa (ON) [9].

Despite the fact that ON is currently not considered as a distinct disease entity in Russia (not included in ICD-10)

and abroad (not recognized by the Diagnostic and Statistical Manual of Mental Disorders, fifth edition (DSM-V)), modern researchers study this disorder considering orthorexia as a syndrome that requires in-depth research [6, 8–11]. A number of psychological aspects are distinguished (emotional, social, personal) that bring together this condition and other eating disorders [11], which makes it possible to consider ON as a type of anorexic behavioral syndrome.

The available scientific research results suggest high prevalence of this syndrome among young adults adherent to specific dietary behavior involving restricted alcohol consumption and smoking restriction [6, 12]. On the one hand, this trend can be regarded as positive, however, individuals with ON are characterized by higher anxiety levels and feeling guilty. Some consider ON as a type of obsessive-compulsive neurosis or hypochondria [11]. From another perspective, ON is associated with the presence of obsessive-compulsive features [13]. Among risk factors of ON, modern researchers distinguish innate psycho-physiological characteristics,

such as characteristics of the central nervous system (CNS) and temper, high birth weight; genetic factors, including family history of eating disorders and inherited constitutional type; social factors, i.e. appearance standards accepted by the society, relationship with parents, discipline, culinary culture in family. Moreover, personality traits, such as suggestibility degree, system of life priorities and values, are also considered the risk factor of ON [6].

The issue is of interest to foreign researchers, who propose definitions of ON [6], develop the diagnosis methods [14, 15] and diagnostic criteria [13], assess prevalence of the condition in various population groups [6, 9–11]. At the same time, there is no reliable data on the ON severity in the Russian youth, therefore, the study aimed to assess severity and specifics of ON manifestations in students.

METHODS

The data provided were obtained by conducting the field hygienic survey of 160 medical students aged 19 ± 0.4 , among them 72 were young men and 88 were girls. The inclusion criteria were as follows: the subject's age (18–20 years), fact of attending medical university, voluntary consent to take part in the study. The criteria for students' exclusion from the study were age below 18 and over 20 years, as well as the lack of voluntary informed consent.

Examination was performed in the middle of the semester. We assessed anthropometric measurements (body height, body weight). The subjects' standing height was measured using the RM medical stadiometer (TZMT; Russia), while body weight was measured using the VEM-150-Massa-K (AZ) medical floor scales (Massa-K; Russia). Body mass index (BMI) was calculated using the Quetelet's formula as a ratio of body weight (kg) to the square of the height (m^2). In accordance with the WHO guidelines [16], BMI values below 16 were considered as severe underweight; 16–18.4 — underweight; 18.5–24.9 — normal weight; 25–29.9 — overweight; BMI values of 30–34.9 indicated obesity of the 1st degree; 35–39.9 — obesity of the 2nd degree; BMI > 40 indicated obesity of the 3rd degree. Since modern foreign studies have revealed body weight alteration in patients with ON [13], we have found it appropriate to study BMI as a possible phenomenon severity criterion.

The ORTO-15 questionnaire was used to detect signs of ON in the subjects, with subsequent assessment of point ON prevalence using the threshold ORTO-15 score < 35 [14, 15]. The questionnaire was selected due to its high diagnostic value (98.9%) according to [15].

The eating habits, frequency of food and beverage intake within a certain period were assessed using the semiquantitative Food Frequency Questionnaire [17] convenient in terms of statistical processing and allowing one to simultaneously determine the frequency and quantitative characteristics of the diet for the long period [18]. The questionnaire contained the list of foods and beverages with the portion size or weight specified, as well as estimates of the frequency of intake by categories “never”, “less than once a month”, “1–3 times per month”, “once a week”, “2–4 times per week”, “5–6 times per week”, “once a day”, “2–3 times a day”, “4–5 times a day”, and “more than six times a day”. The intake frequency values reflected the period of 12 months. When assessing the diet in general, the number of requested foods and beverages combined into major food groups was 185. The results of the questionnaire survey of the respondents were assessed in accordance with the data used for the questionnaire validation and reproducibility estimation in the studies [18].

Statistical processing of the results was performed using the StatTech 4.0 software package (StatTech; Russia). The differences were considered significant at the two-tailed significance levels $p < 0.05$; $p < 0.01$; $p < 0.001$ for all the results obtained; the minimum significance of differences was 95%. Correlations between the values of the data obtained were determined using the nonparametric Spearman's rank correlation coefficient. Positive values of the coefficient corresponded to positive correlation, negative values corresponded to negative correlation, $p = 0$ corresponded to no correlation. The correlation strength was estimated based on the coefficient values: the correlation was considered to be weak at p between 0 and 0.3, moderate at p between 0.3 and 0.5, strong at p between 0.5 and 0.7, very strong at p exceeding 0.7. The sample distribution was tested for normality using the Mann–Whitney U test at $p = 0.05$. When testing the hypothesis H_0 , it was found that the hypothesis H_0 was true, since $U_{kr} < U_{emp}$.

RESULTS

The results obtained (Table) showed that the subjects' average BMI values were 22.6 ± 2.6 kg/ m^2 and corresponded to normal weight (18.5–24.9 kg/ m^2).

Significant differences in BMI between young men and girls were revealed based on the data processing applied. Thus, the number of underweight girls was 20.4%; it was significantly higher compared to that of young men ($p < 0.001$). The number of overweight young men was 25%, it was significantly higher compared to that of girls ($p = 0.02$).

The analysis of the subjects' diet showed that it was decentralized. The surveyed young men and girls preferred homemade food, less often public food services. According to the ORTO-15 questionnaire data, there were no significant differences between the average scores of the groups of young men and girls; the average scores were 36.3 ± 6.7 and 36.1 ± 0.1 , respectively. At the same time, the results of the questionnaire data processing made it possible to reveal high ON severity in both girls and young men, since 80.2% of the respondents (128 individuals) scored below 35 based on the ORTO-15 questionnaire results. Predisposition to orthorexia was found in 13.7% of subjects (22 individuals), and there was no risk of this condition only in 6.8% of cases (11 individuals). However, in 93.1% of cases (149 individuals), answers to the questions “When eating, do you pay attention to the calories of the food?”, “Are you willing to spend more money to have healthier food?”, “Do you feel guilty when transgressing?” showed propensity for food selectivity, obsessive desire for healthy diet.

According to the Food Frequency Questionnaire results, significant food selectivity was found only in 3.3% of cases. However, the test made it possible to reveal nutritional imbalance represented by refusal (in some cases) to eat dairy products (28.3% of cases), by-products (51.6% of cases), and vegetables (13.3% of cases), as well as by limited consumption of foods with high simple carbohydrate content (48.3% of cases) and various beverages (21.6% of cases) by female students. Chicken dishes, various side dishes and soups were most common in the girls' diet.

Among young men showing signs of eating disorders, only one subject stuck to a diet and restricted himself in eating sweets, pastry, and products containing large amounts of oil. The majority of students (64.6%) refused to eat animal source foods (meat) or consumed these less than once a month. Both young men and girls showed reduced consumption

Table. Results of the subjects' BMI assessment

BMI values (kg/m ²)	Young men, % (<i>n</i>)	Girls, % (<i>n</i>)	<i>P</i> -values
< 16	–	–	–
16–18.4	–	20.4 (18)	< 0.001
18.5–24.9	69.4 (50)	57.9 (51)	0.13
25–29.9	25 (18)	11.3 (10)	0.02
30–34.9	6.9 (5)	10.2 (9)	0.46
35–39.9	–	–	–
< 40	–	–	–

of by-products (40% of respondents), vegetables (30%), and fish (23.3%); foods high in simple carbohydrates predominated in the diet of 63.3%.

The results of statistical data processing suggest no significant correlation between BMI values and ON manifestations (Spearman's rank correlation coefficient is 0.182 in the group of surveyed girls and 0.108 in the group of young men; $p > 0.05$). Thus, it was considered that body weight alteration was not typical for the subjects showing signs of ON. Furthermore, significant food selectivity was determined only in 3.3% of cases, while signs of ON we reported in 80% of the respondents.

DISCUSSION

The findings of modern scientific research suggest vulnerability of students to borderline mental disorders associated with insufficient stability of personal convictions, lack of life experiences, everyday stress, specifics of studying in institutions of various profiles [19].

Our study revealed considerable ON severity in students, which confirmed the view that the prevalence of this phenomenon is extremely high based on the findings of previous studies. Thus, the studies [6] revealed signs of ON in 69.4% of respondents, while the studies [11] revealed these in 100% of subjects. Foreign researchers found ON in 88.7% of students [20]. The prevalence of this phenomenon in the U.S. adult population varied between 41.9 and 81.9% [21]. The research showed that girls were more prone to ON [22]. However, we revealed equal severity of this phenomenon in young men and girls, without any significant differences in the data obtained ($p > 0.05$). Thus, young men need more attention from appropriate medical specialists for timely implementation of preventive measures.

Based on the ORTO-15 questionnaire results, signs of ON have been found in 80.2% of the respondents ($p < 0.05$), which

suggests high prevalence of this phenomenon. Furthermore, young men and girls showed the same ON severity that was not significantly correlated to anthropometric measurements (Spearman's rank correlation coefficient was 0.182 in the group of girls and 0.108 in the group of young men; $p > 0.05$).

However, the findings of modern research make it impossible to determine the causes of this condition. Our findings showed some differences in the subjects' anthropometric measurements. Despite the fact that the students' average BMI values were 22.6 ± 2.6 kg/m², which corresponded to normal values, a significantly larger number of girls were underweight ($p < 0.001$) and a significantly larger number of young men were overweight ($p = 0.02$).

It is believed that ON is associated with food selectivity. The Food Frequency Questionnaire data did not confirm this belief, but made it possible to reveal some concerns about eating in both young men and girls. The surveyed young men and girls reduced consumption of dairy products, by-products, and foods high in simple carbohydrates, which was combined with violations of the rational nutrition principles. However, food selectivity accompanying the ON phenomenon was found only in 3.3% of cases.

CONCLUSIONS

It has been found that the issue of orthorexia nervosa (ON) is relevant for students. The study conducted makes it possible to conclude that the surveyed individuals constitute the group at risk of eating disorders, since they show high vulnerability to the effects of environmental factors. Further research is required aimed to accurately diagnose ON and reveal the correlation with the risk factors of this condition. It is necessary to organize screening for the youth in order to ensure early detection of the group at risk and subsequent provision of adequate prevention and treatment.

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DEVELOPMENT OF A PROGRAM FOR SHAPING HEALTHY LIFESTYLE AND HEALTH IMPROVEMENT IN STUDENT YOUTH

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In the light of the issue, specifically health preservation in students, the development and introduction of the program for shaping healthy lifestyle and health improvement in student youth seems relevant, which constitutes the objective of the paper. Considering the data of the analytical literature review and the results of our study involving assessment of behavioral health risk factors in young adults, the program focused on shaping healthy lifestyle and health improvement in individuals engaged in educational process was developed and introduced at the Yaroslavl State Medical University. The program brings together five workstreams: optimization of training conditions and regime, assessment of lifestyle and the related risk factors, health culture development, sport and wellness activities, health services management. The program developed includes medical and hygienic, educational, sport and wellness health preservation technologies.

Keywords: health, healthy lifestyle, students, wellness program, health preserving education

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РАЗРАБОТКА ПРОГРАММЫ ПО ФОРМИРОВАНИЮ ЗДОРОВОГО ОБРАЗА ЖИЗНИ И ОЗДОРОВЛЕНИЮ СТУДЕНЧЕСКОЙ МОЛОДЕЖИ

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В свете рассматриваемой проблемы, а именно здоровьесбережения обучающихся, актуальными представляются разработка и внедрение программы по формированию здорового образа жизни и оздоровлению студенческой молодежи, что и стало целью настоящей работы. С учетом данных аналитического обзора литературы и результатов собственного исследования, связанного с оценкой поведенческих факторов риска здоровью молодежи, на базе ФГБОУ ВО «Ярославский государственный медицинский университет» Минздрава России разработана и внедрена программа по формированию здорового образа жизни и оздоровлению участников образовательного процесса. Программа объединяет пять направлений работы: оптимизация условий и режима обучения, оценка образа жизни и связанных с ним факторов риска, развитие культуры здоровья, спортивно-оздоровительная работа, организация медицинского обслуживания. Разработанная программа включает в себя медико-гигиенические, образовательные и физкультурно-оздоровительные здоровьесберегающие технологии.

Ключевые слова: здоровье, здоровый образ жизни, студенты, программа оздоровления, здоровьесберегающее образование

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Health preservation in children, adolescents, and young adults is one of the highest priorities of preventive medicine. The rising generation determines the country's reproductive potential and prospects for social and economic development [1]. It is well known that some diseases and certain functional disorders occur as early as at school [2], however, university training places considerable burden on almost all organs and systems

of the young body, thereby making these vulnerable during the development and exacerbation of chronic diseases [3, 4].

The role of controllable risk factors related to tobacco smoking, alcohol abuse, malnutrition, and insufficient physical activity in the development of non-communicable diseases have been proven [5, 6]. The Russian and foreign students' lifestyle is characterized by high prevalence of addictive behaviors, spending

large amounts of time on social media, reduced night sleep duration, hypodynamia, violation of the basic principles of healthy eating [1, 7–9].

Contemporary development of higher education institutions is aimed at maintaining health of individuals engaged in educational process [10]. Some regions of Russia have a good experience with implementation of projects on creating health preservation environment in higher education institutions [1, 11, 12], however, their contribution to health preservation in the studying youth remains small throughout the country [13–16].

Our aim was to develop and introduce the program for shaping healthy lifestyle and health improvement in student youth.

Workstreams within the framework of the program for shaping healthy lifestyle and health improvement in students

The program for shaping healthy lifestyle and health improvement in student youth was developed step by step. The first stage assumed analytical review of the research papers presenting the results of effective introduction of health preservation programs for university students [16]. At the second stage, behavioral health risk factors were assessed in students. It has been shown that the lack of the shaped health culture in young adults is associated with the development of morphofunctional disorders [17, 18]. The literature data and the results of our own studies provided the basis for the development of the complex

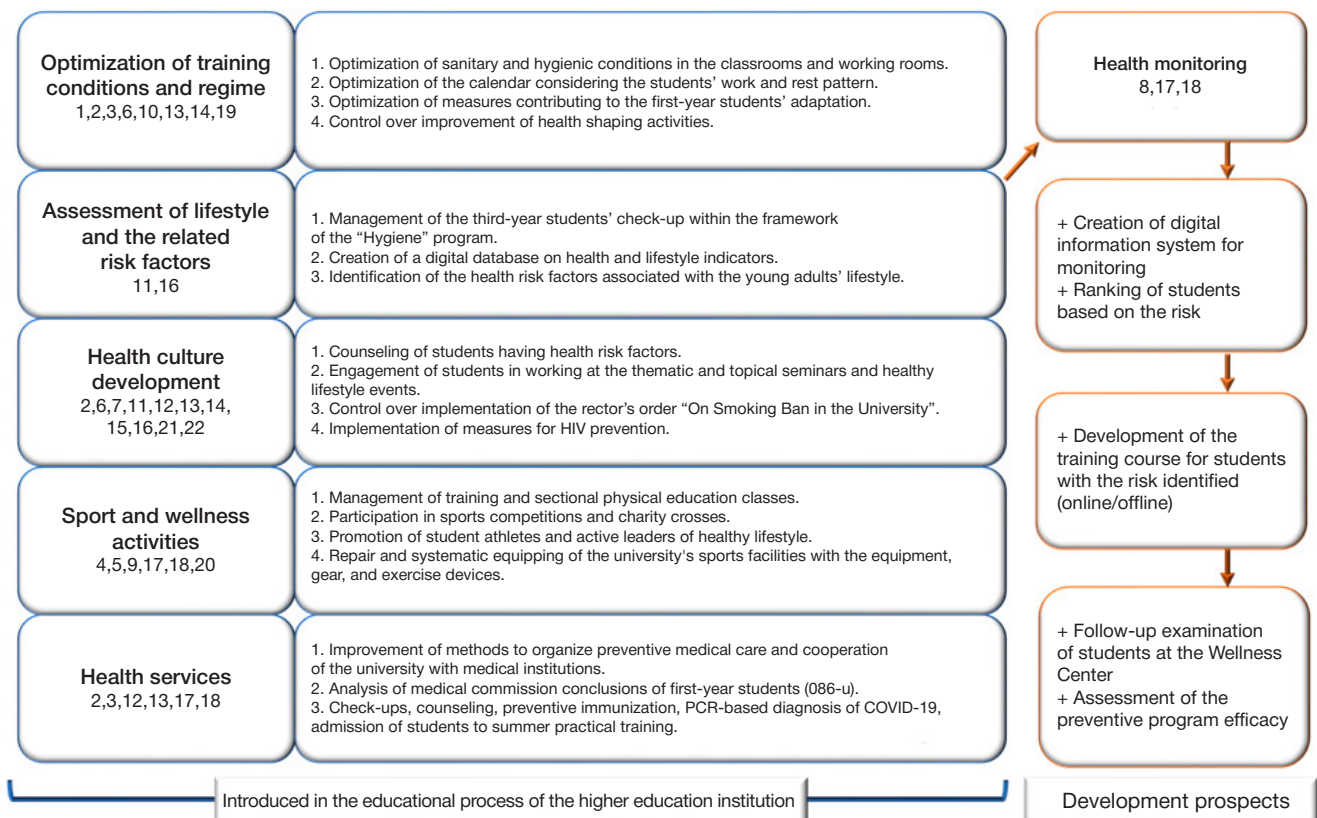
of preventive measures as part of the educational process in the university.

The program for shaping healthy lifestyle and health improvement in individuals engaged in educational process for the years 2022–2027 (hereinafter, the Program) was developed and introduced at the Yaroslavl State Medical University. During implementation of the program the responsible executives are administration, structural units of the Yaroslavl State Medical University, and the Wellness Center of the Yaroslavl Central City Hospital. The Program brings together five workstreams (Fig.):

1. Optimization of training conditions and regime in accordance with the sanitary rules and regulations [19, 20]. This is a fundamental area that should provide the basis for other health preservation components of the educational process in the university.

2. Assessment of lifestyle and the related risk factors. This workstream is implemented in the university for the first time. To identify the priority behavioral health risk factors, university staff together with the Wellness Center of the Yaroslavl Central City Hospital assess lifestyle, estimate morbidity, physical development and functional capabilities of the young adults' cardiorespiratory system (in accordance with the contract No. 225/27-1 on the research and technical cooperation). When studying at the Department of General Hygiene and Ecology, students of the general medicine and pediatric faculties are screened at the Wellness Center, where each student is both patient and supervisor of the Center.

3. The workstream "Health Culture Development" includes adjustment of the identified behavioral health risk factors



Note: responsible executives to implement the Program — 1. Rector's assistants. 2. Supervising Vice-Rector for Educational Activities and Digital Transformation. 3. Supervising Vice-Rector for Medical Care and Development of Regional Healthcare. 4. Supervising Vice-Rector for Tutorial Work and Youth Policy. 5. Supply and Secretariat. 6. Department of Tutorial Work. 7. PR Department. 8. Information Technology Department. 9. Center for Extracurricular Activities and Youth Policy. 10. Center for Social and Psychological Support. 11. Wellness Center of the Yaroslavl Central City Hospital. 12. Chief physician of the medical center. 13. Deans of faculties. 14. Heads of departments. 15. Teaching staff. 16. Department of General Hygiene and Ecology. 17. Department of Physical Education and Sports. 18. Department of Medical Rehabilitation and Sports Medicine. 19. Student Committee on Quality of Education. 20. "Zdorovye" Sports and Recreation Center. 21. Dormitory managers. 22. Academic building supervisors.

Fig. Program for shaping healthy lifestyle and health improvement in individuals engaged in educational process in the Yaroslavl State Medical University and its development prospects

in the form of individual counseling at the Wellness Center of the Yaroslavl Central City Hospital and the Department of General Hygiene and Ecology (at both individual and group levels); risk communication through engagement of students in working at the thematic and topical seminars and healthy lifestyle events.

4. Sport and wellness activities are included in the separate workstream of the Program due to high prevalence of irregular physical activity among young adults. The activities are supported by the “Zdorovye” Sports and Recreation Center of the Yaroslavl State Medical University. Organization of training and sectional classes, as well as systematic equipping of the university's sports facilities contribute to creation of favorable conditions for physical training and sports, while participation of teaching staff in the sports events and their orientation toward high physical activity contribute to shaping the health preserving behavioral pattern in students.

5. Health services management. The activities are implemented at the medical center of the Yaroslavl State Medical University. Currently, the center is responsible for vaccination and immunodiagnostics, counseling of the appealing students and medical check-ups; analysis of the medical commission conclusions of first-year students and admission of students to summer practical training. The leading measures of this workstream are improvement of methods to manage medical and preventive care and ensuring cooperation of the university with medical institutions.

Health preservation technologies included in the program for shaping healthy lifestyle and health improvement in students

The literature data confirm that risky behavior and health problems of students living in various regions have much in common [21–24]. Today there is no unified system for protection of university students' health [13, 15], however, there are effective local projects [1, 10–12, 25] and prospects for the development of this field, as suggested by the results of the meeting of the Coordination Council of the Russian Academy of Sciences and Russian Academy of Education “Health and Education of Children, Adolescents, and Youth” [26].

From the point of view of approaches to health protection, the Program developed combines several health-saving technologies:

1. Medical and hygienic technologies include management of health services for individuals engaged in educational

process, optimization of sanitary and hygienic conditions, and implementation of preventive measures.

2. Health preserving educational technologies. The workstream of the Program “Assessment of Lifestyle and the Related Risk Factors” is important for the development of the future specialists' skills and thinking related to health preservation, which currently represents a pressing issue of higher education [27]. Visits to the Wellness Center allow junior students to learn about the activities of preventive medical institutions and the equipment for screening, as well as to combine the roles of patient and supervisor of the Wellness Center. After the check-up conducted within the framework of the “Hygiene” training course the students fill the “Health Card”, identify behavioral risk factors and select an individual preventive program, which is preceded by the questions about perception of the risk factors and current lifestyle. Teachers of the department assess the proposed preventive program. It should be noted that such interdepartmental cooperation increases primary and secondary attendance of the Wellness Center by young adults. Thus, integrative activity of the Wellness Center physicians and staff of the Department of General Hygiene and Ecology seems to be an important component of the student health culture development. The monograph [10] provides an example of a pedagogical system for developing a culture of students' health based on the integration of academic disciplines.

3. Sport and wellness technologies. Help of the “Zdorovye” Sports and Recreation Center of the Yaroslavl State Medical University expands development opportunities for individuals engaged in educational process. The university administration and teaching staff activity and adherence to healthy lifestyle contribute to formation of the health preserving behavioral pattern in students, so the health culture should be considered as joint activity of all individuals engaged in educational process. The health preserving education forms both health culture and general culture of a person [10].

CONCLUSION

The start-up program for shaping healthy lifestyle and health improvement in individuals engaged in educational process has been developed for students of the Yaroslavl State Medical University and introduced. The development prospects for the topic are improvement of the program in terms of interaction between its structural blocks and integration of academic disciplines, as well as creation of a digital information system for monitoring the health of young people and the system implementation in the educational process.

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HYGIENIC ASPECTS OF HUMAN CARCINOGENIC SAFETY WITH RESPECT TO BIOLOGICAL FACTORS

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Current approach to sanitary and hygienic measures in various parts of the national health care system should create new challenges aimed at practical prevention in the context of the safety of people from the environmental carcinogenic factors. The effective Russian SanPiN 1.2.3685-21 regulates hygienic requirements for the safety of environmental factors for humans; inter alia, the documents lists biological carcinogens and carcinogenic lifestyle factors. The efforts of sanitary specialists in general and employees of Rospotrebnadzor in particular aimed at prevention of harmful impact of the existing carcinogenic factors shall be more effective if the available information on the potentially dangerous biological agents of carcinogenesis is more complete. This paper reviews the modern sanitary and hygienic aspects of carcinogenic factors of biological nature, and describes the causes of oncological diseases caused by them as well as the respective prognosis. Viruses, bacteria and trematodes, whose participation in the occurrence and development of a specific cancer is an established fact, are posed as etiological agents of the carcinogenic hazard biological factors present for a human being.

Keywords: biological carcinogenic factors, viruses, bacteria, sanitary prevention efforts organization, oncological morbidity

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ГИГИЕНИЧЕСКИЕ АСПЕКТЫ РЕШЕНИЯ ПРОБЛЕМЫ ОБЕСПЕЧЕНИЯ КАНЦЕРОГЕННОЙ БЕЗОПАСНОСТИ ДЛЯ ЧЕЛОВЕКА ФАКТОРОВ БИОЛОГИЧЕСКОЙ ПРИРОДЫ

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Современная организация санитарно-гигиенических мероприятий в сфере различных звеньев отечественного здравоохранения должна создать новые вызовы, направленные на практическое обеспечение профилактической работы в отношении безопасности для человека канцерогенных факторов среды обитания. На сегодняшний день в Российской Федерации действует СанПиН 1.2.3685-21, регламентирующий гигиенические требования к безопасности факторов среды обитания для человека, в котором перечислены биологические канцерогены и канцерогенные факторы образа жизни. Вместе с этим для организации специалистами санитарной службы и прежде всего сотрудниками Роспотребнадзора эффективной профилактической работы в отношении существующих канцерогенных факторов необходима более полная информация о потенциально опасных биологических агентах канцерогенеза. В представленном обзоре приведены современные санитарно-гигиенические аспекты изучения канцерогенных факторов биологической природы, описаны причины генеза и прогноза развития обусловленной ими онкозаболеваемости населения. В качестве этиологических агентов канцерогенной опасности для человека факторов биологической природы в обзоре представлена характеристика вирусов, бактерий и трематод, участие которых в возникновении и развитии конкретного онкозаболевания является установленным фактом.

Ключевые слова: канцерогенные факторы биологической природы, вирусы, бактерии, организация профилактической работы санитарной службой, онкологическая заболеваемость

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Introduction and improvement of measures designed to organize prevention work aimed at ensuring safety of people from carcinogenic environmental factors is one of the priorities for the current Russian healthcare system in the field of preservation of health of the population. Set up competently by sanitary service and, above all, Rospotrebnadzor, the effective efforts arranging state control over the said safety should further improve sanitary and epidemiological well-being of the population [1–10]. Currently, within the framework of a holistic view of the problems of safety of people from biological and environmental carcinogens, SanPiN 1.2.3685-21 considers such as the indisputable triggers of existing and potentially dangerous conditions promoting the spread of malignant neoplasms (MN) [11].

At the same time, doctors of medical and preventive care organizations as well as sanitary service specialists face an increasingly growing number of cancer patients, with various carcinogenic environmental factors often being the causes of specific nosologies [12, 13]. The difficulties associated with an objective study of human safety from carcinogenic environmental factors necessitate an analysis of works systematizing the use of modern sanitary and hygienic knowledge and standards in the context of the current situation in the domestic health system [14, 15]. The developments related to prevention measures, designed to assess the degree of danger biological carcinogenic factors pose to humans, are topical for the hygiene science and have both fundamental and applied importance.

Sanitary and hygienic rules of safeguarding people from carcinogenic environmental factors: current legislation

The International Agency for Research on Cancer (IARC), which is part of the World Health Organization (WHO) system, considers studying carcinogenic environmental factors to be a global problem of our time. Currently, WHO notes that MN are on the rise, and predicts continuation of this trend: in 2022, there were 20 million new cancer cases registered in the world, and by 2050, the number will increase to 35 million per year. In the Russian Federation, there up to 600 thousand new MN cases reported annually. The cumulative risk of developing a malignant tumor, i.e., one caused by a combination of stressors, is 23%, that is, almost one in five Russians may suffer the onset of cancer every year. At the same time, according to the IARC experts, the overall MN morbidity risk decreases by full 70% when a person stops being exposed to carcinogens [14–19].

The long-term exposure of people to carcinogenic risk factors that promote development of MN obliges the environmental safety and hygienic services to take supervisory legislative decisions at the level of the state that are designed to safeguard the population from the said factors.

Moreover, reduction of the level of pollution is one of the priorities of the Russian state policy in the field of environmental protection, reflected both in Article 42 of the Constitution of the Russian Federation and in the Federal Law "On Environmental Protection" [20, 21].

Legislation is constantly appended with sanitary regulations designed to make living and industrial environments safe in general and in terms of carcinogenic hazards in particular. Article 2 of Federal Law 52-FZ of 30.03.1999 "On the sanitary and epidemiological well-being of the population" lists legal, organizational and other measures aimed at ensuring the sanitary and epidemiological well-being of the population of the Russian Federation [22].

SanPiN 1.2.3685-21 "Hygienic standards and requirements for safety and (or) harmlessness of environmental factors for humans" lists known carcinogenic substances and their maximum permissible concentrations; section VIII of this regulation also gives biological carcinogenic factors that pose a danger to the population.

Analyzing biological carcinogenic factors, one should note that 18% of MN are of infectious genesis. Section VIII of the mentioned SanPiN lists more viruses than any other biological carcinogenic factor, which, according to the latest data, cause about 15% of human tumor neoplasms [23, 24].

Hepatitis B and C viruses, being exogenous oncogenic viruses, not only trigger acute hepatitis that becomes chronic but also entail liver cancer. It is generally recognized that chronic viral infections caused by hepatitis B and C viruses remain the dominant risk factors for the development of hepatocellular cancer. According to the available data, over 50% of hepatocellular carcinoma cases are attributed to chronic hepatitis B virus infection. In 2019, approximately 820,000 people died from hepatitis B, mainly because of liver cirrhosis and hepatocellular carcinoma. Moreover, in such situations, hepatitis C virus is an additional carcinogenesis risk factor, especially for non-Hodgkin lymphomas; it also makes development of thyroid cancer twice as probable, and raises the possibility of occurrence of hepatocellular carcinoma 2.5-fold [25–27].

Human papillomavirus (HPV) can cause oncological diseases, primarily those affecting female population (cervical

intraepithelial neoplasia, cervical cancer), and a rare skin disease, Lewandowsky dysplasia. The share of malignant tumors associated with HPV is 5%; 75% of them are localized in the genital area, 25% outside it. The latter include oropharyngeal cancer affecting the oral cavity (tongue, pharynx, and larynx), malignant tumors in the anal canal, and penile cancer. However, not all HPV strains are biological carcinogenic factors, only those of the high oncogenic risk types: 17, 19, 35, 37, 39, 43, 49, 55, 56, 60, 62, 63, 72. Of them, types 16 and 18 exhibit maximum oncogenic activity, triggering development of malignant tumors of the cervix in 95% of cases [23, 27–32].

Epstein-Barr virus (EBV), one of the most common human viruses, is very important among the biological carcinogenic factors. EBV is widespread in the environment; contracted by humans, it most often leads to the development of non-oncological infectious mononucleosis. However, EBV can also provoke oncological diseases: nasopharyngeal cancer (nasopharyngeal carcinoma), lymphoepithelial-like carcinomas in the stomach, esophagus, tonsils, salivary glands, thymus, etc., as well as various lymphomas, including a malignant tumor of B-cell lymphocytes developing in the lymphatic system and hematopoietic organs, the so-called Burkitt lymphoma [33, 34].

It is now generally believed that the long-term persistence of functionally active **herpes viruses** in the cells of a human body creates conditions for occurrence and development of the factors causing MN. Immune, hormonal and genetic triggers related to the imbalance of homeostasis play a significant role in the pathogenesis of tumors associated with the herpes virus. Thus, human B lymphocytes turned out to be the target cells for it, and infection of immune cells with herpes virus sharply ups the rate of chromosomal aberrations with translocation of chromosome sections, which indicates a carcinogenic danger [35]. Electron microscopic studies confirmed the link between this virus and a number of human tumors: cervical cancer, nasopharyngeal cancer, Burkitt lymphoma. It was also discovered that malignant tumors are mainly caused by the human herpes virus type 8, and they develop against the background of severe immunodeficiency. For example, it is known to cause the Kaposi's sarcoma, a malignant lung tumor typically registered in patients with immunodeficiency syndrome [19, 36].

Human T-lymphotropic virus (HTLV) is a representative of the genus of delta retroviruses (*Deltaretrovirus*). HTLV-1 is a type I human T-lymphotropic virus capable of causing rare cancers several decades after infection, including T-cell leukemia and T-cell lymphoma (developing in about 5% of the infected population). The pathogenesis of cancer is associated with the introduction of the HTLV-1 virus into T-cells, which, illogically, rearrange themselves to produce proteins that enhance proliferation of the virus, and block protective CD4⁺ and CD25⁺ T-regulatory immune cells, which ultimately translates into immunosuppression conducive to malignant cell degeneration [37–41].

Human immunodeficiency virus (HIV) can be HIV-1 and HIV-2, with both variants closely resembling each other. They weaken the T-cell immunity, but produce no genomic oncogenic effects. Embedding a section of viral DNA into the genome of an infected organism, HIVs destroy CD4⁺ lymphocytes and thus promote the development of dangerous opportunistic infections, subsequently increasing the risk of cancer growth. HIV-1 is not only ubiquitous, but also has greater virulence and infectious pathogenicity. At the same time, HIV patients have a higher incidence of cancer and higher mortality rates compared to the general patient population [42–46].

Currently, due to the high incidence of oncological diseases like Kaposi's sarcoma, lymphoma, and cervical cancer in AIDS patients, these diseases are labeled AIDS-associated. HIV patients are likely to have tumors in lungs, oral cavity, anal canal, testicles, skin (including squamous cell carcinoma and malignant melanoma) [47, 48].

An ideal example of how bacteria trigger cancer, especially stomach cancer, is the infection caused by *Helicobacter pylori* (*H. pylori*). The microbe is contracted in childhood, and half of the world's population has it in the gastric mucosa throughout life; in 1994, the IARC classified *H. pylori* as a group 1 carcinogen [49]. *H. pylori* has motile flagella, which enable to effectively colonize gastric mucosa, something other bacteria are poor in. As a result, patients with *H. pylori* not only suffer lesions of digestive organs accompanied by chronic inflammation, but also have MN developing in them with clinical signs of cancer or a MALT lymphoma (maltoma), characterized by damage to the lymphoid tissue of the stomach [50–52]. Some strains of *H. pylori* have the *CagA* virulence gene that disrupts apoptosis in the epithelial cells of the stomach, which plays a major role in this process. The *CagA* is also called a carcinogenesis factor or the first bacterial oncoprotein [53]. An infection with *CagA*-positive strains of *H. pylori* increases the risk of oropharyngeal and oral MN, esophageal, pancreatic, colon and colorectal cancers [54–58].

Based on the epidemiological studies conducted in Southeast Asia that showed a link between cholangiocarcinoma and *Opisthorchis viverrini* and *Clonorchis sinensis*, IARC included these **liver trematodes** in the register of biological carcinogens. Trematodes are a subclass of obligately endoparasitic flatworms [59–63]. A human can be invaded by trematodes when eating raw fish, crustaceans or aquatic plants that have not undergone heat treatment and contain larvae of the parasite. Chronic invasions, accompanied by frequent repeated infections by *O. viverrini* and *C. sinensis*, lead to chronic inflammation with fibrosis of the bile ducts, damage to the hepatic parenchyma, and subsequent development of cholangiocarcinoma, a deadly form of cancer. Hepatic trematodosis caused by *Opisthorchis felinus* is a disease frequently registered in the endemic regions of Western Siberia of the Russian Federation, where chronic invasion of opisthorchiasis is common. Numerous experimental and clinical data yielded by studies focusing on the *O. felinus* trematode also point to its of carcinogenic potential [64, 65].

Schistosomes, one of the most dangerous among the 12 species of trematodes parasitizing the human digestive tract, are recognized by the IARC as group 1 carcinogens. In many endemic regions, these helminths are considered responsible for oncogenesis. Every year, the incidence of schistosomiasis worldwide can claim up to half a million human lives. Helminthiasis infection results from the penetration of fresh water larvae (cercariae) of *Schistosoma haematobium* through the skin and mucous membranes into human blood vessels. The most typical symptoms of the disease are dermatitis, fever, malaise, myalgia, abdominal pain, hemorrhagic diarrhea, hematuria. According to WHO, over 250 million people in the world need prevention of and treatment against schistosomiasis currently [66]. Becoming chronic, schistosomiasis contributes to the development of such diseases as squamous cell carcinoma of the bladder, cholangiocarcinoma, and hepatocellular carcinoma [67–70].

Sanitary and hygienic aspects of the prevention efforts aimed at safeguarding humans from biological carcinogenic factors

Currently, the biological factors listed in SanPiN 1.2.3685-21 and presented in this review (viruses, bacteria and parasites)

are recognized by IARC as group 1 carcinogens responsible for oncogenesis contributing to the development of a number of MN [16, 71].

Most modern researchers claim that chronic inflammation is a common pathway for the occurrence and development of cancer, and oncogenes trigger oncopathology after activation caused by mutational changes in the genomes of somatic and germ cells as well as violations of immune homeostasis (inactivation of suppressor genes, etc.) [72, 73]. The induction of a chronic inflammatory process is accompanied by the biosynthesis of toxic and genotoxic metabolites, immune response impairments; it affects the composition of the host microbiome, ultimately leading to the progression of oncogenesis of various etiology [32, 74, 75].

For example, hepatitis B and C viruses, which cause acute hepatitis and turn into chronic inflammation, have been found to be the cause of liver cancer [26]. In patients with *H. pylori*, damage to the cells of the digestive organs is accompanied by chronic inflammation with the development of MN and clinical signs of cancer of the lymphoid tissue of the stomach. *O. viverrini* trematodes change the composition of the host's microbiome, which entails a cholangiocarcinoma [76].

Based on the above ideas, which determine the factors of biological nature involved in the development of cancer, preventive sanitary and hygienic measures designed to ensure carcinogenic safety can be outlined as a number of provisions:

- it is necessary to inform the population about the risks of oncological pathology associated with biological factors (viruses, bacteria and parasites) recognized by IARC as group 1 carcinogens;
- it is necessary to identify such factors and inform sanitary and medical professionals about them, monitor to detect biological carcinogens from the SanPiN in the environment and industrial facilities;
- it is necessary to timely diagnose infection with carcinogenic biological factors in various segments of the population;
- upon receiving information about epidemiological danger associated with a growing number amount of biological carcinogens, it is necessary to organize specific preventive measures in a timely manner;
- the number of persons who may be exposed to carcinogenic factors of a biological nature should be as limited as possible;
- it is necessary to organize therapeutic and preventive measures that limit the development of chronic inflammatory diseases under the influence of biological carcinogens;
- it is necessary to effect immunobiological measures aimed at vaccination against pathogens of hepatitis B virus and human papillomavirus;
- it is necessary for the sanitary service to organize multi-level oncogigienic education for general medical workers, oncologists.

CONCLUSION

SanPiN 1.2.3685-21 are of particular importance from the point of view of ensuring control over environmental factors dangerous for humans. In particular, this regulation focuses on countering the spread of carcinogenic lifestyle factors and the danger of contact with biological carcinogenic factors. Non-compliance with the rules set out by the SanPiN that concern interaction of the population with carcinogenic factors can lead to the development of a number of oncological diseases as well as extremely severe socio-economic consequences associated with the spread of this process. At the same time, the biological carcinogenic factors and carcinogenic

factors of the human environment listed in the SanPiN should be supplemented by several other dangerous contaminants found in the environment. There is preventive value in sanitary and medical professionals learning about the consequences of

the presence of carcinogenic biological factors in the environment and at production facilities, such value allowing to create conditions for the timely implementation of health-preserving measures.

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HYGIENIC FEATURES OF THE QUALITY OF DRINKING WATER FROM THE REGIONAL CENTER CENTRALIZED WATER SUPPLY SYSTEM BASED ON ORGANOLEPTIC INDICATORS

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Drinking water occupies one of the leading places among environmental factors responsible for shaping public health, so providing sanitary-and-epidemiologic wellbeing of the population cannot be considered separately from solving the hygienic problem of water supply. The study aimed to provide comparative hygienic characteristics of the quality of drinking water from the Ryazan centralized water supply system based on organoleptic indicators. Comparative assessment of the quality of drinking water was performed based on the analysis of the data of the years of research for the years 2017–2022. We performed analysis of the long-term average annual values of odor at 20 °C and 60 °C, taste, color and turbidity, share of samples non-compliant with the hygienic standards, over time. Indicators were also assessed based on the season of the year and territorial belonging. The average indicator values were compared using analysis of variance; pairwise comparison involved the use of the Scheffe and Tamhane tests considering the Levene's test results. Confidence intervals of the relative indicators were determined based on the Wilson score. The long-term average annual values of organoleptic indicators of the quality of drinking water in Ryazan are compliant with SanPiN 1.2.3685-21. A small number of samples had odor, taste, and color exceeding the hygienic standards. Turbidity that was non-compliant with the hygienic requirements in 2.2% of samples and reached the maximum value of 16.4 mg/L (kaolin) should be considered the most challenging indicator of the quality of test drinking water.

Keywords: drinking water, centralized water supply, water quality, organoleptic indicators, regional center

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ГИГИЕНИЧЕСКИЕ ОСОБЕННОСТИ КАЧЕСТВА ПИТЬЕВОЙ ВОДЫ ЦЕНТРАЛИЗОВАННОЙ СИСТЕМЫ ВОДОСНАБЖЕНИЯ ОБЛАСТНОГО ЦЕНТРА ПО ОРГАНОЛЕПТИЧЕСКИМ ПОКАЗАТЕЛЯМ

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Питьевая вода занимает одно из главных мест среди факторов окружающей среды, ответственных за формирование здоровья населения, поэтому обеспечение санитарно-эпидемиологического благополучия населения невозможно рассматривать в отрыве от решения гигиенической проблемы водоснабжения. Целью исследования было дать сравнительную гигиеническую характеристику качества питьевой воды централизованной системы водоснабжения г. Рязани по органолептическим показателям. Сравнительная оценка качества питьевой воды проведена на основании анализа данных многолетних исследований за 2017–2022 гг. Выполнен анализ средних многолетних значений запаха при 20 °C и 60 °C, привкуса, цветности и мутности, удельного веса проб, не соответствующих гигиеническим нормативам, в динамике. Показатели также анализировали в зависимости от сезона года и территориальной принадлежности. Средние значения показателей сравнивали методом дисперсионного анализа, для парных сравнений использовали критерии Шеффе и Тамхейна с учетом результатов теста Ливиня. Доверительные интервалы относительных показателей определяли по методу Уилсона. Средние многолетние значения органолептических показателей качества питьевой воды в г. Рязани соответствовали требованиям СанПиН 1.2.3685-21. Незначительное количество проб имело запах, привкус и цветность, превышающие гигиеническую норму. Наиболее проблемным показателем качества исследуемой питьевой воды следует считать мутность, которая не соответствовала гигиеническим требованиям в 2,2% проб и достигала максимального значения 16,4 мг/л по каолину.

Ключевые слова: питьевая вода, централизованное водоснабжение, качество воды, органолептические показатели, областной центр

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Drinking water occupies one of the leading places among environmental factors responsible for shaping public health. Support of sustainable development of the State and providing sanitary-and-epidemiologic wellbeing of the population cannot be considered separately from solving the hygienic problem of water supply [1–3]. Furthermore, the drinking water organoleptic properties are sensitive markers of its quality that largely determine consumer satisfaction. Organoleptic properties can worsen due to anthropogenic pollution of water supply

sources or due to natural processes related to water stagnation and blooming, as well as to eutrophication of water bodies [4]. Water treatment effectiveness and stability have a significant impact on the drinking water organoleptic properties [4, 5]. Secondary deterioration of the quality of drinking water in the water supply system is possible resulting from the reduced water demand and stagnation, increased wear of the aqueduct, high accident rate, and inadequate hygiene in the sanitary protection areas [6, 7].

High rate of the drinking water organoleptic property deterioration suggests poor reliability of the water supply system and poses considerable public health risk [8, 9]. According to a number of authors, the use of water non-compliant with the hygienic standards based on turbidity for water supply increases the risk of viral intestinal infections [10], and the aluminum ion content higher than permissible increases the risk of the central nervous system disorders [11, 12]. The increased drinking water color resulting from high iron ion (2^+) content is considered to be a risk factor of the disorders of gastrointestinal mucosa, skin, blood, immune system [8, 9].

Despite close attention of hygienists to the issue of water supply, the region-specific hygienic features of the drinking water quality are still poorly understood. Thus, the most recent research on the issue in Ryazan was conducted more than 30 years ago. Considering the importance of the problem, the study seems to be timely and relevant [13].

The study aimed to provide comparative hygienic characteristics of the quality of drinking water from the Ryazan centralized water supply system based on organoleptic indicators.

METHODS

The study was conducted in Ryazan, the center of the Ryazan Region. As for February 1, 2023, the population of the regional center was 539,000 people. Surface water of the Oka River and artesian water of the Podolsko-Myachkovsky, Kashirsky, and Oksko-Protvinsky coal system aquifers is used for water supply to the population [3]. In the overall water balance of the centralized water supply system, slight predominance of surface water (62%) was reported, except for water supply networks of the Solotcha and Stroitel area, supplied mainly by artesian water. The urban ring water distribution system consists of 143.9 km of water mains, 285.5 km of street water network, and 428.9 km of yard water distributions [3]. The average wear of water supply systems is 74% [14].

We performed analysis of organoleptic indicators of the drinking water quality (odor at 20 °C and 60 °C, taste, color, and turbidity) in control points of the Ryazan water distribution system for the years 2017–2022 based on the data provided by the sanitary and hygienic laboratory of the Center for Hygiene and Epidemiology in the Ryazan Region. A total of 3440 drinking water samples were analyzed. We calculated average values and their confidence intervals, as well as the percentage of samples non-compliant with SanPiN 1.2.3685-21 [15] in certain years of the studied period, depending on the season of the year and territorial belonging.

The average indicator values were compared by analysis of variance (ANOVA) based on Fisher's exact test (F); pairwise comparison involved the use of the Scheffe and Tamhane tests considering the Levene's test results. Confidence intervals of the relative indicators were determined using the Wilson score [16]. Statistics were calculated in SPSS Statistics 19 (IBM; USA) with the target significance level set as $p < 0.05$.

RESULTS

The long-term average annual values of organoleptic indicators of the quality of drinking water in Ryazan were compliant with SanPiN 1.2.3685-21 (Table 1). However, certain values of odor at 20 °C, 60 °C and taste exceeded the hygienic standard and reached 3 points; the percentage of such samples was 0.5%, 0.9%, and 0.1%, respectively. Water color in control points of water distribution system was above normal only in 0.03% of samples. At the same time, turbidity did not meet hygienic requirements in 2.2% of samples and reached the maximum value of 16.4 mg/L (kaolin).

It should be noted that in 2018 the average values of the drinking water odor (at 20 °C/60 °C) and taste that were $0.70 \pm 0.05/0.67 \pm 0.06$ points and 0.68 ± 0.06 points, respectively, were 1.9–2.3 times lower, than in other years ($p < 0.05$). At the same time, the highest average color and turbidity values reported in 2017 were $7.25 \pm 0.07^*$ and 0.95 mg/L, respectively, and were significantly higher, than in other years of the studied period ($p < 0.05$).

The average values of all organoleptic indicators for the studied years were compliant with SanPiN 1.2.3685-21, but in 2020 the odor (at 20 °C and 60 °C) and taste values non-compliant with the hygienic standards were reported for some points of water distribution system: in 3.5%, 6.3%, and 0.7% of samples, respectively. In 2022, the color of 0.5% of drinking water samples was non-compliant with the hygienic standard. At the same time, the drinking water samples non-compliant with SanPiN 1.2.3685-21 based on turbidity were reported annually, and the largest share (3.0%) was reported in 2019, while the smallest was reported in 2021 (1.1%).

During the studied period the average seasonal values of all organoleptic indicators were compliant with the hygienic standards (Table 2). We revealed a considerable effect of the season on the average seasonal values of organoleptic indicators; the highest values of all organoleptic indicators were typical for winter, while the lowest values were reported for various seasons: odor and taste for summer, color for spring ($p < 0.001$), turbidity for fall ($p = 0.009$).

Drinking water samples, the odor and taste of which were non-compliant with hygienic standards, were reported in winter and spring only (Fig. 1), and in winter the percentage of those was 2.4% and 0.2%, respectively, which considerably exceeded the values reported for spring. It should be noted that the above-level drinking water color was reported in summer only in 0.1% of samples, while increased turbidity was found in all seasons of the year. Deterioration of drinking water quality based on turbidity was most often found in winter (in 3.5% of samples) and least often in spring and summer (in 1.8% of samples).

In control points of municipal water mains of the residential areas Solotcha, Dyagilevo, and Moskovsky, the long-term average annual values of odor did not exceed 1 point, while in other areas the values were significantly higher, within

Table 1. Organoleptic indicators of the quality of drinking water from the Ryazan centralized water supply system, on average for the years 2017–2022

Indicator	Units	Number of samples	Average $\pm$ 95% CI	Maximum value (characteristic)	Standard	% of samples above the hygienic standard
Odor (20 °C)	points	3408	1.35 ± 0.03	3.00 (fish)	2	0.5
Odor (60 °C)	points	3408	1.24 ± 0.03	3.00 (fish)	2	0.9
Taste	points	3407	1.29 ± 0.03	3.00 (fish)	2	0.1
Color	cs*	3407	6.56 ± 0.07	23	20	0.03
Turbidity	mg/L (kaolin)	3406	0.84 ± 0.02	16.4	1.5	2.2

Note: *cs — cobalt scale.

Table 2. Organoleptic indicators of the quality of drinking water from the Ryazan centralized water supply system, on average for seasons of the years 2017–2022

Indicator	Units	Winter	Spring	Summer	Fall	Fischer's exact test (<i>F</i>)	<i>P</i>
Odor (20 °C)	points	1.62 ± 0.07	1.32 ± 0.04	1.17 ± 0.06	1.40 ± 0.06	32.47	< 0.001
Odor (60 °C)	points	1.52 ± 0.08	1.23 ± 0.05	1.02 ± 0.07	1.27 ± 0.07	30.33	< 0.001
Taste	points	1.56 ± 0.07	1.27 ± 0.05	1.08 ± 0.06	1.35 ± 0.07	33.88	< 0.001
Color	cs*	7.00 ± 0.16	6.44 ± 0.10	6.47 ± 0.15	6.57 ± 0.15	11.84	< 0.001
Turbidity	mg/L (kaolin)	0.92 ± 0.05	0.83 ± 0.03	0.85 ± 0.04	0.82 ± 0.04	3.89	0.009

Note: *cs — cobalt scale.

the range of 1.17–1.48 points (Table 3; $p < 0.05$). The drinking water samples non-compliant with SanPiN 1.2.3685-21 based on odor at 20 °C were reported only for the residential areas Oktyabrsky, Sovetsky, and Dashkovo-Pesochnya, and the percentage of those in the total number of tests was 0.23%, 0.87%, and 1.24%, respectively. Assessment of odor at 60 °C revealed high percentage of non-standard samples in a larger number of urban areas. In Dashkovo-Pesochnya, the share of such samples was the highest 1.98%, which was followed (in a descending order) by the residential areas Sovetsky (1.22%), Kanishhevo (0.75%), Oktyabrsky (0.45%), and Zheleznodorozhny (0.37%).

Distribution of the Ryazan areas based on the average drinking water taste values showed the same features, as the distribution by odor. Furthermore, in Solotcha, Moskovsky, and Dyagilevo the average values were within the range of 0.77–0.92 points are significantly lower, than in other areas (1.25–1.43 points) ($p < 0.05$). It should be noted that the drinking water samples, the taste of which was non-compliant with the hygienic standard, were found in the Sovetsky area and Dashkovo-Pesochnya, and the percentage of such samples was 0.17% and 0.25%, respectively.

The long-term average annual values of the drinking water color and turbidity did not exceed the hygienic standard in certain areas of Ryazan (Table 4). Furthermore, the values of the above indicators in Solotcha were significantly higher, than in the majority of the territories compared, except for the Stroitel area. These were $7.39 \pm 0.49^{\circ}$ and 1.34 ± 0.14 mg/L, respectively ($p < 0.05$). In the Stroitel area, the average drinking water turbidity was 1.01 ± 0.11 mg/L, it was 1.3 times lower, than in Solotcha, and 1.2–1.3 times higher, than in the majority of other areas ($p < 0.05$).

In the studied period the above-normal drinking water color indicators were found in the Solotcha area only (in 1.56% of samples). The largest share of water samples non-compliant with SanPiN 1.2.3685-21, the turbidity of which was 10.94% and twice exceeded the value for the Stroitel area, was typical for the same area, while in other urban territories it was between 0.75% (Kanishhevo) and 3.23% (Dyagilevo).

DISCUSSION

Based on the fact that in the 6-year period considered deterioration of the quality of drinking water from the centralized water supply system were reported only in 2020, it can be due to certain combination of factors. Such factors can include baseline water quality deterioration in the water supply source resulting from rapid production of phytoplankton in the warm period and subsequent phytoplankton mass die-off in winter [17, 18]. This suggestion is supported by predominant deterioration of the drinking water quality in winter, along with the largest share of samples non-compliant with the hygienic standards in Dashkovo-Pesochnya and Sovetsky area receiving water mainly from the Oka water supply inlet located in the Dyatkovsky backwater prone to eutrophication [19]. Certain contribution to deterioration of the drinking water organoleptic properties can be made by the decreased effectiveness of water treatment under these conditions [19]. Furthermore, secondary deterioration of water quality in the water supply system due to pronounced wear of water distribution networks and accidents cannot be ruled out [20]. The latter assumption largely explains regular registration of drinking water samples, the turbidity of which is non-compliant

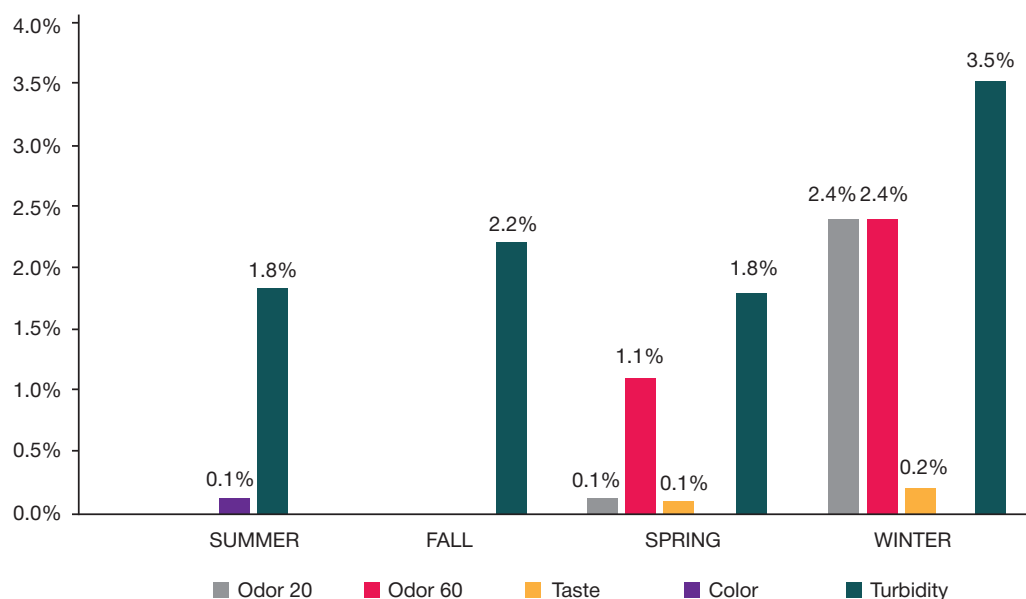
**Fig.** Rate of organoleptic indicator non-compliance with hygienic standards for drinking water samples by seasons of the year (%)

Table 3. Odor of drinking water from the centralized water supply system in certain areas of Ryazan, on average for the years 2017–2022

Area	Number of observations, 20 °C	Average value, points		Samples > MPC, % [95% CI]	
		20 °C	60 °C	20 °C	60 °C
Solotcha	65	0.85 ± 0.20	0.68 ± 0.23	0	0
Kanishhevo	398	1.33 ± 0.08	1.20 ± 0.09	0	0.75 [0.26–2.19]
Oktyabrsky	443	1.40 ± 0.08	1.24 ± 0.09	0.23 [0.04–1.24]	0.45 [0.12–1.63]
Dyagilevo	93	0.86 ± 0.17	0.67 ± 0.19	0	0
Moskovsky	237	1.00 ± 0.11	0.82 ± 0.12	0	0
Dashkovo-Pesochnya	404	1.41 ± 0.08	1.32 ± 0.09	1.24 [0.53–2.86]	1.98 [1.01–3.86]
Zheleznodorozhny	538	1.35 ± 0.07	1.24 ± 0.08	0	0.37 [0.10–1.35]
Sovetsky	1147	1.48 ± 0.05	1.41 ± 0.05	0.87 [0.47–1.60]	1.22 [0.73–2.04]
Stroitel	115	1.30 ± 0.15	1.17 ± 0.17	0	undefined

Table 4. Color and turbidity of drinking water from the centralized water supply system in certain areas of Ryazan, on average for the years 2017–2022

Area	Number of observations, 20 °C	Average value, points		Samples > MPC, % [95% CI]	
		Color, °	Turbidity, mg/L	Color, °	Turbidity, mg/L
Solotcha	64	7.39 ± 0.49	1.34 ± 0.14	1.56 [0.28–8.33]	10.94 [5.40–20.90]
Kanishhevo	398	6.56 ± 0.20	0.79 ± 0.06	0	0.75 [0.26–2.19]
Oktyabrsky	443	6.52 ± 0.19	0.83 ± 0.05	0	2.26 [1.23–4.10]
Dyagilevo	93	6.39 ± 0.41	0.82 ± 0.12	0	3.23 [1.10–9.06]
Moskovsky	236	6.28 ± 0.26	0.82 ± 0.12	0	3.81 [2.02–7.09]
Dashkovo-Pesochnya	404	6.38 ± 0.20	0.86 ± 0.06	0	1.24 [0.53–2.86]
Zheleznodorozhny	538	6.60 ± 0.17	0.83 ± 0.05	0	2.60 [1.56–4.32]
Sovetsky	1147	6.64 ± 0.12	0.84 ± 0.03	0	1.48 [0.93–2.36]
Stroitel	115	6.81 ± 0.37	1.01 ± 0.11	0	5.22 [2.41–10.92]

with the hygienic standard. At the same time, predominance of such samples in the residential areas Solotcha and Stroitel can result from the features of the water supply system, where artesian water predominates that is characterized by high content of hardness salts and iron (2⁺) [20]. The excess increase in the drinking water color in Solotcha in summer was one-time; it could also result from high iron content or malfunction of the iron removal station [20].

CONCLUSIONS

The long-term average annual values of the drinking water quality organoleptic indicators in Ryazan were compliant with SanPiN 1.2.3685-21. However, a small number of samples had odor, taste, and color exceeding the hygienic standard.

Turbidity, which did not meet hygienic requirements in 2.2% of samples and reached the maximum value of 16.4 mg/L (kaolin), should be considered the most challenging indicator of the tested drinking water quality.

With relatively stable quality of drinking water, in 2020, at certain points in the water distribution network, odor (at 20 °C and 60 °C) and taste indicators were recorded that did not meet hygienic standards: in 3.5%, 6.3%, and 0.7% of samples, respectively.

Water samples with excess turbidity were reported in all areas of the city, most often in Solotcha and Stroitel (in 10.94% and 5.43% of samples, respectively), which was associated with additional supply of artesian water to the centralized water supply system. The excess increase in the drinking water color was one-time and could result from random factors.

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COMPARATIVE ASSESSMENT OF THE INCIDENCE OF MALIGNANT NEOPLASMS OF THE OVARIES IN WOMEN LIVING IN THE ENVIRONMENTALLY DISADVANTAGED AREAS (2000–2019)

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Radioactive and chemical contamination can affect carcinogenesis, including the development of malignant neoplasms of the ovaries (MNOs) in women. The study aimed to perform comparative assessment of environmental situation in the towns and districts of the Bryansk Region based on chemical, radioactive, and combined radioactive contamination, as well as primary incidence of MNOs in women in accordance with official statistics for the years 2000–2019. The data for the study were provided by the Bryansk Regional Oncology Dispensary, Bryanskstat, Rostekhnadzor, Rospotrebnadzor. Neither significant differences in primary incidence of MNOs, nor increased risk of MNO were revealed in female population aged 18–80 years, regardless of the environmental conditions of living in 2000–2019. We revealed a significantly elevated relative risk (RR) of primary incidence of low-grade MNOs in women aged 41–60 years living in the environmentally disadvantaged areas compared to women living in the control areas: RR 1.88 (95% CI: 1.43–2.48); $p < 0.0001$). The rate of low-grade MNOs in women aged 41–60 years in the areas of the combined exposure is 17.6 ± 1.96 , which 1.5-fold exceeds the values reported for radioactively contaminated areas (11.7 ± 2.73) and 1.2-fold exceeds the values reported for chemically contaminated areas (15.2 ± 1.31). The combined effects of radioactive and chemical contamination results in the higher RR of low-grade MNOs compared to the areas with only one pollution factor, i.e. radioactive contamination (RR 1.51 (95% CI: 1.00–2.28)), chemical contamination (RR 1.17 (95% CI: 0.90–1.50)). The findings suggest synergistic effect of radiation and chemical factors on the incidence of low-grade MNOs.

Keywords: Chernobyl accident, malignant neoplasms of the ovaries, radioactive contamination, chemical pollution, combined contamination, regression analysis, relative risk, Bryansk region

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Author contribution: Golovleva AA — search for literature, statistical analysis, manuscript writing, editing and discussion; Korsakov AV — literature data analysis, study concept and design, interpretation of the results, approval of the final version of the article; Troshin VP — data analysis and interpretation, manuscript writing, editing and discussion; Milushkina OYu — literature data analysis, data analysis and interpretation, manuscript editing and discussion; Pivovarov YuP, Korolik VV — data analysis and interpretation, manuscript editing and discussion; Lagerev DG — statistical processing, data analysis and interpretation.

Compliance with ethical standards: the study involved the use of impersonal statistical information about the incidence of MNOs in women in the areas of the Bryansk Region for the years 2000–2019.

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СРАВНИТЕЛЬНАЯ ОЦЕНКА ЗАБОЛЕВАЕМОСТИ ЗЛОКАЧЕСТВЕННЫМИ НОВООБРАЗОВАНИЯМИ ЯИЧНИКОВ ЖЕНЩИН, ПРОЖИВАЮЩИХ НА ЭКОЛОГИЧЕСКИ НЕБЛАГОПОЛУЧНЫХ ТЕРРИТОРИЯХ (2000–2019 ГГ.)

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Радиоактивное и химическое загрязнение может влиять на процессы канцерогенеза, в том числе на формирование злокачественных новообразований яичников (ЗНОЯ) у женщин. Целью исследования было выполнить сравнительную оценку состояния окружающей среды в городах и районах Брянской области по химическому, радиоактивному и сочетанному радиационно-химическому загрязнению и уровня первичной заболеваемости женщин ЗНОЯ на основании данных официальной статистики за 2000–2019 гг. Данные для исследования предоставили Брянский областной онкологический диспансер, Брянскстат, Ростехнадзор, Роспотребнадзор. Не выявлено как значимых различий уровня первичной заболеваемости ЗНОЯ, так и повышенного риска заболеваемости ЗНОЯ у женского населения 18–80 лет, независимо от экологических условий проживания в 2000–2019 гг. Установлено значимое повышение относительного риска (ОР) первичной заболеваемости низкодифференцированными формами ЗНОЯ у женщин 41–60 лет, проживающих в экологически неблагоприятных районах, по сравнению с проживающими на контрольных территориях — ОР 1,88 (95% ДИ: 1,43–2,48); $p < 0,0001$). Частота низкодифференцированных форм ЗНОЯ у женщин 41–60 лет на территориях сочетанного воздействия составляет $17,6 \pm 1,96$, что в 1,5 раза превышает значения территорий радиоактивного загрязнения ($11,7 \pm 2,73$) и в 1,2 раза — значения территорий химического загрязнения ($15,2 \pm 1,31$). Сочетанное воздействие радиационно-химического загрязнения привело к более высокому ОР заболеваемости низкодифференцированными формами ЗНОЯ по сравнению с территориями, где присутствует только один фактор загрязнения — радиоактивное загрязнение (ОР 1,51 (95% ДИ: 1,00–2,28)), химическое загрязнение (ОР 1,17 (95% ДИ: 0,90–1,50)). Полученные результаты позволяют предположить синергическое влияние радиационного и химического факторов на заболеваемость низкодифференцированными формами ЗНОЯ.

Ключевые слова: авария на ЧАЭС, ЗНОЯ, радиоактивное загрязнение, химическое загрязнение, сочетанное загрязнение, регрессионный анализ, относительный риск, Брянская область

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Соблюдение этических стандартов: для исследования использовали обезличенную статистическую информацию о заболеваемости женщин ЗНОЯ на территориях Брянской области в период с 2000 по 2019 г.

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According to recent WHO GLOBOCAN 2020 estimates [1], the increase in the global rate of malignant neoplasms (MNs) to 19.3 million incident cases and 10.0 deaths is reported. Malignant neoplasms of the ovaries (MNOs) occupy the seventh place among all cancer types being generally one of fatal diseases affecting female reproductive system [2]. According to the data provided by the Blokhin National Medical Research Center of Oncology, MNOs are second only to endometrial cancer and cervical cancer based on the incidence rate in Russia [3].

The papers [4–12] report a significant correlation between the risk of MNOs and the increase in environmental ill-being.

Radioecological monitoring of the South-Western areas of the Bryansk Region suggests that the cesium-137 (^{137}Cs) contamination density exceeds the established radiological standards 37 years after the Chernobyl accident, and the average annual effective doses reach hundreds mSv [13–18]. Furthermore, an increase in the emission of pollutants into the atmosphere is reported for the Bryansk Region in recent years [19].

In certain areas of the Bryansk Region, the population is exposed to combined effects of radioactive and chemical contamination [20–22].

Table 1. Ranking of the Bryansk Region territories based on the levels of radioactive, chemical, and combined environmental pollution, and primary incidence of MNOs (2000–2019)

Territories	Major gaseous pollutants in atmospheric air					Radioactive contamination density, kBq/m ²		Primary incidence of MNOs, M ± m
	Total	Из них:						
		VOCs	NO _x	SO ₂	CO	¹³⁷ Cs	⁹⁰ Sr	
	Gross emissions per area of the district, g/m ²							
Rognedinsky District	11.5	0	6	0	7	21.7	0.8	25.8 ± 6.5
Suzemsky District	27	5	9	1	13	18.6	2.5	26.3 ± 4.5
Mglinsky District	31	6	6	2	17	6.6	0.6	17.5 ± 3.1
Kletnyansky District	47	27	5	5	10	5.4	0.5	21.6 ± 3.5
Navlinsky District	53	12	13	4	25	18.9	0.8	18.7 ± 3.6
Dubrovsky District	56	13	17	0.4	26	7.2	0.4	19.4 ± 5.0
Brasovsky District	64	10	19	6	29	25.2	0.4	20.0 ± 3.2
Sevsky District	68	20	10	24	14	18.9	1.4	19.4 ± 4.5
Komarichsky District	98.7	24.9	18.9	9.2	46.1	27	1	15 ± 2.9
Karachevsky District	114.8	28.8	35.1	1.1	50.8	14	0.9	25.7 ± 2.7
Surazhsky District	128.2	35.1	34.8	5.8	51.9	8	0.3	18 ± 3.2
Average value	63.5	16.1	15.7	5.3	26.4	15.6	0.9	20.5 ± 1.3 (–8.8%*)
Pogarsky District	123	65	22	4	32	29.9	1.1	29.3 ± 3.9
Zhiryatinsky District	154.8	103	17	0.9	34.9	5	0.84	18 ± 4.5
Zhukovsky District	195.9	23	52	40.5	80.7	6.68	0.85	20 ± 1.7
Trubchevsky District	276	87	28	2.1	157.7	23.67	0.88	16.3 ± 2.5
Pochepsky District	363.8	224	33	2.9	105.9	5	0.54	19 ± 3.2
Unechsky District	559	292	58	32	177	7.2	0.8	24.1 ± 3.1
Vygonichsky District	857	749	37	2	70	9.5	0.4	12.7 ± 3.9
Bryansky District	959	813	47	13	86	5.7	0.4	23.8 ± 1.9
Town of Seltso	5207.6	772	2406	96.8	1935	4	0.86	23 ± 2.7
Dyatkovsky District	8044.8	340	3759	1140	2808	38	1	22.2 ± 1.8
City of Bryansk	32189	5218	10887	2617.7	13471	9	6	24 ± 1.5
Average value	4450.8	792.2	1576.8	359.4	1723.4	13.7	1.39	22.8 ± 1.2 (+0.4%*)
Krasnogorsky District	16	1	5	0	9	303.4	9.3	18.8 ± 4.2
Gordeyevsky District	29	2	11	0.2	15	328.6	5	11.0 ± 4.2
Zlynkovsky District	36.8	4.8	10.8	4.1	18.1	412	16	18 ± 3.7
Novozybkovsky District	52	11	0.1	0.2	40.7	460	8.6	14.8 ± 5.7
Klimovsky District	71.9	15.9	8.1	14.5	32.9	139.8	6.3	21 ± 3.6
Klintsovsky District	169.3	16.8	69.8	2.1	81	194	4.8	20.2 ± 3.1
Average value	62.2	8.4	17.6	3.6	32.6	305.8	8.3	18.2 ± 2.0 (–19.0%*)
Starodubsky District	392	316	24	9	43	45.4	1.4	20.9 ± 2.4
Town of Klintsy	7264	2059	2616	139	2450	195.6	3	17.4 ± 1.1
Town of Novozybkov	7422	1778	2159	406	3079	456.5	9.7	24.0 ± 2.1
Average value	5026	1384.3	1599.7	184.7	1857.3	232.5	4.7	20.1 ± 0.9 (–11.1%*)

Note: * — difference (%) from the all-Russian level of primary incidence of MNOs (2000–2019). Differences in primary incidence of MNOs based on the Mann–Whitney U test: in environmentally safe territories and territories with chemical ($p = 0.67$), radioactive ($p = 0.22$), and combined ($p = 0.95$) contamination; chemical and radioactive ($p = 0.11$), chemical and combined ($p = 0.94$), radioactive and combined ($p = 0.30$) contamination.

Table 2. Relative risk (RR) of primary incidence of MNOs in women aged 18–80 years living in the territories with varying levels of radioactive, chemical, and combined environmental contamination for the years 2000–2019

Territory type	Population	Affected, abs.	Unaffected, abs.	RR (95% CI)
With chemical, radioactive, and combined contamination (total)	9599974	2096	9597878	1.07 (0.96–1.19)
Environmentally safe	2058551	420	2058131	
Chemically contaminated	7319942	1657	7318285	1.11 (1.00–1.23)
Environmentally safe	2058551	420	2058131	
Radioactively contaminated	906651	163	906488	0.88 (0.74–1.06)
Environmentally safe	2058551	420	2058131	
With combined contamination	1373381	276	1373105	0.98 (0.85–1.15)
Environmentally safe	2058551	420	2058131	
Chemically contaminated	7319942	1657	7318285	1.26 (1.07–1.48)
Radioactively contaminated	906651	163	906488	
With combined contamination	1373381	276	1373105	0.89 (0.78–1.00)
Chemically contaminated	7319942	1657	7318285	
With combined contamination	1373381	276	1373105	1.12 (0.92–1.36)
Radioactively contaminated	906651	163	906488	

Thus, environmental pollution results in the mutation rate increase, which creates a threat to the genetic security of all living things [23].

The study aimed to perform comparative assessment of environmental situation in the towns and districts of the Bryansk Region based on chemical, radioactive, and combined radioactive contamination, as well as primary incidence of MNOs in women in accordance with official statistics for the years 2000–2019.

METHODS

The analysis of density of the cesium-137 (^{137}Cs) and strontium-90 (^{90}Sr) contamination resulting from the Chernobyl accident was conducted based on the data [17], the average cumulative effective doses (CED_{90}) were assessed based on the data [24], the levels of the atmospheric air chemical pollution with CO , NO_x , SO_2 , and volatile organic compounds (VOCs) were assessed based on the data [25] for the years 2010–2019.

The incidence of newly diagnosed MNOs in female population (aged 18–80 years) of the Bryansk Region was analyzed using the official data provided by the Bryansk Regional Oncology Dispensary [26]. A total of 2647 MNO cases were revealed in 2000–2019. The analysis of the MNO histological forms was performed in the reported 942 cases (age 41–60 years). Absolute values were recalculated per 100,000 population.

Linear regression and relative risk (RR) of primary MNO incidence were calculated depending on chemical and radioactive contamination levels for the period of 2000–2019. Statistical analysis was performed using the Shapiro–Wilk test, Mann–Whitney U test, Spearman's rank correlation, linear regression; 95% confidence intervals (95% CI) were calculated; the significance levels were as follows: $p < 0.05$, $p < 0.01$, $p < 0.001$. Statistical analysis of the data obtained was performed using the MyOffice software package (New Cloud Technologies; Russia).

RESULTS

Towns and districts of the Bryansk Region were divided into four groups based on chemical and radioactive contamination levels, as well as primary incidence of MNOs in 2000–2019 (Table 1). Analysis of the results provided in the table was earlier reported in the paper [27].

Analysis of the data provided in Table 2 showed that there was no increase in the RR of MNOs among women in the territories with chemical, radioactive, and combined contamination compared to the control (environmentally safe) territories: RR 1.07 (95% CI: 0.96–1.19). However, the risk of MNOs in women living in the chemically contaminated territories was slightly higher, than in women living in the control districts (RR 1.11 (95% CI: 1.00–1.23)), but the differences were non-significant ($p = 0.06$). It should be noted that we revealed a significantly ($p = 0.005$) increased risk of MNOs in the chemically contaminated territories relative to the radioactively contaminated areas: RR 1.26 (95% CI: 1.07–1.48). No such patterns were revealed in other territories (Table 2).

As shown in Fig. 1, a significant increase in the long-term trend of primary MNO incidence was revealed in the group of chemically contaminated territories only ($p < 0.05$).

Comparative assessment of primary incidence of high-grade, intermediate grade, and low-grade MNOs among women aged 41–60 years living in environmentally different territories of the Bryansk Region in 2000–2019 showed that the rate of high-grade MNOs in the environmentally safe territories was 7.1 ± 0.83 , which exceeded the values of the territories with radioactive (1.4 ± 0.65), chemical (1.6 ± 0.35), and combined (3.2 ± 0.75) contamination 5.1-fold, 4.4-fold, and 2.2-fold, respectively ($p < 0.001$) (Table 3).

We revealed no significant differences in the rate of intermediate grade MNOs in the towns and districts of the Bryansk Region, regardless of the living conditions (the values vary between 7.0 and 8.8) (Table 3).

The rate of low-grade MNOs in the chemically contaminated territories is 15.2 ± 1.31 , which 1.3-fold ($p < 0.05$) exceeded the values of the radioactively contaminated territories (11.7 ± 2.73), suggesting the leading role of chemical factor vs. radioactive in shaping the incidence of MNOs (Table 3).

The rate of low-grade MNOs in the areas with combined contamination reaches its maximum (17.6 ± 1.96), it 2.2-fold exceeds ($p < 0.001$) the values of the control areas (8.1 ± 1.20), 1.5-fold ($p < 0.05$) the values of the radioactively contaminated areas (11.7 ± 2.73), and 1.17-fold ($p > 0.05$) the values of the chemically contaminated areas (15.2 ± 1.31). The results obtained suggest synergistic effect of radiation and chemical factors on the incidence of low-grade MNOs (Table 3).

Analysis of the data provided in Table 4 revealed a significant increase in the RR of primary incidence of low-grade MNOs

Trend

$$y = 1.833x + 15.6$$

Fisher's exact test = 0.02

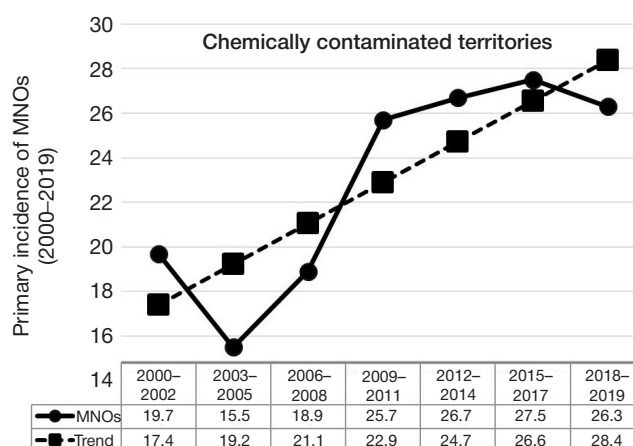
Standard error = 0.54

Spearman's rank correlation coefficient

$$\rho = 0.79, p = 0.04$$

Coefficient of determination = 0.70

95% CI of coefficient A (0.45; 3.22)



Trend

$$y = 2.338x + 9.53$$

Fisher's exact test = 0.12

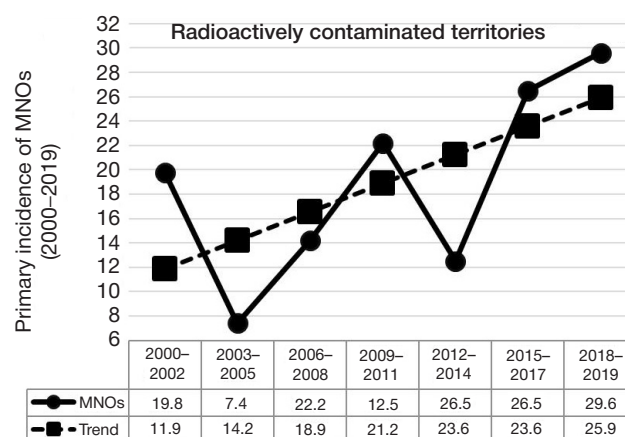
Standard error = 1.27

Spearman's rank correlation coefficient

$$\rho = 0.64, p = 0.12$$

Coefficient of determination = 0.41

95% CI of coefficient A (–0.91; 5.59)



Trend

$$y = -0.038x + 20.2$$

Fisher's exact test = 0.92

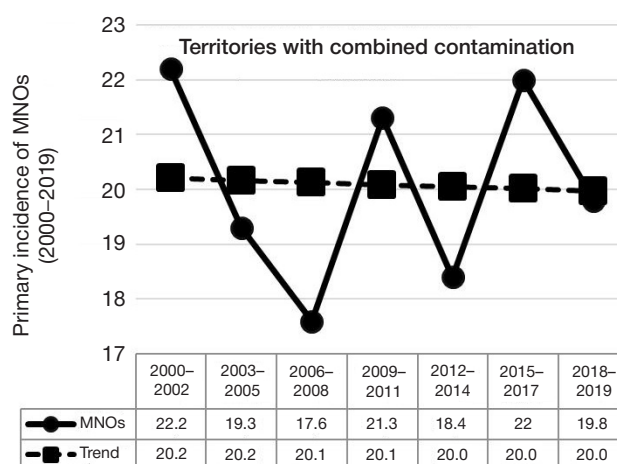
Standard error = 0.37

Spearman's rank correlation coefficient

$$\rho = -0.07, p = 0.88$$

Coefficient of determination = 0.002

95% CI of coefficient A (–0.99; 0.92)



Trend

$$y = 1.164x + 16.0$$

Fisher's exact test = 0.21

Standard error = 0.82

Spearman's rank correlation coefficient

$$\rho = 0.64, p = 0.12$$

Coefficient of determination = 0.29

95% CI of coefficient A (–0.94; 3.27)

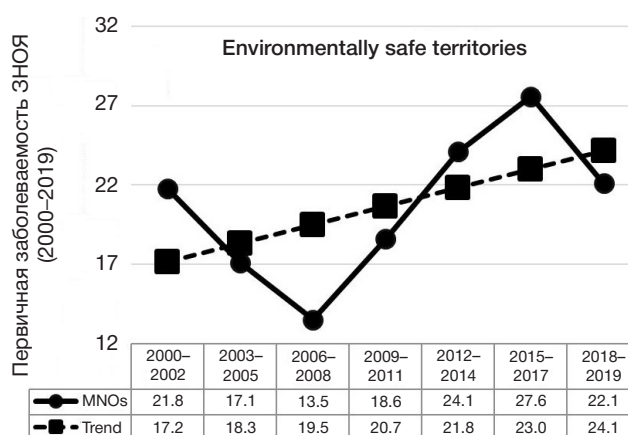


Fig. Dynamics of primary incidence of MNOs in women living in environmentally different territories of the Bryansk Region with the long-term trends by 3-year periods for the years 2000–2019 (recalculated per 100,000 population)

Table 3. Comparative assessment of primary incidence of high-grade, intermediate grade, and low-grade MNOs among women aged 41–60 years living in environmentally different territories of the Bryansk Region for the years 2000–2019 (recalculated per 100,000 population)

Studied territories MNO forms	Environmentally safe territories (control)	Chemically contaminated territories	Radioactively contaminated territories	Territories with combined contamination	Significance of intergroup differences based on the Mann-Whitney <i>U</i> 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 (<i>n</i> = 166)	II (<i>n</i> = 603)	III (<i>n</i> = 62)	IV (<i>n</i> = 111)	
All forms	23.9 ± 2.00	25.4 ± 2.55	22.0 ± 3.84	27.6 ± 2.5	p_1 n/s; p_2 n/s; p_3 n/s; p_4 n/s; p_5 n/s; p_6 n/s
of those:					
High-grade	7.1 ± 0.83	1.6 ± 0.35	1.4 ± 0.65	3.2 ± 0.75	p_1^{**} ; p_2^{**} ; p_3^{**} ; p_4^{**} ; p_5 n/s; p_6 n/s
Intermediate grade	8.7 ± 1.20	8.6 ± 1.11	8.8 ± 2.17	7.0 ± 1.32	p_1 n/s; p_2 n/s; p_3 n/s; p_4 n/s; p_5 n/s; p_6 n/s
Low-grade	8.1 ± 1.20	15.2 ± 1.31	11.7 ± 2.73	17.6 ± 1.96	p_1^{**} ; p_2 n/s; p_3^{**} ; p_4^{**} ; p_5 n/s; p_6^{**}

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

in women aged 41–60 years living in the environmentally disadvantaged areas (territories with chemical, radioactive, and combined contamination in total) relative to the environmentally safe (control) territories (RR 1.88 (95% CI: 1.43–2.48); $p < 0.0001$). Furthermore, RR was significantly increased in the territories with radioactive (RR 1.45 (95% CI: 0.95–2.23)), chemical (RR 1.88 (95% CI: 1.42–2.50)), and to the greater extent combined contamination (RR 2.20 (95% CI: 1.55–3.11)) of the environment compared to the control areas.

The combined effects of radioactive and chemical contamination resulted in the higher RR of low-grade MNOs compared to the territories with only one pollution factor, i.e. radioactive contamination (RR 1.51 (95% CI: 1.00–2.28)), chemical contamination (RR 1.17 (95% CI: 0.90–1.50)) (Table 4). The findings have been fully confirmed by analysis of the data provided in Table 3.

DISCUSSION

The papers [28, 29] report that the incidence of solid low-grade MNOs became higher compared to the incidence of high-grade MNOs with increasing levels of chemical [28] and radioactive [29] environmental contamination, which suggests worse outcomes characterized by low 5-year survival and early metastasis.

Table 4. Relative risk (RR) of primary incidence of low-grade MNOs in women aged 41–60 years living in the territories with various levels of radioactive, chemical, and combined contamination of the environment for the years 2000–2019

Territory type	Population	Affected, abs.	Unaffected, abs.	RR (95% CI)
With chemical, radioactive, and combined contamination (total)	153394	465	152929	1.89 (1.43–2.49)
Environmentally safe	34823	56	34767	
Chemically contaminated	119153	361	118792	1.88 (1.42–2.50)
Environmentally safe	34823	56	34767	
Radioactively contaminated	14127	33	14094	1.45 (0.95–2.23)
Environmentally safe	34823	56	34767	
With combined contamination	20114	71	20043	2.20 (1.55–3.11)
Environmentally safe	34823	56	34767	
Chemically contaminated	119153	361	118792	1.30 (0.91–1.85)
Radioactively contaminated	14127	33	14094	
With combined contamination	20114	71	20043	1.17 (0.90–1.50)
Chemically contaminated	119153	361	118792	
With combined contamination	20114	71	20043	1.51 (1.00–2.28)
Radioactively contaminated	14127	33	14094	

The findings confirm the research data [28, 29] and suggest the increase in the rate of low-grade MNOs in women aged 41–60 years living in the environmentally disadvantaged territories, with the most significant increase under combined exposure to radiation and chemical factors.

It should be noted that the fact that the analysis of MNO incidence in female population did not consider the distribution by disease stages and immunohistochemistry profiles was a limitation of the study.

CONCLUSIONS

1. The study revealed neither significant differences in primary incidence of malignant neoplasms of the ovaries (MNOs), nor increased risk of MNOs in the female population aged 18–80 years, regardless of environmental conditions of living in 2000–2019.

2. We determined a significant increase in the relative risk (RR) of primary incidence of low-grade MNOs in women aged 41–60 years living in the environmentally disadvantaged areas (territories with chemical, radioactive, and combined contamination in total) relative to the environmentally safe (control) territories (RR 1.88 (95% CI: 1.43–2.48); $p < 0.0001$).

3. It was shown that the rate of low-grade MNOs in women aged 41–60 years in the territories with the combined

exposure was 17.6 ± 1.96 , which 1.5-fold exceeded the values of the radioactively contaminated territories (11.7 ± 2.73) and 1.2-fold exceeded the values of the chemically contaminated territories (15.2 ± 1.31).

4. The combined effects of radioactive and chemical contamination resulted in the higher RR of the incidence

of low-grade MNOs compared to the territories with only one pollution factor, i.e. radioactive contamination (RR 1.51 (95% CI: 1.00–2.28)), chemical contamination (RR 1.17 (95% CI: 0.90–1.50)).

5. The findings suggest synergistic effect of radiation and chemical factors on the incidence of low-grade MNOs.

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SLEEP DISORDERS IN PRIMARY SCHOOL CHILDREN ASSOCIATED WITH USE OF VARIOUS TYPES OF DIGITAL DEVICES

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Health of children and adolescents largely depends on the quality of their sleep. However, the effect of digital devices and screen time on thereon have not been studied thoroughly. This study aimed to investigate the influence of digital devices on the sleep quality of primary school children. We surveyed 333 parents of children aged 7–10 years. The questionnaire included questions about the types of digital devices used by children, and frequency and duration of use daily and weekly use. We studied the specifics and quality of sleep of children. It was found that using a laptop for more than an hour a day increases the risk of sleep disorders (RR = 1.87; 95% CI: 1.37–2.54; EF = 46%). Children using a computer every day run a higher risk of nightmares (RR = 4.7; 95% CI: 1.49–15.11; EF = 79%). Neither TV, nor mobile phones were shown to produce such effects. The study has revealed that the type of the device and the patterns of its use (on both daily and weekly levels) are factors in the development of sleep disorders.

Keywords: sleep disorders, digital devices, children aged 7–10, health risks

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Compliance with ethical standards: the study was carried out under the State Task "Systemic preventive health-supporting technologies for attendees of educational organizations" (2022–2024), and approved by the Ethics Committee of the National Medical Research Center for Children's Health (protocol No. 3 of March 25, 2021). Each parent signed an informed consent form allowing participation of their children in the study after receiving explanations about the potential risks and benefits, as well as the nature of the study.

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НАРУШЕНИЯ СНА У МЛАДШИХ ШКОЛЬНИКОВ ПРИ ИСПОЛЬЗОВАНИИ РАЗЛИЧНЫХ ВИДОВ ЦИФРОВЫХ УСТРОЙСТВ

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Качество сна является важной составляющей здоровья детей и подростков. При этом окончательно не изучено влияние экранного времени на сон, в особенности влияние экранного времени, проводимого с различными видами цифровых устройств. Целью исследования было оценить влияние использования цифровых устройств на качество сна младших школьников. Проведено анкетирование 333 родителей детей 7–10 лет. Анкета состояла из вопросов о видах используемых детьми цифровых устройств, а также о частоте и продолжительности их использования в течение дня и недели. Изучены особенности и качество сна у детей. Установлено, что использование ноутбука свыше часа в день увеличивает риск нарушений сна (ОР = 1,87; 95% ДИ: 1,37–2,54; EF = 46%). Ежедневное использование компьютера увеличивает риск возникновения страшных сновидений у детей (ОР = 4,7; 95% ДИ: 1,49–15,11; EF = 79%). При оценке использования мобильных телефонов и просмотра телепередач таких результатов получено не было. Исследование показало, что на нарушение сна влияют вид устройства и режим его использования — как в течение дня, так и в течение недели.

Ключевые слова: нарушения сна, цифровые устройства, дети 7–10 лет, риски здоровью

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Соблюдение этических стандартов: исследование, выполненное в рамках государственного задания «Системные профилактические технологии формирования здоровья обучающихся в образовательных организациях» (2022–2024), одобрено этическим комитетом ФГАУ «НМИЦ здоровья детей» Минздрава России (протокол № 3 от 25 марта 2021 г.). Каждый родитель дал добровольное письменное информированное согласие на участие детей в исследовании после получения разъяснений о потенциальных рисках и преимуществах, а также о характере предстоящего исследования.

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Quality of sleep is known to have a pronounced effect on the health of children and adolescents [1–3]. Sleep disorders can trigger to various abnormalities, both somatic and neurological [4, 5]. Moreover, sleep quality also affects adaptation of children to the educational process [6].

As confirmed by a number of Russian and foreign studies, use of digital devices (DD) can negatively affect various aspects of health [7–23]. An important component of the negative impact of DD is the blue light emitted by LEDs that are an integral part of screens [24–26]

Noise is another problem associated with DD that should be paid attention to in the context of a respective analysis effort [27].

In professional Russian publications covering hygienic aspects, screen time is commonly perceived as a monolith factor and not broken down into types. Foreign authors, on the contrary, differentiate between types of screen time and investigate them separately, writing respective reports. Screen time is categorized on physiological and functional grounds, i.e., there is an active (interactive) type thereof

associated with games, social media, and learning, and a passive type of screen time, which involves watching TV and video content [28, 29]. Some papers point to the connections between various types of screen time and sleep disorders, and the degree of interactivity of the former was shown to influence the severity of the latter [30, 31]. From a practical standpoint, it is very difficult to limit a child's actual screen time, but it is much easier to control the devices they use. In this connection, this work attempts to assess the influence of various types of DD used for different tasks on sleep quality, one of the most significant factors characterizing the state of a child's nervous system.

This study aimed to investigate the influence of DD on the sleep quality of primary school children.

METHODS

The survey was conducted in Zemskaya Gymnasium of Balashikha, and involved 333 parents of primary school children (ages 7–10 years). The questionnaire consisted of two blocks. The first block covered the purposes various DD were used for, and how often they were in use on the levels of a week and a day. The second block sought to investigate the quality of sleep, with questions about complaints such as frequent waking up, nightmares, and sleep disorders in general.

In the context of the study, we calculated relative risk (RR), odds ratio (OR), etiological fraction (EF). The risks were calculated at $p < 0.05$ (χ^2). We used an online calculator available at <https://medstatistic.ru/> for the purpose. For data gathering and statistical processing, Yandex Tables, StatTech (StatTech; Russia) software was used.

RESULTS

The study showed that 12.9% of children use a computer, 12.7% watch TV for more than three hours, 10.5% use mobile phones, and 6.1% of children use a laptop (Table 1). Only 3.3% of primary school children use a tablet for more than three hours.

In the course of the study, we collected data on the weekly use of DD: 53.2% of children use a mobile phone daily, 47% of children watch TV shows, 25.9% of children use a laptop, 25.5% of children use a computer, and 18.8% use a tablet (Table 2).

The study yielded data on the DD use-related risks of sleep disorders, nightmares and general abnormalities.

By (EF), the strength of casualty associated with DD was medium for the complaints of sleep disorders in general (RR = 1.87; 95% CI: 1.37–2.54; EF = 46%) (Table 3).

We encountered a very strong causality between daily use of computer and nightmares by EF (RR = 4.75; 95% CI: 1.49–15.11; EF = 79%). A similar pattern was revealed for the tablet, which requires further study, since this device has a relatively large screen (more than 10 inches), but does not have the data input components like a laptop and a computer.

Other results were only showing trends: over 3 hours of daily computer use and difficulties with falling asleep; 5–6 sessions with a laptop a week (or more) and nightmare complaints; 5–6 sessions with a tablet a week (or more) and nightmare complaints; watching TV in the evening and difficulties with falling asleep; watching TV shows in the evening and nightmare complaints.

DISCUSSION

Known publications that explore the hygienic aspects of use of DD rarely differentiate between types of digital addiction. Psychological literature, on the other hand, distinguishes between gadget addiction, fabbing, social media addiction, Internet addiction [32]. Since 2022, the ICD sees gambling addiction as an individual phenomenon.

From standpoint of a child hygienist, it is quite difficult to control the content that a child consumes, but from a practical viewpoint, parents can be recommended to control what kind of DD the child uses. An analysis of the influence of DD allows identifying smartphone as the source of addictions associated with gadgets, personal computer and laptop producing mainly gaming addiction, and TV as the device for consumption of video content in lengthy sessions.

If we consider playing on a smartphone and a desktop computer with a keyboard, mouse, subwoofer, and a screen with the diagonal exceeding 20 inches, it becomes clear that video game addiction is device-dependent.

Smartphone use patterns are characterized by shorter, one-time sessions, more frequent changes of activity, i.e., switching between applications, and a more pronounced multitasking.

At desktops, the level of control over the gameplay is higher, same as that of concentration and anxiety, and a single session lasts longer, since completing one level can last several hours.

Thus, it can be assumed that higher complexity of sensorimotor connections associated with playing on a stationary device translates into a deeper immersion in virtual reality.

At the same time, the type of video game addiction plaguing the younger generation has changed. Earlier, children preferred games that require hours of immersion (which can be conditionally compared with a second job), but nowadays, they favor simpler entertainment, when you can play several different games on the phone within 15 minutes. Thus, it may be concluded that this type of addiction takes features of clip perception, which is consistent with our reasoning. It can also be said that use of different types of DD brings forward different properties of the central nervous system: process mobility, balance, anxiety, excitability, etc.; this phenomenon should be investigated further.

At the same time, it is obvious that the addiction to TV shows and video content is also qualitatively different from the two addictions described above.

Currently, a popular concept is the triple-network model of the brain [33]: it includes the salience network (SN), the central

Table 1. Duration of use of various types of DD by schoolchildren aged 7–10 years during the day (%)

Daily DD use duration	Type of DD				
	Computer <i>n</i> = 101	Laptop <i>n</i> = 66	Tablet <i>n</i> = 61	Mobile phone <i>n</i> = 171	TV <i>n</i> = 157
Less than 30 minutes	31.7	36.4	29.5	30.4	22.9
30 minutes to 1 hour	32.7	40.9	36.1	31	28.7
1 hour to 2 hours	16.8	13.6	26.2	17	24.9
2 hours to 3 hours	5.9	3	4.9	11.1	10.8
Over 3 hours	12.9	6.1	3.3	10.5	12.7

Table 2. Frequency of use of DD of various types by schoolchildren aged 7–10 years during the week (%)

Weekly frequency of Digital Device usage	Type of DD				
	Computer <i>n</i> = 102	Laptop <i>n</i> = 85	Tablet <i>n</i> = 80	Mobile phone <i>n</i> = 205	TV <i>n</i> = 202
Weekend	24.5	28.2	38.8	9.3	10.4
1–2 days	34.3	18.8	20	7.3	15.8
3–4 days	8.8	16.5	17.4	16.6	15.4
5–6 days	6.9	10.6	5	13.7	11.4
Daily	25.5	25.9	18.8	53.2	47

Table 3. Risks of sleep disorders depending on the purpose the DD is used for, children aged 7–10 years

DD use/complaints	χ^2	<i>p</i>	Risks		95% CI	EF (strength of casualty)
Laptop use for more than 1 hour per day/complaints about sleep disorders	9.03	0.01	RR	1.87	1.37–2.54	46% (medium)
			OR	14	1.07–1.71	
Daily computer use/complaints about nightmares	7.17	0.01	RR	4.75	1.49–15.11	79% (very high)
			OR	8.5	1.51–47.96	
Daily tablet use/complaints about nightmares	6.13	0.02	RR	4.66	1.31–16.69	79% (very high)
			OR	8.33	1.34–52.04	

executive network (CEN), and the default mode network (DMN). SN defines attention. It is activated when processing new information, and triggers fast, more superficial reactions, without great physiological investments. From the point of view of P.K. Anokhin's theory of functional systems, this network can hypothetically be compared with an afferent synthesis unit. For example, this system is activated when a person scrolls through the news feed and selects the content that interests him.

When the brain is thinking or playing a complex game, CEN starts working. This network is responsible for working memory and control [34], it is slower, requires more immersion in the process and imposes a greater physiological cost, which hypothetically can be described akin to the programming and control unit.

There are reciprocal relationships between these brain networks: activation of one suppresses the activity of others.

Several authors have expressed similar views on information processing [34, 35]. SN dominates when a person surfs the Internet and tends to subconsciously practice clip perception; in such situations, CEN is not active. For information processing, including that peculiar to complex games, the brain activates CEN, which requires more physiological resources, and DMN is triggered for passive content viewing. Authors of [36] distinguish between interactive and receptive screen time, and point out that receptive screen time is based on DMN basis, which deactivates for interactive screen time. Thus, it is obvious that DMN deactivation triggers SN or CEN, depending on the type of interactive activity.

The type of DD is important from the practical point of view: it can be assumed that different DD are associated with domination of different brain structures. Devices with a large screen, keyboard and mouse activate CEN (programming and control unit) to a greater degree, and in the domain of smartphones (viewing clips, playing simple games, no complex

control involved), it is less active, which, apparently translates into a lower physiological cost of the process and the absence of neuroticism. SN dominates in smartphone and clip perception scenarios, and the CEN and DMN networks are hypothetically not activated in such situations. TV watching involves DMN. The SN and CEN networks are not activated for TV, thus, there is no physiological costs involved, and no subsequent neuroticism and sleep disorders.

Thus, from the standpoint of the three-network model, it is CEN that can affect sleep since its activation means a more pronounced psychophysiological effect that translates into sleep disorders. The other two systems, SN and DMN, have no negative effect on sleep.

CONCLUSIONS

It was found that 53.2% of children use a mobile phone daily, 47% of children watch TV shows, 25.9% of children use a laptop, 25.5% of primary school children use a computer daily, and 18.8% use a tablet.

The study has shown that the parameters of sleep are influenced by type of DD as much as by the respective use patterns, which is explained by various types of digital addiction.

Thus, it has been shown that daily use of a computer and tablet increases the risk of nightmares in children. Using a laptop for more than an hour a day increases the risk of complaints of sleep disorders in general. According to the results of the study, smartphone use and watching TV are not associated with complaints of sleep disorders.

To prevent sleep disorders, children and adolescents should follow hygienic recommendations covering use of DD. It is especially important to limit the use of DD two hours before bedtime and just refrain from using such devices immediately before going to sleep.

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COMPREHENSIVE ASSESSMENT OF THE NUTRITIONAL STATUS OF FIGURE SKATERS IN THE MODERN WORLD

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Monitoring and studying nutritional status is an important stage in the planning of dietary and metabolic support program for figure skaters. However, currently, there is no comprehensive approach to the assessment of this status that would have factored in the specifics of the given sport. In this regard, this study aimed to update the comprehensive figure skaters nutritional status assessment program. We invited male ($n = 13$) and female ($n = 19$) students of the Lesgaft National University, aged 19–20 years, to participate in the study; they all specialize in figure skating. At the first stage, we measured the subjects' anthropometric parameters (body mass index, body fat percentage), clinical indicators (based on the results of the health complaints survey), and speed of dark adaptation. The measurements have shown that the values of body mass index and body fat percentage were normal in all participants for their age. The survey revealed indirect signs of dietary deficiencies, in particular, insufficient amounts of vitamins A, C, P, and B₁. To make the nutritional status check more informative, we suggest completing the program with functional testing (general and special standards) involving registration of the dynamics of the respective indicators, and bioelectrical impedance analysis to learn body composition.

Keywords: figure skating, nutritional status, anthropometry, caliperometry, body composition, dark adaptation

Author contribution: Zadorozhnaya NA — concept of the article, study design, critical revision of the manuscript; Dubkova NV — concept of the article, study design, literature processing, description of the results, article authoring; Domozhilova AA — literature processing, description of the results, article design; Petrochenko DE — conducting the study, literature processing, description of the results.

Compliance with ethical standards: the study was approved by the Ethics Committee of the Lesgaft National State University of Physical Education, Sports and Health (protocol No. 5 of June 21, 2024). All athletes submitted the written informed consent to participate in the study.

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КОМПЛЕКСНЫЙ ПОДХОД К ОЦЕНКЕ ПИЩЕВОГО СТАТУСА ФИГУРИСТОВ В СОВРЕМЕННЫХ УСЛОВИЯХ

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Изучение пищевого статуса является важным этапом планирования нутритивно-метаболической поддержки спортсменов, специализирующихся в фигурном катании. Однако в настоящее время отсутствует комплексный подход к его оценке с учетом особенностей рассматриваемой специализации. Ввиду этого целью работы было актуализировать комплексную программу оценки пищевого статуса спортсменов-фигуристов. В исследовании приняли участие студенты ($n = 13$) и студентки ($n = 19$) НГУ имени П. Ф. Лесгафта, представляющие фигурное катание, в возрасте 19–20 лет. На первом этапе тестирования были изучены такие характеристики испытуемых, как данные антропометрических измерений (индекс массы тела, процент жировой массы тела), клинические показатели (по результатам опроса жалоб на состояние здоровья), время темновой адаптации. Исследование показало, что значения индекса массы тела и процента жировой массы тела соответствуют нормативным показателям для данной возрастной группы как у женщин, так и у мужчин. При этом выявлены косвенные признаки дефицита в рационе питания фигуристов витаминов А, С, Р, В₁ на основании жалоб спортсменов на различные состояния. Для повышения информативности программы изучения пищевого статуса предложены дополнительные исследования таких показателей, как функциональное тестирование по общим и специальным нормативам с регистрацией динамики их изменений, а также расширение применяемых методик оценки компонентного состава тела за счет использования биоимпедансометрии.

Ключевые слова: фигурное катание, пищевой статус, антропометрия, калиперометрия, состав тела, темновая адаптация

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Соблюдение этических стандартов: исследование одобрено этическим комитетом НГУ имени П. Ф. Лесгафта (протокол № 5 от 21 июня 2024 г.). Все спортсмены письменно подтвердили свое добровольное согласие на участие в исследовании.

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Lately, sports community has generally agreed on the confirmed importance of a balanced diet in ensuring the high level of physical performance of an athlete and optimization of post-training recovery [1]. Thus, it is obvious that in such a highly competitive sport as figure skating, a scientific approach to diet planning is essential.

Currently, individual dietary recommendations in figure skating should be based on the accurate assessment of the athlete's nutritional status and factor in the principal type of supply of energy for muscular activity [2], the specifics

of microclimate peculiar to the training process [3], and the high risk of injury to the musculoskeletal system [4–6]. It is important to emphasize that today, nutritional status is considered to be an integral indicator that reflects consumption of nutrients, body composition, and metabolic processes at the level of the organism as a whole [7].

Over the past decades, nutritional status and the approaches to its assessment have undergone a number of changes. The abundance of various foods that do not necessarily offer the needed nutrients in the proper amounts, and frequent

violations of the dietary regime have a significant effect on a person's health and performance. The nutritional status of an athlete depends on many factors, and some of the most important of them are the specifics of the training process combined with adherence to the principles of adequate nutrition (quantity and quality) [8].

Thus, while the analysis of the diet is the key component of the nutritional balance assessment, it should be considered only in the context of a complete and comprehensive study of the athlete's health that involves collection of anthropometric, biochemical, clinical, physiological, and functional data [9].

The purpose of this study was to update the comprehensive figure skaters nutritional status assessment program.

METHODS

The study was conducted at the Department of Preventive Medicine and Fundamentals of Health at the Lesgaft National State University of Physical Education, Sports and Health. It involved figure skaters, 13 male and 19 female, aged 19 to 20 years, with qualifications from the first adult skill category to candidate master. We collected the anthropometric data using RP-150 MG standard medical scales (Vestech; Russia) and an RM height meter (TZMT; Russia), then calculated the body mass index (BMI, kg/m²) by the generally accepted formula. Skinfold assessment was done with the help of the Accu-Measure Fitness 3000 plastic caliper (AccuFitness; USA) at seven standard points (back of the shoulder, chest, armpit, under the shoulder blade, upper iliac region, abdomen, at the middle of the thigh). Subsequently, using formulas adjusted for athletes, we calculated the body fat mass [10].

At the next stage of the study, the participants' dark adaptation capabilities were learned. We use the Kravkov–Purkinje table for the purpose. As per the respective standard, athletes should distinguish the yellow square after 30–40 s, and then the blue one [11].

Subjective feelings and health complaints reported by the participants through a specially designed questionnaire were used to register the clinical indicators of nutritional status. The questions sought to reveal if the athletes had bleeding gums, keratinized skin, high secretion of sebaceous glands, bluish skin color, dry skin, pain in the leg muscles when walking, general weakness.

The MyOffice (New Cloud Technologies; Russia) was used for statistical processing of the results. Herein, the data are given as median (Me) and quartiles (25% and 75%).

RESULTS

An accurate assessment of an athlete's nutritional status is only possible when the criteria selected for the purpose factor in the specifics of the respective sport. In our study, at the first stage, we relied on anthropometric indicators as well as physiological and clinical markers of health status, which, it was assumed, could back a primary conclusion about the adequacy of nutrition of the participants. Next, we critically assessed the informative value of the program's components,

and suggested ways to make it more effective by introducing new methods and techniques.

In the context of grading the figure skaters' nutritional status, we registered BMI and body fat with the help of calipers. Table 1 gives the values of these indicators.

Dark adaptation was the selected physiological test contributing to the assessment of the nutritional status. The ability to adapt to darkness deteriorates if a person's diet lacks sufficient amounts of high-grade protein, vitamins A, C and B₂, which makes this test usable in the context of revealing the adequacy of intake of these nutrients [12]. It is important to emphasize that the dark adaptation test values registered in this study were optimal: 28.9 (28.2; 31.0) s for female participants, and 29.7 (28.3; 30.9) s for male subjects.

Health complaints collected with the help of a questionnaire are as informative in the general assessment of a person's condition [13]. The data shown in the Figure demonstrate that the athletes exhibit signs of vitamin deficiency. For example, dry skin and general weakness may indicate that the diet is deficient in vitamin A. In turn, bleeding gums, muscle pain during walking, and skin cyanosis are indirect signs of vitamin C and P hypovitaminosis, and high secretion of sebaceous glands points to a deficiency in vitamin B₁.

DISCUSSION

Experts have shown that morphofunctional characteristics of nutritional status, primarily body weight, affect competitive success in figure skating [14–16]. In this regard, BMI is of particular diagnostic importance: it is a universal anthropometric indicator widely used to assess the state of health and the adequacy of nutrition [17]. However, in sports, its informational value may be limited by the specific requirements of the given sport. For example, in figure skating, especially in women's singles, BMI values are typically close to the lower limit of the range recommended for the general population (18.5–25.0 kg/m²), because such is the condition of the body needed to performing multi-turn jumps [18, 19]. Our study involved figure skaters from various disciplines, so by this indicator, the nutritional status of all participants, male and female, can be considered "normal."

Body composition is an indicator that is informative in terms of nutritional status, and it defines the functional capabilities of the athlete's body [20]. However, currently, there is no consensus regarding the methodological approaches to the assessment thereof [21]. Bioelectrical impedance analysis is becoming increasingly popular, despite the need to use specialized equipment and ensure strict adherence to the preparation procedure in both laboratory and training conditions [22, 23]. Caliperometry, at the same time, does not lose its relevancy, since this technique yields values on par in accuracy with those obtained using other methods relying on hardware [24]. For figure skaters, body fat is a factor influencing how well they can perform complex technical elements. It is considered to be an indicator requiring systematic evaluation [25]. According to the literature, the percentage of body fat should be 8–10% in men and 11–13% in women [2].

Table 1. Anthropometric indicators, Me (Q1; Q3)

Indicator	Measured value	Standard values
BMI (men), kg/m ²	21.1 (20.5; 21.3)	18.5–25.0
BMI (women), kg/m ²	21.8 (21.3; 22.4)	18.5–25.0
Body fat mass (men), %	11.5 (10.9; 12.2)	8.0–10.0
Body fat mass (women), %	15.3 (14.3; 16.4)	11.0–13.0

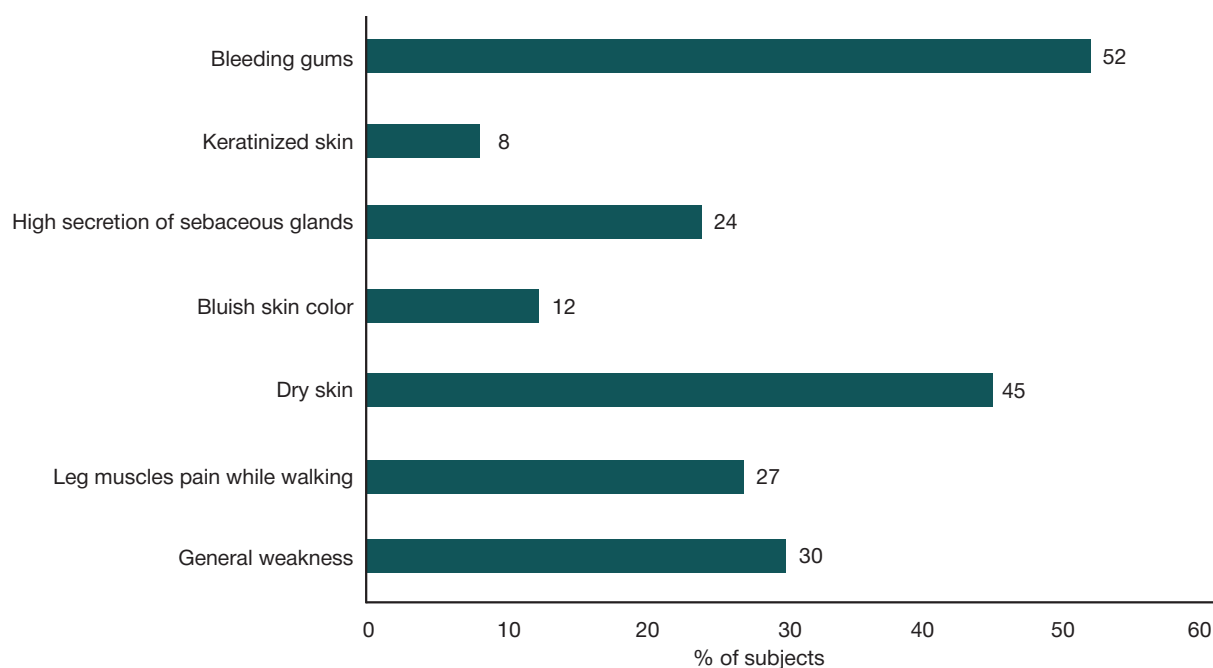


Fig. Clinical signs of inadequate nutrition in athletes

According to the Order of the Ministry of Sports of the Russian Federation "On approval of the federal training standard in figure skating" (No. 738, of September 17, 2022), coordination and vestibular stability have a significant effect on the performance in the considered sport [26]. Therefore, this study pays special attention to the level of vitamin B₆ in the diet the participating athletes when assessing their nutritional status. In this connection, as part of clinical studies, it is necessary to reveal complaints about cheilosis, conjunctivitis, decreased appetite, anxiety, if any [27]. It can be assumed that vitamin B6 deficiency affects physiological tests, Romberg test in particular, which necessitates including it in the comprehensive figure skaters nutritional status assessment program.

Functional tests used to evaluate the physique can also be considered an approach to assessment of the nutritional status. Thus, it is necessary to adjust the set of exercises from such tests to the requirements of the given sport. In particular, the results of the exercise involving flexion and extension of arms while supine are known to positively correlate with how well a figure skater performs complex jumps [28]. Other exercises,

like the Tour jump, which involves complex motor coordination [29], can also yield values reflecting the adequacy of vitamin consumption in general and group B vitamins in particular.

Undoubtedly, the nutritional status study program should include clinical and biochemical blood tests, with their results compared to those of functional tests and 24-h assessment of the quantitative and qualitative characteristics of the diet.

Thus, a comprehensive program should include anthropometric measurements, body composition assessment, study of clinical and biochemical parameters, physiological and functional testing followed by analysis of the diet (Table 2).

CONCLUSIONS

This study aimed to identify possible disorders in the state of health of figure skaters in order to substantiate the selection of informative criteria needed to develop a nutritional status assessment program. The selected indicators characterized the health of figure skaters and how it depends on nutrition. Thus, we obtained the primary results that laid the foundation

Table 2. Figure skaters' nutritional status assessment program: components

Program components	Methods and studied indicators
1. Anthropometric measurements	– Height and weight; – BMI; – skinfold measurement (caliperometry)
2. Body composition	Bioelectrical impedance analysis (musculoskeletal body mass, body fat, total water, etc.)
3. Clinical indicators	Identification of clinical signs of dietary deficiencies
4. Biochemical parameters	– Protein metabolism; – carbohydrate metabolism; – lipid metabolism; – vitamin metabolism; – mineral metabolism
5. Physiological testing	– Dark adaptation; – the Romberg test
6. Functional testing	The dynamics of indicators based on the results of testing at different stages of sports training: – general standards (arms flexion and extension while supine; squat jumps); – special standards (Pistol, Tour)
7. Diet analysis	24-h food intake registration (determination of quantitative and qualitative adequacy of nutrition by macro- and micronutrients)

for the comprehensive nutritional status assessment program. According to the currently accepted concept, a comprehensive assessment of the nutritional status of an athlete can be given based on a wide range of anthropometric data, with the general functional indicators completing the picture given by the tests adjusted to the given sport, and the subjective feelings

of an athlete and the results of a medical examination supporting clinical and biochemical parameters. Since there are other factors that can trigger changes in the health status of athletes, it is necessary to adjust the diet once its comprehensive assessment is complete, and follow up with the next round of assessment of the same indicators after such optimization of nutrition.

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QUALITY OF LIFE AND LIFESTYLE ASSESSMENT IN STUDENTS OF MEDICAL AND HUMANITARIAN FACULTIES OF VORONEZH UNIVERSITIES

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Currently, studying the quality and style of life of students is an urgent task due to the need to improve the demographic situation and increase the intellectual potential of the country. This article presents an analysis of the quality of life of medical and humanitarian specialties students of Voronezh universities. We sought to compare these parameters based on the data collected with the help of the SF-36 survey and the HPLP (Health-Promoting Lifestyle Profile) questionnaire. The study involved 262 students of the Burdenko Voronezh State Medical University, Voronezh State University and Voronezh branch of Plekhanov Russian University of Economics aged 18–25 years. We revealed significant differences between educational institutions in a number of key indicators, which highlights the importance of factoring in the specifics of the educational environment when designing health preservation programs for students. According to the results of the survey (SF-36), humanitarian specialties students self-assessed their health better than future medical professionals (median values 70 points vs. 65 points, respectively), same as physical activity and nutrition, as shown by the HPLP questionnaire (20.5 points vs. 18 points and 24 points vs. 23 points, respectively). The resulting data revealing the differences in the quality and lifestyle of students can be used in the development of health and wellbeing improvement recommendations for students, and in the design of comprehensive physical and mental health preservation programs.

Keywords: students, specialty, quality of life, lifestyle, SF-36, HPLP-II, survey, healthy lifestyle, health-saving technologies

Author contribution: Komissarova OV — study design, resulting data analysis; Komissarova OV, Fertikova TE — manuscript authoring; Fertikova TE — review of publications covering the subject of the article; Sapina AE, Trofimova AS — data collection.

Compliance with ethical standards: the study met the biomedical ethics requirements. All participants consented to take part voluntarily.

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ОЦЕНКА КАЧЕСТВА И ОБРАЗА ЖИЗНИ СТУДЕНТОВ МЕДИЦИНСКИХ И ГУМАНИТАРНЫХ СПЕЦИАЛЬНОСТЕЙ ВУЗОВ Г. ВОРОНЕЖА

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На современном этапе актуальной задачей является изучение качества и образа жизни студентов — это обусловлено необходимостью улучшения демографической ситуации и повышения интеллектуального потенциала страны. В статье представлен анализ качества жизни студентов медицинских и гуманитарных специальностей воронежских вузов. Целью исследования было выполнить сравнительную оценку качества и образа жизни студентов медицинских и гуманитарных специальностей вузов г. Воронежа на основании данных опросников SF-36 и «Профиль здорового образа жизни». В исследовании приняли участие 262 студента Воронежского государственного медицинского университета имени Н. Н. Бурденко, Воронежского государственного университета и Воронежского филиала Российского экономического университета имени Г. В. Плеханова в возрасте 18–25 лет. Результаты анализа данных показали значительные различия между учебными заведениями по ряду ключевых показателей, что подчеркивает важность учета специфики образовательной среды при формировании программ поддержания здоровья студентов. Самооценка здоровья студентов-гуманитариев по опроснику SF-36 была выше — медианные значения этого показателя составили 70 баллов против 65 баллов у студентов-медиков. При использовании опросника «Профиль здорового образа жизни» также получены более высокие медианные значения показателей физической активности и питания студентов гуманитарного профиля (20,5 балла против 18; 24 балла против 23). Полученные данные о различиях в качестве и образе жизни студентов могут быть использованы для разработки рекомендаций по улучшению здоровья и благополучия обучающихся, а также для создания комплексных программ поддержания физического и психического здоровья в вузах.

Ключевые слова: студенты, специальность, качество жизни, образ жизни, SF-36, HPLP-II, анкетирование, здоровый образ жизни, здоровьесберегающие технологии

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Соблюдение этических стандартов: исследование соответствовало требованиям биомедицинской этики. Добровольное информированное согласие получено от всех участников.

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Currently, studying the quality and style of life (QOL) of students is an urgent task, since the state is paying special attention to the youth, who are supposed to solve the demographic problem and form the country's labor and intellectual potential [1]. QOL is a concept that reflects the level of satisfaction of material, spiritual and social needs [2]. According to the definition by the World Health Organization (WHO), QOL is an individual's

perception of their position in life in the context of the culture and value systems in which they live and in relation to their goals, expectations, standards and concerns. Health-related QOL is considered as an integral characteristic of three spheres of human functioning, i.e., physical, mental, and social, from the point of view of the person's subjective perception. Health is a factor affecting the students' subjective perception

of their QOL during the university years. In other words, QOL is a subjective assessment of the state of health. Various questionnaires are used to assess QOL [2–5]. Study [5] compares students' QOL data collected using several questionnaires, including WHOQOL-100, SF-36 Health Status Survey, and QOL Assessment Procedure (O.I. Gubina, 2007).

According to the WHO, a healthy lifestyle is optimal QOL determined by "motivated human behavior aimed at preserving and improving health while affected by the natural and social environmental factors" [2]. A healthy lifestyle is a way of life focused on strengthening the person's health [6]. WHO identifies lifestyle factors that pose risks to health and can lead to its deterioration: poor nutrition, deviant behavior (smoking, alcohol abuse, use of narcotic psychoactive substances), physical inactivity, hygiene-associated behavior (violation of daily routine, work and rest patterns, poor hygiene in the immediate residential environment), medicine-associated behavior (untimely seeking of medical attention, self-medication, lack of self-monitoring of basic health indicators).

A number of studies have revealed a positive trend: more and more young people lead a healthy lifestyle. One of such works [7] has shown that there are more students preferring healthy lifestyle in 2014–2015 than in 1998–2005. The number of students reporting lack of chronic diseases has also increased. However, compared to 1979–1984, the number of smoking young people (both male and female) has increased.

Many studies demonstrate that within the last decade, health indicators and, consequently, QOL of students have been deteriorating [8]. The registered negative impact of the COVID-19 pandemic on QOL of students was associated with weight gain, consumption of harmful products, decreased physical activity, and psychological disorders [9].

Over the past decade, many researches published comparative characteristics of health and QOL of students from different universities [10–22]. The most important factors of students' QOL are material wealth, residential conditions, family, nutrition, performance at the university, and position in society. For young people attending educational institutions, QOL is determined by the specifics of their studies, gender, and curriculum. University students have low mental health indicators [11]. The level of physical activity has a positive effect on QOL [12]. The students of the sports university have a high self-assessment of health.

Medical students exhibit QOL lower than in the general population [13]. In particular, young people studying at non-medical faculties of universities of Voronezh and Sakhalin regions have higher QOL than medical students in the same areas, and underestimated state of health translates into improper control over it [14–16]. Only 12.3% of the surveyed students of I.M. Sechenov First Moscow Medical University have the QOL assessment at a high level [17].

As a rule, male students have higher QOL score than their female counterparts, as shows by surveys conducted at the Medical Institute of the RUDN University, Khanty-Mansiysk State Medical Academy and the Medical Institute of Surgut State University [18–20].

Study [21], conducted at the Siberian Medical University, provides data on how QOL changes depending on the year, with second and third year students being fairly dissatisfied therewith, and this indicator starts to go up from the fourth year only.

The quality of life of students is negatively affected by such factors as bad habits, high academic workload, intense stress associated with the studies and exams, irrational daily routine, low physical activity, financial and housing problems [13, 21–23]. Accordingly, improvement of the general state

of health resulting from adherence to the healthy lifestyle patterns can raise QOL. Health-saving technologies aimed at creating optimal hygienic and psychophysiological conditions in the higher educational institution environments aid in making the students' QOL better.

This study aimed to compare QOL and lifestyle of medical and non-medical students of Voronezh based on the data collected with the help of the SF-36 survey and the Health-Promoting Lifestyle Profile (HPLP) questionnaire.

METHODS

The study involved students from three higher educational institutions: Burdenko Voronezh State Medical University (VSMU), Voronezh State University (VSU), and Voronezh Branch of Plekhanov Russian University of Economics (PRUE); its timeframe was from February to May 2024. The participants were 262 students aged 18 to 25, 79 (30.2%) male and 183 (69.8%) female. The distribution by educational institutions was as follows: VSMU — 146 students (55.7%), VSU — 41 students (15.7%), PRUE — 75 students (28.6%). The results were divided by specialization, first group including VSMU students (medical), second — VSU and PRUE students (humanitarian).

To assess QOL, we used the SF-36 (Short Form Health Survey) Medical Outcomes Study Questionnaire, which reveals the overall well-being and degree of satisfaction with those aspects of human life that affect the state of health [3]. The questionnaire consists of 36 items grouped into eight domains: physical functioning (SF-36/PCS/PF), role physical (SF-36/PCS/RP), bodily pain (SF-36/PCS/BP), general health (SF-36/PCS/GH), vitality (SF-36/MCS/V), social functioning (SF-36/MCS/SF), role emotional (SF-36/MCS/RE), and mental health (SF-36/MCS/MH). These domains support two summary scores, Physical Component Summary (PCS) and Mental Component Summary (MCS). The results are presented as percentages from 0 to 100, where 100% correspond to perfect health. The higher the scores by domains of the questionnaire, the better is the self-assessment of a person's health. There is a particularly close relationship between the said self-assessment and SF-36 domains of physical functioning, role physical, general health, and vitality. These domains directly reflect the physical state and health-related limitations. The fewer physical problems a person experiences, the better is the resulting overall health assessment. Despite subjectivity, self-assessment of health is of great practical importance, as it helps to identify "hidden" health problems.

To assess the healthiness of the lifestyle, we used the Health-Promoting Lifestyle Profile (HPLP) questionnaire, which measures the multicomponent structure of healthy lifestyle and includes 6 subscales: health responsibility (HPLP/HR), physical activity (HPLP/PA), nutrition (HPLP/N), spiritual growth (HPLP/SG), interpersonal relationships (HPLP/IR), and stress management (HPLP/SM). High scores on all subscales indicate that the respondent practices a mature health-promoting behavior.

For statistical analysis of the data, we used StatTech v.4.2.7 (StatTech; Russia). Kolmogorov–Smirnov test and Shapiro–Wilk tests enabled assessment of the conformity of quantitative indicators to the normal distribution patterns. The values outside normal distribution were described with the help of the median (Me) and the quartiles (Q_1 – Q_3). The data by category were given in absolute values and percentages. For comparison of three or more groups by the quantitative indicators with distribution outside of the norm, we applied the Kruskal–Wallis test and Holm-adjusted Dunn's test. The differences were

Table 1. SF-36 results by specialization

Indicators	Categories	Educational institution			<i>p</i>
		Me	Q ₁ –Q ₃	<i>n</i>	
SF-36/PCS/PF	medical specialty	95	85.00–100.00	146	0.06
	humanitarian specialty	95	78.75–100.00	116	
SF-36/PCS/RP	medical specialty	50	25.00–100.00	146	0.123
	humanitarian specialty	75	47.25–100.00	116	
SF-36/PCS/BP	medical specialty	77	57.00–100.00	146	0.203
	humanitarian specialty	75	52.00–100.00	116	
SF-36/PCS/GH	medical specialty	65	50.00–75.00	146	0.009*
	humanitarian specialty	70	60.00–85.00	116	
SF-36/MCS/MH	medical specialty	56	44.00–72.00	146	0.418
	humanitarian specialty	62	44.00–73.00	116	
SF-36/MCS/RF	medical specialty	33	0.00–100.00	146	0.020*
	humanitarian specialty	67	33.00–100.00	116	
SF-36/MCS/SF	medical specialty	75	50.00–87.00	146	0.987
	humanitarian specialty	75	54.00–87.00	116	
SF-36/MCS/V	medical specialty	52.5	40.00–70.00	146	0.048*
	humanitarian specialty	60.00	40.75–70.00	116	

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

considered significant at $p < 0.05$. The study was carefully planned to minimize errors and ensure high reliability of the data.

RESULTS

The SF-36 survey returned significantly different results in several domains describing physical and mental components of health: general health (PCS/GH), role emotional (MCS/RE), and vitality (MCS/V). Table 1 gives the data from each domain in percents, and the significant differences between the groups.

Among all the participants, medical students assessed their general health (PCS/GH) worse than those attending humanitarian faculties, with the median values being 65 vs. 70 points, respectively.

Role emotional (MCS/RE) domain also presented significant differences: the median values were 33 points for future medical professionals vs. 67 points for those learning humanitarian sciences. It is possible that the latter have more opportunities to express emotions and interact socially due to the specifics of the educational process, which has a positive effect on their emotional well-being. The low scores of the Burdenko VSMU students may stem from the part-time employment habitual among them, which translates into shortage of free time and higher levels of psychoemotional stress.

The vitality indicator (MCS/V) also turned out to have higher values among students of humanitarian specializations: the medians were 60 points vs. 52.5 points for medical students. The differences here can be explained by more intense daily routines of the latter combined with a lower level of physical activity, both resulting from time constraints imposed by busy schedules and the need to move between different university buildings and medical organizations.

Thus, VSU and PRUE students rated their general health (PCS/GH) and vitality (PKZ/ZHA) higher than students of medical specialties.

Table 2 gives the results of the analysis of data collected with the HPLP questionnaire. On the subscales PA, N, IR, and SM, the results shown by medical and non-medical students were significantly different.

The questionnaire showed that those attending humanitarian faculties were more active physically than future medics: the median values of this indicator were 20.5 points vs. 18 points, respectively.

Nutrition was another matter the approaches to which differed significantly: humanitarian faculty students scored 24 points on this subscale, while medical students had 23 points. This difference may probably be explained by the latter lacking time for proper meals since they have to regularly move from one university building to another.

In terms of interpersonal relationships, humanitarian students also scored higher than those studying medicine: the medians were 31 points vs. 29 points, respectively. This difference may stem from a greater number of group tasks and projects typical for humanitarian education, which help develop communication skills and strengthen social ties.

On the stress management subscale, VSU and PRUE students also scored more than VSMU students, 22 points against 20 points, respectively. The probable reason behind this difference is the curriculum at humanitarian faculties, which includes disciplines aimed at developing stress tolerance and emotional intelligence (for example, "Personality psychology and its self-development"), and enables students to effectively prevent the negative effects of stress associated with studying at a university.

DISCUSSION

This study revealed significant differences in the QOL of students attending medical and humanitarian faculties of Voronezh universities. The data collected using the SF-36 questionnaire show that the highest QOL assessment was given by the humanitarian students from VSU and PRUE. Compared to the values scored by medical students, they had better results in the domain of health, role emotional (MCS/RE), and vitality.

The revealed differences in QOL are consistent with data from other studies. For example, in the Sakhalin region, non-medical students showed a higher QOL than those specializing in medicine [15]. Medical undergraduates rate

Table 2. HPLP results by specialization

Indicators	Categories	Educational institution			<i>p</i>
		Me	Q ₁ –Q ₃	<i>n</i>	
HPLP/HR	medical specialty	23	19.00–26.00	146	0.536
	humanitarian specialty	23	18.00–27.25	116	
HPLP/PA	medical specialty	18	13.00–21.00	146	< 0.001*
	humanitarian specialty	20.5	16.00–28.00	116	
HPLP/N	medical specialty	23	19.00–26.00	146	0.003*
	humanitarian specialty	24	20.00–31.00	116	
HPLP/N	medical specialty	28	24.00–31.00	146	0.273
	humanitarian specialty	28.5	24.75–32.00	116	
HPLP/IR	medical specialty	29	26.00–32.00	146	0.003*
	humanitarian specialty	31	27.00–36.00	116	
HPLP/SM	medical specialty	20	18.00–24.00	146	0.009*
	humanitarian specialty	22.00	19.00–27.00	116	

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

their emotional status, role functioning, and general well-being extremely poorly [16]. According to the authors, the reasons for such low scores should be looked for in the organization of the studying process, problematic accommodation, and suboptimal timetables. I.B Ushakov, E.P Melikhova et al. have reached similar conclusions, pointing to the heavy weekly academic workload of VSMU students and its irrational distribution through days and weeks [24]. In addition, medical students have to use their breaks to travel from one facility to another. Study [25] highlights the greater load on the part of medical students compared to non-medical specializations.

Second questionnaire, HPLP, has also shown that humanitarian students of Voronezh score higher on most subscales (physical activity, nutrition, interpersonal relationships, and stress management), which reflects a sufficient level of awareness about their health, and mature behavior aimed at preservation of health. Students of VSU and PRUE devote more time to physical activity and proper nutrition. These factors have a positive effect on their health, increasing QOL [26]. Study [21] points to the lack of time for physical activity among medical students.

Thus, the data from the two questionnaires reveal a lower QOL among future medical doctors, and their lax attitude towards the principles of healthy lifestyle. This may be due to certain specifics of the educational process, the necessary contacts with patients and part-time employment, as well as poor implementation of psychological support programs that are especially essential for medical specialties [22, 27,

28]. These assumptions are confirmed by the lower scores shown by VSMU students in the role emotional domain of SF-36 and on the stress management subscale of the HPLP questionnaire.

In medical universities, curricula and teaching methods are focused on the intensive consumption of large amounts of specialized knowledge and preparation for professional activities involving a high degree of responsibility. This creates a significant level of stress, worsens general well-being and vitality. Therefore, it is necessary to pay more attention to the organization of health preservation programs in medical universities [29, 30].

CONCLUSIONS

The data obtained in the context of this study demonstrate the need to adapt educational programs and extracurricular activities to the specifics of the studying process and needs of students of each educational institution. Effective implementation of comprehensive health improvement programs can significantly boost the students' QOL and academic performance. The data underscore the importance of developing and implementing programs aimed at strengthening students' physical and mental health, as well as increasing their awareness of a healthy lifestyle. The study confirms the importance of further investigation of the relationship between educational environment and well-being of students, which can form the basis of education and health policy at the level of higher education institutions.

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