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OPINION

4

Pressing issues of medical assistance of students receiving secondary medical education

Shkarin VV, Latyshevskaya NI, Tikhonova EN, Levchenko NV

Актуальные проблемы медицинского обеспечения студентов, получающих среднее медицинское образование

В. В. Шкарин, Н. И. Латышевская, Е. Н. Тихонова, Н. В. Левченко

ORIGINAL RESEARCH

9

Hygienic characteristics of some aspects of students' psychological health

Kopylov AS

Гигиеническая характеристика некоторых аспектов психологического здоровья студентов

А. С. Копылов

ORIGINAL RESEARCH

14

Hygienic aspects of general medicine ward operation: problems and solutions

Pivovarov YuP, Milushkina OYu, Kaminer DD, Bulatseva MB, Malikov IV

Гигиенические аспекты организации работы терапевтических отделений: проблемы и пути их решения

Ю. П. Пивоваров, О. Ю. Милушкина, Д. Д. Каминар, М. Б. Булацева, И. В. Маликов

ORIGINAL RESEARCH

22

Rationale for the need to prevent allergic rhinitis across the Voronezh region

Krasnikova AA, Mamchik NP, Mekhantsev II

Обоснование необходимости профилактики аллергического ринита на территории Воронежской области

А. А. Красникова, Н. П. Мамчик, И. И. Механтьев

ORIGINAL RESEARCH

28

Specialty "preventive medicine": from applicant to specialist

Shepeleva OM, Gerasimova ES, Churilin MI

Специальность «Медико-профилактическое дело» — от абитуриента до специалиста

О. М. Шепелева, Е. С. Герасимова, М. И. Чурилин

ORIGINAL RESEARCH

34

Psychophysiological features of students at different risk of internet-addictive behavior

Setko NP, Zhdanova OM, Setko AG

Психофизиологические особенности студентов с разным уровнем риска интернет-зависимого поведения

Н. П. Сетко, О. М. Жданова, А. Г. Сетко

ORIGINAL RESEARCH

42

Ranking of territories in the Voronezh Region by the incidence rates resulting from chemical load

Mekhantsev II, Enin AV

Ранжирование территории воронежской области по заболеваемости населения, обусловленной химической нагрузкой

И. И. Механтьев, А. В. Енин

OPINION

48

Pulse-width modulation as a new hygienic factor determining the visual comfort of modern screens

Kurgansky AM

Широтно-импульсная модуляция как новый гигиенический фактор, определяющий зрительный комфорт современных экранов

А. М. Курганский

PRESSING ISSUES OF MEDICAL ASSISTANCE OF STUDENTS RECEIVING SECONDARY MEDICAL EDUCATION

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The paper reports the issues of the medical assistance of students attending secondary medical educational institutions in Volgograd and the Volgograd region. It has been found that the regional regulatory documents contain no unified requirements related to students' health protection. Primary medical care provision to students is ensured by pediatric (under the age of 18 years) and adult outpatient clinics (over the age of 18 years) of Volgograd and the Volgograd region in accordance with the concluded contracts. Furthermore, the students have a mandatory medical check-up before the beginning of practical training in accordance with the Order № 29N of the Ministry of Health of the Russian Federation dated January 28, 2021. At the same time, there is no dynamic monitoring of the students' health status during the educational process. It has been shown that none of the secondary medical educational institutions of Volgograd and the Volgograd region conducts assessment and monitoring of occupational risk factors corresponding to the studied specialty. It is necessary to develop the system for informational communication of medical professional with medical institutions conducting preventive medical examinations and routine check-ups of students. Furthermore, it is important to consider the features of the chosen profession taking into account potential risk factors of the learning process and future professional activity.

Keywords: medical examinations, students, medical college, secondary vocational education, risk factors

Author contribution: Shkarin VV, Latyshevskaya NI — developing the study design, data analysis; Latyshevskaya NI — manuscript writing; Tikhonova EN — review of paper on the topic; Tikhonova EN, Levchenko NV — data acquisition.

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АКТУАЛЬНЫЕ ПРОБЛЕМЫ МЕДИЦИНСКОГО ОБЕСПЕЧЕНИЯ СТУДЕНТОВ, ПОЛУЧАЮЩИХ СРЕДНЕЕ МЕДИЦИНСКОЕ ОБРАЗОВАНИЕ

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В статье проанализированы вопросы медицинского обслуживания студентов организаций среднего профессионального образования медицинского профиля г. Волгограда и Волгоградской области. Установлено, что в региональных нормативно-правовых документах отсутствуют единые требования в области охраны здоровья обучающихся. Оказание первичной медико-санитарной помощи обучающимся осуществляется в детских (до 18 лет) и взрослых (старше 18 лет) поликлиниках г. Волгограда и Волгоградской области в соответствии с заключенными договорами. При этом студенты проходят обязательный медосмотр перед началом производственной практики в соответствии с требованиями приказа Минздрава России от 28.01.2021 № 29Н. Вместе с тем в процессе обучения отсутствует динамическое наблюдение за состоянием здоровья студентов. Показано, что ни в одном из учреждений среднего профессионального образования медицинского профиля г. Волгограда и Волгоградской области не проводят оценку и мониторинг профессиональных факторов риска, соответствующих изучаемой специальности. Необходимо разработать систему информационного взаимодействия медицинского работника с медицинскими организациями, осуществляющими профилактические медицинские осмотры и диспансеризацию студентов. При этом важно учитывать особенности изучаемой профессии с учетом потенциальных факторов риска здоровью как в процессе обучения, так и в дальнейшей профессиональной деятельности.

Ключевые слова: медицинские осмотры, студенты, медицинский колледж, среднее профессиональное образование, факторы риска

Вклад авторов: В. В. Шкарин, Н. И. Латышевская — разработка дизайна исследования, анализ полученных данных; Н. И. Латышевская — написание текста рукописи; Е. Н. Тихонова — обзор публикаций по теме статьи; Е. Н. Тихонова, Н. В. Левченко — получение данных для анализа.

Соблюдение этических стандартов: исследование одобрено этическим комитетом ФГБОУ ВО «Волгоградский государственный медицинский университет» Министерства здравоохранения Российской Федерации (протокол № 068 от 11 сентября 2023 г.). От всех участников было получено информированное согласие.

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In the past decade, great attention was paid to the hygienic, medical and social issues of secondary vocational education (SVE). Training of secondary professionals is the most important prerequisite for further technological and economic development of Russia [1, 2]. In the beginning of the academic year 2021/2022, SVE programs were implemented by 4600 educational institutions (including their branches), the majority

of which (70%) were represented by SVE institutions [3]. In recent years, the number of trained secondary professionals in the Russian Federation increased from 469,100 in 2016 to 573,800 in 2021, including healthcare specialists and medical scientists — their number increased from 54,700 to 73,600 [4].

Given the fact that more than 80% high school students have various health problems, it can be assumed, that young

adults showing deterioration of health indicators and having functional disorders enter colleges and technical schools. Furthermore, in addition to educational workload, students receiving SVE are exposed to occupational factors, while the training conditions often have unsatisfactory sanitary and epidemiological characteristics [5, 6]. Thus, one third of adolescents in the Sverdlovsk region, who attend SVE institutions, are susceptible to additional medical and social, training and occupational risk [7].

It should be noted that the majority of studies focused on the issues of SVE provide the data on hygienic assessment of the conditions and arrangement of training in the colleges and technical schools, where the workers are trained [8–11]. Furthermore, among SVE institutions, more than 28% have sectoral specialization, and the largest share falls on the healthcare and medical educational institutions [12]. However, there is still a shortage of secondary medical personnel in the country, for many years there has been no positive upward trend in the number of this cohort of medical professionals; many of them do not stay in the profession, including due to potential health risks [13, 14]. In general, it should be noted that there are just a few studies focused on the hygienic problems of secondary medical education, including assessment of care provision and social assistance, which determines the relevance of our study.

The study was aimed to determine the problematic aspects of organizing care provision and social assistance in adolescents and young adults attending medical colleges, including those working in the Volgograd region and having different administrative subordination.

In September 2023, a review of scientific papers, regulatory and methodological documents, and orders, regulating the organization of medical and social assistance of students attending medical SVE institutions, was conducted. The search for literature sources was performed in the eLIBRARY.RU, Medline PubMed databases.

In the Volgograd region, secondary medical professionals are trained by two educational institutions: Volgograd medical college (VMC) of the Volgograd region Health Committee and medical college of the Volgograd State Medical University of the Ministry of Health of the Russian Federation (MC of VolgSMU).

A total of 2369 students attend the first one, among them 720 are adolescents under the age of 18 years. Furthermore, VMC has four branches located in four large district centers of the region. A total of 668 students attend MC of VolgSMU, among them 40 are minors. The total number of adolescents and young adults receiving secondary medical education in the Volgograd region (considering branches in the districts of the region) is 5619 people, among them 1700 are people under the age of 18 years.

As is known, nowadays one of the directions of health preservation in students is represented by development of the unified preventive environment including provision of medical and social assistance (MSA) to students, appropriate level of the institution sanitary and epidemiological welfare, the requirements for which are specified in a number of regulatory documents. At the same time, some authors note that all the existing regulatory documents are focused primarily on the MSA organization in comprehensive educational institutions and do not consider the features of care provision to students attending SVE institutions, including medical colleges [15, 16]. This information was fully confirmed by our study.

It has been found that adolescents aged 16–17 years constitute about 30–35% of all surveyed 1st grade college students. This fact substantiates the need to organize MSA

of adolescents in accordance with the Orders of the Ministry of Health of the Russian Federation No. 822 and № 514 [17, 18] by creating a medical unit deployed in the premises of the educational institution and consisting of the office of pediatrician (paramedic) and the treatment room. The above provision is not implemented in any medical college or branch in the region. No routine check-ups of students are also performed, since the contracts with medical institutions are concluded based on the territorial principle and assume care provision only. Our data are consistent with the information reported in the articles by a number of authors [19, 20]. As for underage students, all the information about their health status is confined to the certificates No. 086/u received by adolescents and young adults when entering the educational institution. Our review has shown that this legal document is not always handed to the college staff. Furthermore, the information contained in the document is never analysed, therefore, there is a lack of baseline data on the young adults' health status. Moreover, there is a problem of formal and incorrect completion of medical certificate, the rate of which is as large as 70% [21]. One can also accept the opinion [22] that the certificate № 086/u should be added to the list of documents that have to be provided when entering a university or a SPE institution (by the applicant's discretion).

The issue of licensing medical offices deployed in the medical SPE institutions is relevant. While in comprehensive educational institutions medical offices are licensed and mandatory, and medical professionals are part of staff of the pediatric outpatient clinic responsible, inter alia, for preventive work with school students, colleges decide to create and license medical offices on their own.

The study has shown that VMC and its branches are not licenced to provide medical care. Primary medical care provision to underage students is ensured by pediatric outpatient clinics of Volgograd and the Volgograd region, while care provision to students over the age of 18 years is ensured by adult outpatient clinics in accordance with the concluded contracts. As stated above, the college of VolgSMU is a structural unit of the Volgograd State Medical University licenced to provide medical care; care is provided in the Clinic of Family Medicine being a structural unit of the university. However, information contained in the medical records is also not analyzed due to the fact that there is no employee responsible for activities of this type in the MC of VolgSMU.

The issue of outpatient monitoring of college students, including medical students, seems to be important. According to the Order № 404 of the Ministry of Health of the Russian Federation [23], young adults over the age of 18 years should have preventive medical check-ups every three years. The importance of timely assessment is substantiated by few data on the health status of students attending colleges of different specialization. The leading place is occupied by the diseases of the musculoskeletal system and diseases of the eye [24]. There is no up-to-date information about morbidity among students receiving secondary medical education.

In medical colleges of the Volgograd region, all students obtain all the necessary information about the possibility of check-up through the Gosuslugi website, however, the lack of medical professional in the college staff makes it impossible to analyze the number of students, who have had a preventive check-up, and the examination results. Undoubtedly, the option for the organization of medical check-ups of students reported in the paper [25] deserves attention, when the university organizes such work in the outpatient clinics and medical centers, which have signed the contract for medical care provision. Students

may undergo appropriate medical assessment for free, within the framework of compulsory medical insurance. However, such financial burden is unsustainable for colleges, and the problem of funding should be solved at the regional level.

Moreover, attention should be paid to the fact that, according to the requirements of the Order № 29N of the Ministry of Health of the Russian Federation dated January 28, 2021, the students attending SVE institutions should undergo mandatory medical examinations before the beginning of practical training. However, the educational institution does not finance medical examinations of this type, since it is not an employer. Young adults choose the accredited medical institution on their own and pay for the services. Furthermore, their choice is based on the examination cost varying between 1200–4500 roubles. It is necessary to understand that specialists of these institutions have no experience with representatives of this social group, which can affect the examination results.

The admission of students for practical training is included in the health permit, which is provided by the student to the practice base, but educational institutions never analyze the results of medical examination, since, as stated above, in none of the medical colleges of Volgograd and the Volgograd region there is a position of a medical professional in the staffing table, as well as of anybody responsible for medical check-ups. When there is no medical professional in the staff, this work should be done by local pediatrician or local general practitioner. In the majority of cases, no analysis of the students' health status is performed, so the college administration does not receive appropriate information about the health status of the trained contingent.

All the above is the cause of the lack of dynamic monitoring of the health status of students during the training process from grade to grade, while the analysis of the data of preventive medical check-ups should form the basis for the development of comprehensive plans of preventive activities in the college.

The issue of medical assistance is particularly relevant for non-resident underage students, since they have no regular physician or outpatient clinic they could contact in case of disorder at the new place. On the other hand, minors, who have not resigned from the outpatient clinic at their past places of residence, are considered to be unorganized. They should not be invited for examination, when they are in another city.

Moreover, no analysis of the incidence of acute disorders is conducted in medical colleges, since the certificates handed by students to the supervisor of the group are of interest to the latter only in terms of "legitimate excuse for missed class" or "absence". The decision on admission of student for physical education lessons after recovery from illness is still a problem.

An important problem of social assistance of medical college students is the lack of work to familiarize them with health risk factors in both learning process and their future professional activities. This issue becomes more and more relevant due to implementation of dual (practice-oriented) model of professional education [26]. Exposure to occupational factors during mastering the academic disciplines usually becomes possible in medical colleges starting from grade 2 (and sometimes from grade 1). These can be harmful factors

of various types (chemical, physical, biological), tension and hard work. The papers focused on assessing the conditions of training and upbringing of adolescents and young adults attending SVE institutions of various specialization report that, despite short-term exposure to various occupational factors during labor training, some of these factors can cause failure of regulatory mechanisms underlying physical adaptation and development of functional disorders [11, 27]. We have found that none of the SPE institutions of Volgograd and the Volgograd region conduct assessment and monitoring of risk factors associated with the professions corresponding to the chosen specialty. Furthermore, the development of practical skills when mastering some specialties of secondary medical education is directly related to the exposure to harmful occupational factors. Thus, the results of air chemical composition assessment in the educational dental laboratory, where the students studying on the specialty "Prosthetic Dentistry" mastered their practical skills, showed the presence of such substances, as chromium oxide (III), formaldehyde, methyl methacrylate, etc. The maximum permissible concentrations were not exceeded, however, some of the detected chemical compounds (ozone, methyl acrylate) emitted a distinct smell, therefore, there was a possibility of organoleptic (olfactory) effects, which could be the risk factors for exacerbation of respiratory tract disorders in the sensitized individuals. It is important to make the students, future dental technicians, familiar with potential occupational health risks at the stage of professional training. It is necessary to conduct the research focused on determining the role (features) of the educational process technology as the students' health risk factor [28].

Thus, the conducted comparative analysis of the activity of medical colleges of Volgograd and the Volgograd region confirmed the problem of medical and social assistance of students, regardless of the SVE institution administrative subordination. It is necessary to develop an appropriate regulatory and methodological document regulating medical and social assistance of students receiving secondary medical education at the regional level. It seems urgent to solve the identified problems (including the introduction of the position of a full-time health worker) both from compulsory health insurance funds and from additional budgetary allocations of the region. It is necessary to develop the system for informational communication of medical professional (if there is one) with medical institutions conducting preventive medical examinations and routine check-ups of students. Furthermore, it is important to consider the features of the chosen profession taking into account potential risk factors of the learning process and future professional activity.

CONCLUSION

The lack of unified methodological approach to the issues of the organization of medical and social assistance is among most important and serious shortcomings contributing to deterioration of health in students receiving secondary medical education. It is necessary to optimize legislation and regulatory framework at both federal and regional levels.

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HYGIENIC CHARACTERISTICS OF SOME ASPECTS OF STUDENTS' PSYCHOLOGICAL HEALTH

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Recently, the problem of psychological status of students, including university students, and its influence on the health of the individual has become very relevant. The applicants entering higher education institutions of our county face an especially difficult period. They have to deal with a lot of exams affecting their future destiny, the complicated process of adaptation to the new training conditions existing in the educational institutions, as well as with the completely unfamiliar team of teachers and students. The study was aimed to perform comparative analysis of psychological health of the students attending the medical university and to determine the indicators most strongly affecting the students' quality of life and body's condition. A total of 1050 first-year, third-year, and sixth-year students of the medical university were enrolled. Each subject was offered to voluntarily pass three different tests to determine his/her psychological status. The scores of functional reserve of the CNS below 50% were reported for more than one third of students of the pediatric faculty (39%). In students of the faculty of pediatrics, the decreased performance was observed in 51% of cases, mostly in females. To summarize, it is worth noting, that medical students, especially first-year students, often have psychological health problems.

Keywords: psychological health, students, emotional stability, anxiety, functional reserves

Compliance with ethical standards: the study was approved by the Ethics Committee of the Burdenko Voronezh State Medical University (protocol № 7 dated 8 November 2021). Each subject mandatorily submitted the informed consent to study participation; confidentiality of the data collected was ensured.

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ГИГИЕНИЧЕСКАЯ ХАРАКТЕРИСТИКА НЕКОТОРЫХ АСПЕКТОВ ПСИХОЛОГИЧЕСКОГО ЗДОРОВЬЯ СТУДЕНТОВ

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В последнее время очень актуальной стала проблема психологического состояния учащихся, в том числе студенческой молодежи, и его влияния на здоровье индивида. Особенно сложный период переживают абитуриенты, которые поступают в вузы нашей страны. Они сталкиваются с множеством экзаменов, от которых зависит их дальнейшая судьба, с непростым процессом адаптации к новым условиям обучения, существующим в учебных заведениях, а также с совершенно незнакомым коллективом преподавателей и студентов. Целью исследования было выполнить сравнительный анализ психологического здоровья студенческой молодежи, обучающейся в медицинском вузе, и определить показатели, которые наиболее сильно влияют на качество жизни и состояние организма учащихся. В исследовании приняли участие 1050 студентов медицинского вуза 1-го, 3-го и 6-го курсов обучения. Каждому из учащихся было предложено пройти три различных вида тестирования для определения психологического состояния. Более чем у трети студентов педиатрического факультета (39%) отмечен уровень функциональных резервов центральной нервной системы ниже 50%. У студентов педиатрического факультета в 51% случаев снижена работоспособность, преимущественно у лиц женского пола. Подводя итоги, стоит отметить, что у студентов-медиков, особенно первокурсников, часто имели место отклонения в психологическом здоровье.

Ключевые слова: психологическое здоровье, студенты, эмоциональная стабильность, тревожность, функциональные резервы

Соблюдение этических стандартов: исследование было одобрено этическим комитетом ВГМУ имени Н. Н. Бурденко (протокол № 7 от 8 ноября 2021 г.). Каждый участник в обязательном порядке подписывал добровольное информированное согласие на участие в исследовании, была гарантирована конфиденциальность полученных данных.

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The university years represent the most difficult period of training characterized by significant academic workload of students. It is not always easy for the student's body to adapt when switching from school to the completely different level of complexity, which entails effects on the students' health and psychological status. The levels of stress are directly related to the individual's mental performance: stress contributes to cognitive decline in humans [1–4].

The process of adaptation of first-year students seriously hampers the radical change in the training conditions in the higher education institutions. A small school is replaced by multiple separate buildings of the university that are often located at a rather large distance from each other. The familiar schoolteachers are replaced by the university teachers, and the group consists of complete strangers. Unfortunately, not all first-year students adapt fairly quickly and successfully,

the adaptation process usually stretches to the next academic year and sometimes continues for longer [5–7].

The university applicants and the forward-thinking first-year students bear a huge responsibility for the selection of their future profession, with which they will spend the rest of their lives. It is essential that the student makes the choice on his/her own in accordance with his/her aspirations and abilities, without any pressure from parents or consideration of various benefits that could come from the further employment. Furthermore, students themselves note that difficulties they face on their way to higher education are complexity of mastering various academic disciplines and excessive academic workload they experience during the learning process [8–10].

The combined effects of various negative factors entail multiple negative consequences having an adverse effect on the health of immature students and increasing the risk

of different disorders. Since the regulatory framework essential to ensure the training conditions for students is incomplete, the institutional capacity of higher education institutions is reduced [11].

Psychological health is very important for students of all specialties, since the constantly high levels of stress and anxiety cause a negative response to training and further work in the profession, as well as professional burnout [12, 13].

This is especially important for medical students, who will become doctors in their nearest future and have to be strong, including psychologically strong, in order to work as hard as possible in the field of healthcare. The population of our country is interested in the qualified human resources capable of working most effectively when being in the state of psychological harmony [14].

High workload experienced by students when coming to universities after school also adversely affects the status of their nervous system and the quality of life. This is particularly true for first-year students, who cope with a large amount of information they have to master due to the lack of experience. In addition, year by year computer technologies are being introduced more and more intensively, and the reading rooms are gradually replaced by electronic libraries. This, in turn, results in the fact that it is necessary to spend much time on gadgets to go through the literature and successfully prepare for classes [15–18].

The study was aimed to perform comparative analysis of psychological health of the students attending the medical university and to determine the indicators most strongly affecting the students' quality of life and health.

METHODS

The randomized study was performed at the Center for Public Health and Preventive Healthcare of the Burdenko Voronezh State Medical University in 2022–2023. A total of 1050 students of the medical university were enrolled: first-year, third-year, and sixth-year students studying at the faculties of general medicine and pediatrics.

Each subject was offered to voluntarily pass different tests (sensorimotor test to determine the functional reserve of the central nervous system (CNS) and performance; color test to assess anxiety level and emotional stability; nonspecific adaptation test to calculate the resistance level) in the Origins of Health Valeometer program (Breath Technologies; Russia).

Statistical analysis of the results was performed using the MyOffice 2022 software package (New Cloud Technologies; Russia); the descriptive statistics, Student's *t*-test, and Spearman's rank correlation were used. The differences were considered significant at $p < 0.05$.

Table 1. Sensorimotor test scores

| Indicators | Females (<i>n</i> = 810) | Males (<i>n</i> = 240) | Faculty of General Medicine (<i>n</i> = 660) | Pediatric faculty (<i>n</i> = 390) |
|--|------------------------------|----------------------------|---|--|
| Functional reserve of the CNS below 50% | 36% | 24% | 30% | 39% |
| Functional reserve of the CNS between 50 and 74% | 43% | 45% | 45% | 42% |
| Functional reserve of the CNS above 75% | 21% | 31% | 25% | 19% |
| Decreased performance | 47% | 35% | 41% | 51% |

Note: the differences are statistically significant ($p < 0.01$).

RESULTS

After passing the sensorimotor test, the functional reserve of the CNS that showed the body's reserve capacity and determined its capacity to work was defined for each student as a percentage. Furthermore, software assessed performance of each respondent based on these data.

Comparison of the first-year, third-year, and sixth-year students revealed no significant differences. The worst performers were third-year students of the medical university. Among them almost a half (48%) showed decreased body's performance. The lowest functional reserves of the CNS (below 50%) were also reported for the third-year students (38%).

Significant differences were revealed when comparing the scores of the test of visual-motor response in students of different genders and students studying at different faculties (Table 1). The levels of functional reserve of the CNS below 50% were more often found in girls, than in boys. Decreased performance also prevailed in females: the test results showed that almost every second girl demonstrated decreased performance. Both of these scores showed smaller deviation from the norm in boys.

Comparison of the scores of students studying at two different faculties of the Burdenko Voronezh State Medical University showed that the students of the faculty of general medicine with the score of functional reserve of the CNS exceeding 74% predominated over students of the other faculty, i.e. students of the faculty of pediatrics had lower functional reserve of the CNS. Moreover, it should be noted that every second student of pediatric faculty has decreased performance, which may subsequently have an impact on the state of his/her nervous system, result in impaired functional state of the body and eventually in disorders affecting various organs and systems.

The decrease in performance and functional reserve of the CNS puts a lot of strain on the entire nervous system of the body, thereby increasing the risk of various adverse psychological conditions capable of causing persistent mental disorders in the future.

The color test demonstrated the anxiety levels and emotional stability of medical students, as well as the advantageous method to overcome stressful situations. The data obtained show that on average about 30% of students have medium to high anxiety levels, which is indicative of increased anxiety during the training process. No fundamental differences between boys and girls or students of different faculties were revealed. Significant differences were reported only when comparing the first-year and sixth-year students (Table 2). Among first-year students, low anxiety levels were reported only

Table 2. Anxiety level scores by years of training

| Anxiety level | 1 st year (n = 390) | | 3 rd year (n = 345) | | 6 th year (n = 315) | | <i>p</i> |
|---------------|--------------------------------|----|--------------------------------|----|--------------------------------|----|--|
| | abs. | % | abs. | % | abs. | % | |
| Low | 270 | 69 | 257 | 75 | 236 | 75 | <i>p</i> _{1,2} = 0.06 <i>p</i> _{1,2} = 0.57 <i>p</i> _{1,2} < 0.05 |
| Medium | 87 | 22 | 63 | 18 | 60 | 19 | |
| High | 33 | 9 | 25 | 7 | 19 | 6 | |

Note: *p*_{1,2} — significance of differences between first-year and third-year students; *p*_{1,2} — significance of differences between third-year and sixth-year students; *p*_{1,2} — significance of differences between first-year and sixth-year students.

for 69%, while the anxiety levels of sixth-year students were about 75%. Such results indicate the decreased adaptability of first-year students, as well as the increased levels of stress and anxiety during training. These score decreases considerably by the end of training.

When assessing emotional stability, all scores were divided into four groups: normal, moderate, increased, and high emotional stability. Based on the results, it is important to emphasize that 55% of boys and 52% of girls had the increased scores that were outside the normal range. This means that every second student, regardless of gender, was not emotionally stable. Table 3 reflects the dynamic changes in the emotional stability scores, from junior students to senior ones. If among first-year students the indicators exceeding the norm were noted in 58%, and among third-year students in 51%, then by the 6th year these dropped to 48%. Such results suggest better students' adaptation to training at senior courses. Unfortunately, the process of the first-year students' adaptation to the medical university is slow, which can adversely affect their psychological status.

The levels of body's resistance to environmental factors show the extent, to which the nervous system is resistant to various changing environmental conditions. Assessment of this parameter revealed statistically significant differences (*p* < 0.005) between boys and girls, who had decreased resistance in 31 and 38% of cases, respectively. Comparative analysis by courses of training showed that the resistance levels of first-year students were much better than that of third-year students, and the differences were significant (Table 4). Furthermore, the results of first-year students turned out to be more upbeat compared to graduate students. The sixth-year students had very low resistance levels 10% more often than first-year students. The scores of third-year and graduate students were almost the same and showed no significant differences.

DISCUSSION

In recent years, insufficient attention is paid to psychological status of students, however, a comprehensive approach to the issue is needed when assessing the students' bodies and morbidity. The decrease in performance and the increase in anxiety levels can result in depression and later transform into stress [19].

Table 3. Emotional stability scores by years of training

| Emotional stability | 1 st year (n = 390) | | 3 rd year (n = 345) | | 6 th year (n = 315) | | <i>p</i> |
|---------------------|--------------------------------|----|--------------------------------|----|--------------------------------|----|--|
| | abs. | % | abs. | % | abs. | % | |
| Normal | 43 | 11 | 38 | 11 | 38 | 12 | <i>p</i> _{1,2} < 0.05 <i>p</i> _{1,2} = 0.57 <i>p</i> _{1,2} < 0.05 |
| Moderate | 119 | 31 | 131 | 38 | 126 | 40 | |
| Increased | 142 | 36 | 122 | 35 | 101 | 32 | |
| High | 86 | 22 | 54 | 16 | 50 | 16 | |

Note: *p*_{1,2} — significance of differences between first-year and third-year students; *p*_{1,2} — significance of differences between third-year and sixth-year students; *p*_{1,2} — significance of differences between first-year and sixth-year students.

When comparing emotional stability of university students with the results of adolescents, it should be noted, that schoolchildren demonstrate better results compared to first-year students of the medical university, whose scores are almost 2-fold decreased (31% and 58%, respectively). Unfortunately, the emotional stability score significantly decreases by the time of entering the higher education institution; the influence of the higher education institution itself and the specifics of training on the former applicants also become evident. The decrease in emotional stability score associated with the effects of some stressful situation can result in the development of various psychological conditions adversely affecting the body's health and the quality of life [20].

The functional reserve of the CNS often represents the essential energy reserve that helps the body overcome various stressful situations, furthermore, it contributes to mobilization of all organs and systems, as well as to increased performance of the individual [21, 22]. On average, the drop of functional reserve of the CNS to the level below 50% is observed in 30% of students of the medical university, while the decreased performance is reported for a half of students studying at the faculty of pediatrics. These two scores are directly related to processing new information and the students' academic success.

When assessing anxiety in all students, medical students show not the worst results. In total, 7.3% have increased anxiety levels, and the highest anxiety scores are reported for first-year students (9%). The rate of high anxiety levels is higher in the students of humanitarian university, than in medical students, and constitute 10% [23]. We can say that students of different universities usually demonstrate standard anxiety levels, except for a small number of people. Medical students from Tajikistan showed high anxiety levels in 33% of cases, which 3-fold exceeded the anxiety levels observed in the Russian students. Such results suggest reduced adaptability, lower quality of life of the residents of Tajikistan, including students [24].

CONCLUSIONS

The first-year students of the medical university mostly have unstable psychological status, increased anxiety levels. They often demonstrate decreased performance, high emotional instability. All these characteristics can later transform into

Table 4. Scores of body's resistance to environmental factors

| Resistance level | 1 st year (n = 390) | | 3 rd year (n = 345) | | 6 th year (n = 315) | | p |
|------------------|--------------------------------|----|--------------------------------|----|--------------------------------|----|--|
| | abs. | % | abs. | % | abs. | % | |
| Very low | 54 | 14 | 74 | 21 | 75 | 24 | $p_{1,2} < 0.05$ $p_{1,2} = 0.99$ $p_{1,2} < 0.05$ |
| Low | 67 | 17 | 61 | 18 | 47 | 15 | |
| Medium | 118 | 30 | 94 | 27 | 85 | 27 | |
| High | 90 | 23 | 72 | 21 | 64 | 20 | |
| Very high | 61 | 16 | 44 | 13 | 44 | 14 | |

Note: $p_{1,2}$ — significance of differences between first-year and third-year students; $p_{1,2}$ — significance of differences between third-year and sixth-year students; $p_{1,2}$ — significance of differences between first-year and sixth-year students.

various depressive disorders, and, therefore, finally transform into stress. It is necessary to pay more attention to the students' adaptation and psychological status. This is particularly true for first-year students, who were recently applicants and came to universities to face a completely different from school

education system. It is reasonable to engage tutors from among senior students or teachers, who will gradually facilitate systematic immersion of former schoolchildren into the student environment, in order to improve adaptation of first-year students.

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HYGIENIC ASPECTS OF GENERAL MEDICINE WARD OPERATION: PROBLEMS AND SOLUTIONS

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The existing problems in the field of healthcare and prevention create new challenges and difficulties in various parts of the national public health system. Today, there is an effective set of new sanitary rules and regulations important for competent organization and stable functioning of general medicine wards. In 2023, this set is SanPIN 2.1.3678-20, developed to ensure safe and effective work in medical facilities. There are special bodies tasked with controlling compliance with the standards, including Rospotrebnadzor. The COVID-19 pandemic revealed a number of problems in the organization of work of inpatient departments, which required revision of the ways of rendering medical assistance. This article considers current sanitary and hygienic aspects of organization of operations at a general medicine ward, as well as the approaches to infection prevention in the context of medical care.

Keywords: organization of work, general medicine ward, COVID-19 pandemic, SanPIN, medical care

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ГИГИЕНИЧЕСКИЕ АСПЕКТЫ ОРГАНИЗАЦИИ РАБОТЫ ТЕРАПЕВТИЧЕСКИХ ОТДЕЛЕНИЙ: ПРОБЛЕМЫ И ПУТИ ИХ РЕШЕНИЯ

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Существующие проблемы в сфере здравоохранения и профилактики заболеваний создают новые вызовы и сложности в различных звеньях отечественной системы здравоохранения. На сегодняшний день действует перечень новых санитарных правил и нормативов, важных для грамотной организации и стабильного функционирования отделений терапевтического профиля. Гигиенические аспекты организации работы отделений медицинских учреждений в 2023 г. регламентированы санитарными правилами и нормами СанПиН 2.1.3678-20, созданными для обеспечения безопасной и эффективной работы. Соблюдение норм проверяют специальные органы — в частности, сотрудники Роспотребнадзора. Наряду с этим пандемия COVID-19 продемонстрировала ряд проблем в организации функционирования отделений стационаров, что, в свою очередь, потребовало трансформации организации оказания медицинской помощи. В статье рассмотрены современные санитарно-гигиенические аспекты организации работы терапевтического отделения и подходы к профилактике инфекций, связанные с организацией оказания медицинской помощи.

Ключевые слова: организация работы, терапевтическое отделение, пандемия COVID-19, СанПиН, оказание медицинской помощи

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Health of the citizens is one of the crucial components of ensuring operation and security of a state. Therefore, introduction and improvement of measures designed to keep the population healthy is one of the priorities for a country's healthcare system. High efficiency of this system hinges on a combination of competent organization of work of the departments providing medical care to the population, adequate financing, measures designed to ensure good sanitary and epidemiological conditions, and state control over production and turnover of pharmaceutical drugs [1–10].

Currently, general medicine wards can be considered within a holistic view of the current problems in the public health system, since most patients are initially received by primary care physicians. In healthcare, they man the "first line" and have to work with a wide range of different disease entities on a regular basis, as well as plan diagnostics, prescribe treatment, and, if necessary, refer patients to doctors specializing in respective fields [1–10].

The system of primary care was significantly influenced by the COVID-19 pandemic: consistent conversion of hospital

departments into COVID-19 wards left to room for planned medical procedures [5, 7]. Lack of reliable information about specifics of the disease posed considerable difficulties at the beginning of the pandemic, translated into numerous diagnostic and treatment errors, and complicated development of new treatment methods and conversion of the departments [5–13].

Systematization and review of patterns of application of the current sanitary and hygienic aspects and standards in general medicine wards, with the situation and specifics of the national public health system accounted for, are the tasks of both fundamental and applied importance set before the hygienic science today.

Organization of operations in a general medicine ward under current legislation

Russian Federation Ministry of Health Order 923n of 15.11.2012 "On approval of the Procedure of provision of primary/general medical care to adult population" regulates specifics and key

aspects of the respective activity [14]. Medical care is subdivided into primary care; emergency care, including its purpose-specific varieties; specialized care, including high-tech medical assistance; palliative care. Sanitary rules and regulations (SanPiN) include by-laws that provide basic requirements for a safe environment ensuring healthy and full-fledged living for people. In particular, there are SanPiN governing organization of operations in general medicine wards [15]. The main purpose of SanPiN provisions is to maximize health preservation and reinforcement capacities and, consequently, improve quality of life. The by-laws stem from scientific studies; they are mandatory for individuals and legal entities providing services to the population on the territory of the Russian Federation (RF). According to sanitary code SP 2.1.3678-202, a medical organization must control adherence to sanitary rules and hygienic standards, implementation of sanitary and anti-epidemic (preventive) measures, by inviting duly accredited laboratories to perform tests and measurements. Such organization must create conditions ensuring conformity to the hygienic regulations in all the buildings, structures, and rooms it operates. Microclimate and air exchange rate in the rooms should meet the requirements set in the hygienic standards, same as levels of natural and artificial lighting, insolation, noise, vibration, and electromagnetic fields [15]. For the territory of a medical organization, hygienic standards also prescribe limit values of sanitary-chemical, microbiological, parasitological indicators, radiation factor, as well as thresholds for priority pollutants in the atmospheric air, electromagnetic radiation, noise, vibration, and infrasound. It is forbidden to set up microbiological laboratories (departments) in apartment buildings and structures built in or attached thereto. Magnetic resonance imaging (MRI) rooms cannot be located near apartments. In permanently occupied rooms, including rooms with permanently manned workstations, the levels of physical factors (noise, vibration, permanent magnetic field) should not exceed limits stipulated in the hygienic standards [16]. Making a general medicine ward walk-through is not allowed, same as other rooms and units not designed such [16–18]. Inpatient hospitals should have furnished admission and examination boxes or wards for admission, treatment and temporary isolation of patients with suspected infectious diseases [15]. According to Appendix № 3 to SP 2.1.3678-20, determination of the contamination class (total content of microorganisms in 1 cubic m) of indoor air in the general medicine wards of a multidisciplinary inpatient hospital shall factor in temperature and air exchange rate [15]. Patients with infectious (parasitic) diseases that can cause an emergency of sanitary and epidemiological nature, and, as prescribed by the applicable regulations of the Russian Federation, shall be sanitarily controlled, are isolated in boxes with a mechanical ventilation system [15, 19]. The respective equipment and structures shall only be used for the intended purpose.

The main structural and functional unit of a general medicine ward in a multidisciplinary hospital is a section of patient rooms, therapeutic and auxiliary facilities designed for treatment of patients with similar diseases [16–18, 20]. The capacity of one section depends on the specialization of the department and patients' age (children, adults), and usually comprises 20–30 beds. A room for adults has four beds at most, a room for children less than one year old – no more than two beds. Sixty percent of all patient rooms in a ward have 4 beds, 20% are single-bed, and the remaining 20% are 2-bed rooms [16–20]. A modern general medicine ward has 14 m² of area per patient (earlier, this figure was 7 m² per person). In addition, at least two single-bed rooms for serious patients should be located

adjacent to the nurse's station. Treatment rooms are designed to simultaneously accommodate a maximum of 10 patients. The minimum required width of a hallway is 2.5 m, which allows free movement and maneuvering of stretchers and gurneys. It should be noted that the ratio of the patient rooms' area and that of auxiliary/treatment rooms is 1:1, and the standards for the former are as follows: 7 m² per bed in 2-bed rooms, 9 m² in single-bed rooms, and 12 m² in patients rooms with an airlock. According to the regulations, the minimum headroom of a patient room is 3 m, and cubic capacity per bed — 20 m³.

A general medicine ward includes a warden's office, a staffroom, a head nurse's room, a floor nurse's station (6 m²), a doctor's office (10 m²), a treatment room (12 m²), a washroom, a bathroom, a toilet, utility rooms, a pantry, and rooms for outpatients (0.8 m² per bed) [14, 15, 19]. Patient rooms must be fitted with necessary equipment, as well as medical beds, bedside tables, regular tables, and chairs. Individual lamps and nurse call buttons should be in the bedside space. Current codes, despite the expediency thereof, do not require setting up dressing and manipulation rooms in a general medicine ward [16–24], since application of dressings is not a usual activity for a general practitioner, and patients admitted with conditions requiring this type of treatment are examined together with surgeons. After examination, if necessary, they are treated respectively in surgical dressing rooms. In addition, contemporary general medicine wards include no canteens, which saves significant space. The codes allow diagnostic rooms to share floors with the wards proper, thus facilitating the range of respective activities. The design of the ward isolates handled epidemiologically hazardous materials, with an alternative option being the use of special equipment (closed trolleys, sealed waste containers, through-pass sterilizers and washing machines, barrier washing machines, etc.).

Design recommendations suggest arranging sources of natural lighting for the rooms, such as courtyards, and atriums for sky light. The windows may be facing any cardinal direction, but insolation rate should meet the regulated requirements in at least 60% of indoor premises of the medical facility [14–24]. The recommendations for allocation of patient rooms on the floors are as follows:

- sections of children's inpatient departments — not higher than on the fifth floor;
- sections for unaccompanied children of 7 and younger, hospice and nursing sections, geriatric sections and residential sections for elderly with disabilities — not higher than on the second floor.

General medicine wards cannot be located next to rooms and other wards posing a high risk of infection, such as contagious disease wards and purulent surgery departments. The windows in the rooms must face south and south east, since it is necessary to maintain a certain intensity, uniformity and biological usefulness of the lighting spectrum. Placing beds parallel to the wall with windows allows the most efficient use of daylight, but arrangements should be made to prevent excessive insolation (blinds, curtains, or similar elements).

The surfaces in patient and other rooms of the ward should be made of hypoallergenic materials. Surface finishes should be smooth and capable of withstanding wet cleaning and disinfection, selected accounting for the specifics of medical and technological processes. Walls and ceilings of rooms designed to be dry (treatment and diagnostic rooms, patient rooms, doctors' offices, physiotherapy rooms, etc.) are coated with acrylic or silicate water-soluble paints, or other materials that allow wet cleaning and disinfection. The walls of high humidity rooms should be covered with matte ceramic tiles or other moisture-resistant materials floor-to-ceiling [14–24].

The space around workplaces should be designed with the aim at ensuring optimal microclimate and properties of the air (temperature, humidity, velocity, chemical and bacterial composition), as well as the necessary exchange rate thereof. The equipment should be placed, installed and operated as prescribed by the current safety and health regulations, avoiding situations that can be dangerous to health of staff and patients [14–24]. The nurse's station should have a table with separate drawers for medical documentation, as well as a medicines locker with separate lockable compartments for poisonous (group A) and potent (group B) drugs. A treatment room is also set up here, manned by a certified treatment nurse. There are stricter sanitary requirements for treatment rooms; in particular, air there should be disinfected with bactericidal lamps. Effective national legislation stipulates periodical preventive examinations (checkups) for every healthcare professional [14–24].

Currently, national public health system undergoes transition to the new organizational patterns, which significantly altered the approaches to primary and general medicine, above all, by reorganization and dissolution of an array of subdivisions thereof. This modernization resulted in a significant reduction of financial costs and allowed removing duplicate processes in healthcare. Ultimately, responsibility of the physician attending a case and his role in treatment of the respective patient have grown more significant. However, some territorial outpatient clinics were not ready for these transformations; inter alia, they could not routinely assess of the impact of adverse factors on the health of the population. In addition, shortage of medical personnel in the regions has grown into a major problem. As a result, there formed the need to retrain doctors and to develop and deploy a system of high-quality and effective medical assistance and prevention system. Review of the requirements given in the respective codes (SP), as they pertain to organization of work of general medicine wards, allows discerning the following key trends and features: reinforcement of the primary care component (polyclinics), development and extension of the chain of day hospitals, and the resulting changes in types and numbers of beds (fewer beds in overnight and inpatient facilities) [14–24]. Despite the profound economic effect of the decisions taken, this transition has provoked a number of problems. The insufficiency of bed capacity became a serious problem during the COVID-19 pandemic, which brought the urgent need for additional beds, and numerous hospitals and clinics could not respond thereto. Another problem cultivated by reorganization at the level of national healthcare system (not only its general medicine component) is the increasing workload of medical professionals, a factor that is supposed to trigger growth of the respective financial incentives, in the absence of which a number of healthcare facilities sees spiking outflow of professional personnel [17–26].

Thus, today, there is an extensive list of sanitary and hygienic requirements that govern operation of general medicine wards, and current sanitary rules and regulations are routinely refined and supplemented to improve quality, efficiency, and safety of medical assistance rendered to the population. Unfortunately, despite the ongoing work on legislation that conditions functioning of such wards, there are staff-related aspects that negatively affect health and recovery of patients (noise early in the morning, irregular wet cleaning, formal attitude to bed linen changes), as well as occasional disruptions associated with utilities and technical infrastructure (temporary lack of hot water and heating, telephone communication breakdowns). Elimination or minimization of the effect of various negative factors, including those that emerged after reorganization

of the national public health system, will help preserve health of the general medicine wards' patients and personnel.

In addition, healthcare legislation has an array of problems with conflicting by-laws, which complicates implementation of sanitary codes [25]. In the context of organization of work of a general medicine ward, these codes need to be regularly updated with the changes in healthcare factored in.

COVID-19-related sanitary and hygienic aspects of operation of general medicine wards, and suggested solutions to current problems

The COVID-19 pandemic caused by SARS-CoV-2 was a serious challenge not only for infectious disease departments but also for wards not working with such pathologies [5, 7, 26–30]. In different countries of the world, including Russia, a stably functioning public health system did not guarantee lack of problems, which, ultimately, affected virtually every process therein. For example, in the context of conversion of a ward, the said problems pertained to sufficiency/adequacy of staffing, equipment, number of beds (which has been decreasing through the last few years as part of optimization of inpatient hospitals and transition to a contemporary model of work of medical organizations), availability of supplies/tools etc. (an especially serious problem for facilities in the regions), personal protective equipment, and disrupted logistics [5, 7, 26]. The challenges brought by the pandemic triggered an urgent rearrangement of the medical care system and revealed the weakest components in all models of provision of medical assistance to the population. Sanitary and hygienic aspects of operation of general medicine wards in multidisciplinary hospitals were quickly adjusted to the pandemic, driven by the rapid conversion of medical facilities and the registered flaws in their adaptation and functioning in the new conditions [26].

A number of large multidisciplinary medical institutions have had anti-pandemic organizational measures implemented, which, in particular, entail increase of the number of beds in pulmonary departments and extended headcount. Reorganization of logistics boosted efficiency of patient and interdepartmental transfers; there have been set up isolation wards, and some hospitals began to routinely screen individuals with a suspected infectious pathology. Currently, an extremely important matter is training the personnel of general medicine wards to prevent, diagnose, and treat infectious diseases, including those caused by SARS-CoV-2. It is necessary to introduce, implement, and further improve mandatory anti-epidemic and disinfection programs in medical facilities [26, 31–36]. In the current conditions, there is a need for dynamic organization of examination and treatment of patients with suspected COVID-19, as well as timely improvement of the relevant guidance documentation [29, 34–38]. Underpinned by data, the requirements of today necessitate provision of the full range of medicines, disinfectants, personal protective equipment to all services and bodies providing medical care, including general medicine wards, with the list of mandatory equipment also including tools and devices needed to collect, transport, store and analyze biological materials of patients with suspected COVID-19 [26, 31–38]. Current codes prescribe implementing sanitary and epidemiological measures designed to prevent the spread of infection caused by SARS-CoV-2 among patients and staff of medical organizations.

One of the key problems in the context of the pandemic was the lack of reliable information on the principles of diagnosing, treatment and prevention of COVID-19, which forced a quick

alteration of the previously existing paradigm that allowed prompt processing of the emerging new research and empirical data [38]. Nevertheless, after the main wave of the pandemic, the functioning of general medicine wards in multidisciplinary hospitals should be re-engineered accounting for the current epidemiological situation.

The conversion of a number of medical facilities into hospitals admitting only COVID-19 patients (confirmed or suspected) decreased the number of addressed cases of severe non-communicable diseases, which, in turn, translated into more fatalities therefrom and general deterioration of state of those suffering chronic noncommunicable diseases (CNCDs). Today, medical organizations need to balance care for COVID-19 patients, should their number spike, and assistance provided to patients with noncommunicable pathologies [38]. The primary documents that discuss organizational and methodological aspects of infection control (including the novel coronavirus infection) are guidelines and regulations issued by the Ministry of Health of the Russian Federation and the Department of Health of the City of Moscow, as well as local acts of medical institutions [39, 40]. The facilities specializing in infection prevention and mitigation also have lists of respective countermeasures. In addition, medical constituents of the Ministry of Defense of the Russian Federation have procedures regulating deployment of mobile infectious disease hospitals [41]. To date, there has been developed a whole set of instructions, orders and methodological recommendations aimed at arresting the spread of the novel coronavirus infection, primarily through prevention, diagnosis and treatment of the diseases caused thereby [39]. However, there are still no uniform standards regulating operations in general medicine wards in the context of the still high threat of COVID-19, persisting despite the end of the pandemic. One of the reasons behind this shortcoming is the ever-changing nature of the situation, which necessitates adjustment of the existing recommendations. Currently, the incidence of COVID-19 goes down, operation of the public health system gradually normalizes, and patients with respective diseases are admitted to the general medicine wards as usual. Most healthcare institutions work in the normal mode. However, it is necessary to remain highly alert, observing all precautions against the spread of infection. For general medicine wards in multidisciplinary hospitals, it is essential to strictly adhere to the current legislation and codes. In addition, taking into account the experience of conversion of several large multidisciplinary hospitals, it is possible to list the most important recommendations aiding compliance with the rules that factor in the current situation. Any medical institution should have a clear plan of implementation of measures to counter the spread of infection and provide medical assistance to the population in an emergency situation [5, 7, 26–31, 38–43]. For this purpose, there should be formed a task force responsible for preparation and practical execution of such a plan, enlisting medical professionals, utility and maintenance engineers, and managers of the organization. The task force should be capable of preventive mitigation of infection, and adequate implementation of the developed action program [38–49]. In order to avoid shutdown of a general medicine ward and deterioration of the quality of assistance rendered there, in case of a high risk of infection spread through the department/institution, it is feasible to implement the most stringent sanitary and epidemic safety measures in the said ward [38–51]. Medical personnel should be trained the main diagnostic and therapeutic approaches COVID-19 cases, confirmed or suspected. In addition, it is necessary to organize continuous education of the staff for them to learn the current principles

of diagnosing of infectious pathologies and operation of high-tech equipment [38, 49–53]. Regular timely monitoring of the epidemiological situation inside and outside the institution, and sharing the respective information with the medical personnel, as well as direct participation of the management in search for solutions to problems arising in the ward and the facility on the whole, can significantly reduce tensions in the team and prepare it for operation in the emergency mode [38–54]. In the current situation, one of the most significant sanitary and epidemiological aspects of the work of a general medicine ward is regular dynamic monitoring and strictest control over compliance with the introduced safety regulations and codes by all parties involved, with identification and further development of the most effective practices and measures [38–54]. This approach allows developing and coordinating the most effective preventive routines for emergency-like situations that significantly reduce the risk of spread of the infection.

Today, it is advisable to restructure and modernize operations of a general medicine ward. The available beds should be used rationally, which requires constant control over their turnover. Among the patients, it is advisable to differentiate senior citizens (and set up a separate gerontological section for them, if possible), and patients with special social circumstances (alcoholics, homeless individuals). To ensure proper functioning of a general medicine ward in view of the increased workload and difficult working conditions, it is necessary to reallocate resources and extend the staff schedule with additional positions (for junior and mid-level personnel, in the first place). This approach significantly lightens the burden on medical professionals manning departments. In addition, with regard to the current codes, general medicine wards may be extended with specialized sections for serious patients, including incurable ones. Despite the fact that the said codes contain a set of visiting rules, the attitude to their enforcement among the staff is often formal, which makes it advisable for the management of hospitals and departments to focus on strict compliance with these rules. This suggestion is especially relevant in the current epidemiological situation, when the high risk of spread of the new coronavirus infection persists. It is also necessary to carefully analyze and optimize the working hours of mid-level medical staff and general practitioners, since the applicable instructions do not clearly outline proper distribution of time between specific tasks (primarily for nursing staff). In this connection, it is also feasible to optimize the medical records keeping processes.

Given the extremely dynamic development of medicine today, continuous training of general practitioners in modern diagnostic and therapeutic techniques is an important aspect. It is recommended to fully fit the ward with materials and equipment, including medications and consumables, and to ensure doctors and nurses work on modern computers, since in many cases these components of operations of the wards are problematic from the financial perspective. Development of an effective information support system for the ward is a work in progress; the system is supposed to significantly boost execution of a number of diagnostic and therapeutic procedures.

Increasing financial incentives for medical staff is likely to alleviate the existing shortage of personnel, especially in regional healthcare institutions. In some cases, a promising option is to raise funds from private sector and investors in the context of a mutually beneficial cooperation.

In addition to all of the above, it is advisable to allocate restricted zones in general medicine wards, and introduce sanitary measures aimed at prevention of spread of an

infectious pathology, including that caused by SARS-CoV-2. A design deserving consideration is that of semi-detached isolation sections with independent air exchange systems. It is also recommended to impose stricter visiting requirements, up to a fully restrictive regime.

CONCLUSION

The new codes governing operations of general medicine wards are of particular importance. They are designed to improve the quality and safety of medical care provided to patients with diseases addressed in such wards, and to counter development of a range of infectious diseases, including the novel coronavirus infection. Breaches provisions of the codes can lead to the occurrence of nosocomial

infections and a number of other dangerous consequences, which can be extremely severe. Today, the national public health system has transitioned to a more economically feasible model, but this process triggered development of a number of new problems. In addition, the COVID-19 pandemic brought forth completely new challenges and many problems related to both organizational matters and the lack of necessary knowledge and training on the part of medical personnel manning the general medicine wards of multidisciplinary hospitals. Finding solutions to the organizational issues hindering operations of such wards will significantly improve health of the general population, and strict observance of sanitary and epidemiological rules and regulations, as well as recommendations on countering the spread of infectious diseases, will allow providing medical assistance more effectively and with better quality.

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RATIONALE FOR THE NEED TO PREVENT ALLERGIC RHINITIS ACROSS THE VORONEZH REGION

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The allergic diseases, the major role in etiology of which is played by allergens present in ambient air, are common. To develop practical guidelines on prevention of allergic rhinitis as the most prevalent disorder in the structure of allergy, it is necessary to estimate all the conditions, both negatively and positively affecting this disorder. The study was aimed to assess factors affecting the incidence, detection, and registration of cases of allergic rhinitis in the Voronezh Region. The report forms № 12 and № 30 provided substantive inputs to the study, along with the laboratory test data provided by private clinics and the social and hygienic monitoring data. Epidemiological analysis was performed by retrospective method; the territories were ranked by various indicators; the correlation analysis method was applied. We determined the incidence rates and the districts at high risk of allergic rhinitis (pollinosis) in all population groups for the period 2012–2021. We determined the structure of aeroallergens identified in private healthcare institutions, assessed the staffing levels of allergists in the public institutions of the Voronezh Region, and identified significant environmental factors. The identified features of the prevalence, diagnosis, and registration of allergic rhinitis in the Voronezh Region can be used to improve preventive measures targeting this allergic disorder.

Keywords: allergic rhinitis, aeroallergens, pollinosis, diagnosis, report forms, adverse factors, prevention

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ОБОСНОВАНИЕ НЕОБХОДИМОСТИ ПРОФИЛАКТИКИ АЛЛЕРГИЧЕСКОГО РИНИТА НА ТЕРРИТОРИИ ВОРОНЕЖСКОЙ ОБЛАСТИ

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Аллергические заболевания, основное значение в этиологии которых принадлежит аллергенам атмосферного воздуха, распространены повсеместно. Для разработки практических рекомендаций по предупреждению возникновения аллергического ринита как самого распространенного заболевания в структуре аллергии необходимо оценить все условия, как отрицательно, так и положительно влияющие на данную патологию. Целью исследования было проанализировать факторы, влияющие на заболеваемость, выявление и учет случаев аллергического ринита на территории Воронежской области. Основными материалами для исследования послужили учетно-отчетные формы № 12 и № 30, данные лабораторных исследований частных клиник и социально-гигиенического мониторинга. Выполнен эпидемиологический анализ с применением ретроспективного метода, проведено ранжирование территорий по различным показателям, применен метод корреляционного анализа. Определены уровни заболеваемости, а также районы высокого риска в отношении аллергического ринита (поллиноза) среди всех групп населения за период с 2012 по 2021 г. Определена структура аэроаллергенов, выявленных в частных учреждениях здравоохранения, выполнено исследование наполнения штатных должностей врачей-аллергологов в государственных учреждениях Воронежской области, выявлены значимые факторы окружающей среды. Выявленные особенности распространения, диагностики и регистрации аллергического ринита на территории Воронежской области могут быть использованы для совершенствования профилактических мероприятий в отношении данной аллергопатологии.

Ключевые слова: аллергический ринит, аэроаллергены, поллиноз, диагностика, отчетные формы, неблагоприятные факторы, профилактика

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The importance of the issue of allergic diseases can hardly be overestimated considering high prevalence of such disorders [1]. The most common manifestation of allergy is represented by rhinitis, the role in etiology of which can be played by various agents from the environment: pollen, dust, household, animal, fungal, insect agents [2, 3]. Detriment of the patients' quality of life together with substantial cost of treatment and prevention make the research focused on this disorder more and more relevant every year [4, 5].

Despite the fact that allergy occupies a significant position in the overall morbidity structure, there are still significant differences

between the statistically recorded and undocumented cases [6, 7]. The existence of various statistics systems makes it impossible to reflect the true picture of incidence among various population groups [8, 9]. A significant place in detection of allergic diseases is given to private medical practice, however, the data acquired by this healthcare sector are not available for full-fledged statistical analysis [10].

The impact of environmental factors of the allergic diseases is examined from different perspectives. The climate change and the increase in the levels of pollutants in ambient air result in the altered pathogenesis of allergic reactions [11–13].

Accumulation of adverse factors reducing the human body resistance becomes possible in the urban environment, where intense anthropogenic activity is observed [14–16].

In this regard, the study was aimed to determine the factors affecting the incidence, detection, and registration of cases of allergic rhinitis in the Voronezh Region.

METHODS

The study was carried out in the Voronezh Region in 2012–2022. A retrospective method was used to analyze statistical forms № 12 “Information on the number of disorders reported in patients living in the service area of medical institution” and № 30 “Information on the medical institution”. The territories were ranked by the incidence rate of pollinosis (number of cases per 1000 population), forest cover (% of land area covered by forests), long-time annual average levels of nitrates in drinking water (mg/dm³) and food products (mg/kg) by entering the values in the Morbidity Rate Ranking software (Burdenko Voronezh State Medical University; Russia). The data of laboratory allergy tests provided by private clinics were analyzed.

Statistical processing of the results was performed using the My Office Standard software package (New Cloud Technologies; Russia). The correlation analysis method involving calculation of the Pearson correlation coefficient (*r*) was applied, along with assessing the significance of differences between the incidence rate of pollinosis and the forest cover, presence of ragweed, and meteorological phenomena using the Student's *t*-test (*t*). The differences were considered significant when the statistical error probability was below 5% (*p* < 0.05). The data were presented as the mean (*M*) and error of the mean (*m*).

RESULTS

Assessment of statistical forms has confirmed annual recording of the cases of allergic rhinitis (pollinosis) in the Voronezh Region. The differences in incidence rate between the districts of the region are reported for all population groups. According to the ranking of territories, high risk of the disease based on the incidence rate in adult population is reported for eight districts, while that based on the incidence rate in children and adolescents is reported for seven districts (Table 1).

The following incidence rates per 1000 population were assigned high rank in each group: 1.43–3.99 cases, 5.16–12.02 cases, and 3.3–6.63 cases for adults, adolescents, and children, respectively. Match of the data of the territories with high risk of the disease for the studied groups was reported for the Ramonsky District, where the long-time annual average incidence of pollinosis per 1000 population was 2.24 cases for adult population, 6.14 cases for adolescents, 4.23 cases for pediatric population.

Assessment of the data of statistical form № 30 “Information on the medical institution” showed that in the studied period the maximum staffing level of allergists in public institutions was achieved in 2016: 29.25 staffing positions, 12.8% of which were not occupied by physicians of appropriate specialty. The averaged data show that 15.23% remain unoccupied every year. The thorough assessment of the report form revealed the lack of staffing positions of allergists in public medical institutions in 30 districts of the region out of 31, as well as in two administrative territories out of three. It was found that there were physicians of this specialty in the Liskinsky District and in the city district of Voronezh.

It should be noted that allergic rhinitis recorded in the report form №12 is a disorder caused by plant pollen. That is why the cases of rhinitis of other etiology are not reflected in statistical documents.

The structure of aeroallergens causing allergic rhinitis in the population of Voronezh Region was assessed based on the data of laboratory testing for IgE provided by private clinics. A total of 100,000 tests were performed during the studied period, among them more than 20,000 were positive. The allergens contributing to pollinosis were detected more than 13,000 times. The tests for IgE against pollen allergens were positive in more than 6000 cases. IgE against house dust allergens were identified in more than 4000 blood tests. Molds as allergic agents were identified in about 2000 tests. Statistical analysis showed that pollen allergens constituted a significant part of the structure of all aeroallergens. The next place was occupied by house dust allergens, while mold allergens were the least abundant (Fig. 1).

Among positive tests for plant pollen allergens, the leading place was occupied by allergens from birch and ragweed (Fig. 2). The other allergens from pollen of trees and grass

Table 1. Territories at high risk based on the incidence rate of pollinosis (number of cases per 1000 population)

| Adult population LTAAI (<i>M</i> ± <i>m</i>) | Adolescents LTAAI (<i>M</i> ± <i>m</i>) | Pediatric population LTAAI (<i>M</i> ± <i>m</i>) |
|---|--|---|
| Kamensky District (3.84 ± 0.15) | Talovsky District (10.6 ± 1.42) | Bogucharsky District (6.44 ± 0.19) |
| Verkhnemamonsky District (3.07 ± 0.04) | Bogucharsky District (8.9 ± 0.47) | City district of Voronezh (5.13 ± 0.12) |
| Ertilsky District (2.57 ± 0.05) | Borisoglebsky District (6.7 ± 0.14) | Ramonsky District (4.23 ± 0.31) |
| Ramonsky District (2.24 ± 0.04) | Ramonsky District (6.1 ± 0.62) | Liskinsky District (4.03 ± 0.06) |
| Ostrogzhsky District (2.08 ± 0.02) | Semiluksky District (4.9 ± 0.47) | Povorinsky District (3.98 ± 0.15) |
| Paninsky District (1.52 ± 0.02) | Kamensky District (4.5 ± 1.14) | Ertilsky District (3.87 ± 0.09) |
| Povorinsky District (1.47 ± 0.06) | City district of Voronezh (5.3 ± 0.12) | Kashirsky District (3.68 ± 0.38) |
| Liskinsky District (1.44 ± 0.01) | | |

Note: LTAAI — long-time annual average incidence.

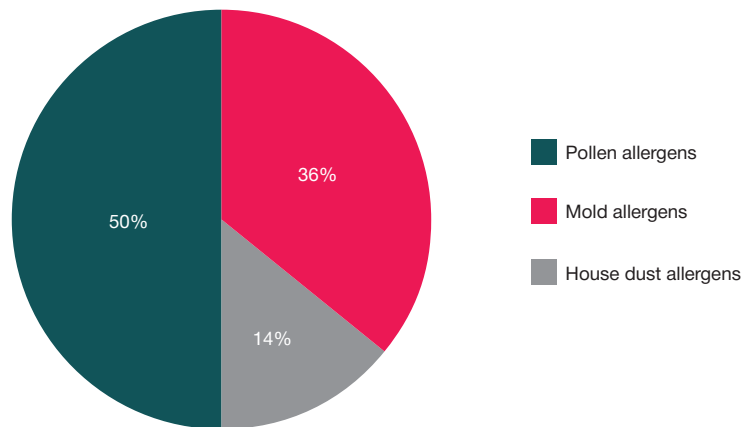


Fig. 1. Laboratory tests for significant aeroallergens – data provided by private clinics (%)

constituted a smaller fraction of the structure of specific IgE detection in blood.

Due to identification of priority pollen allergens, we performed search for the data on the quantitative distribution of significant plants across the territory of Voronezh Region. The regional forest cover assessment data confirmed a considerable spread of plants capable of causing the symptoms of allergic rhinitis [17]. Birch was among the major forest-forming tree species in the region [18]. Ranking the district of the region by forest cover made it possible to determine the territories where birch was most likely to grow (Table 2).

The search for correlation between the incidence rate of pollinosis and the forest cover revealed a significant correlation between these characteristics ($r = 0.45$ at test. = 2.79 > $t_{crit.} = 2.31$ for pediatric incidence and $r = 0.44$ at test. = 2.74 > $t_{crit.} = 2.31$ for adolescent incidence).

No less important is ragweed as a more aggressive allergic agent growing in 19 districts of the region, as well as in the city districts of Voronezh and Borisoglebsk [19]. The presence of ragweed also significantly correlates with the incidence of pollinosis among children and adolescents ($r = 0.42$ at test. = 2.61 > $t_{crit.} = 2.31$ for children and $r = 0.50$ at test. = 3.22 > $t_{crit.} = 2.31$ for adolescents). The correlation between the forest cover, presence of ragweed, and the incidence of pollinosis among children and adolescents of the Voronezh Region is moderate.

The spread of plant pollen is strongly influenced by meteorological conditions. It is well known that pollen spreads over vast distances in dry, windy weather, and vice versa, the spread slows down when it's calm, rainy, and the air humidity is high [20]. We assessed air temperature and rainfalls reported in the Voronezh Region throughout the studied period.

The studied meteorological phenomena were characterized by uneven distribution in the assessed period. To search for the correlation between the incidence rate of pollinosis in the population and the selected meteorological factors, we decided to analyze the months of predominant pollination of allergenic plants, from early spring (March) to mid-fall (October).

The correlation analysis performed revealed a strong correlation between air temperature and pediatric incidence in territorial aspect ($r = 0.73$ at $t_{est.} = 3.03 > t_{tabl.} = 2.3$, $p < 0.05$). When assessing the correlation between the rainfalls and the incidence, the decrease in pollinosis rate with increasing amount of rain was observed, however, this correlation was not significant, which could be due to the need of recording the rainfall frequency.

Not only meteorological phenomena are important, but also the ambient air condition, since air pollution can affect both plant allergens through precipitation of hazardous substances onto pollen grains and humans through reduction of their resistance [21–23]. Contamination with airborne pollutants in the Voronezh region was recorded throughout the assessed period. Furthermore, the diversity of pollutants and districts, where the excess of MPC was recorded, was significantly reduced by the year 2022. Suspended solids in ambient air were the only pollutant recorded throughout the studied period. This indicator exceeded maximum permissible concentration in all the territories, where there were monitoring sites, except for Ostrogozhsky District, where non-compliance with the suspended solids standard was reported in 2009 for the last time.

Human body can be also adversely affected through drinking water and food products. The social and hygienic monitoring data indicate high levels of contamination of these media with such pollutants, as nitrates.

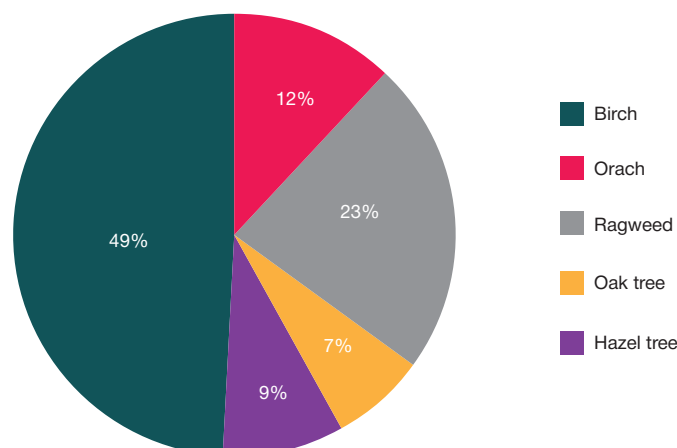


Fig. 2. Structure of pollen allergens — laboratory tests performed by private clinics (%)

Table 2. Territories with high forest cover, %

| District | Forest cover |
|---------------|--------------|
| Ramonsky | 29.7 |
| Bobrovsky | 25.4 |
| Bogucharsky | 21.2 |
| Talovsky | 19.8 |
| Pavlovsky | 19.7 |
| Liskinsky | 18.1 |
| Khokholsky | 17.5 |
| Buturlinovsky | 16.3 |
| Novousmanskyy | 16.2 |
| Povorinsky | 15.6 |

The long-time annual average nitrate level in drinking water of the Voronezh Region is 12.2 ± 2.7 mg/dm³. Five territories of the region rank high by the levels of studied contaminants. The highest levels of nitrate pollution are found in the Ramonsky District (56 mg/dm³).

The nitrate contamination of food products in the Voronezh Region also reaches considerable levels. Contamination of fruit and vegetables is reported annually, it is found in 92.4% of the tested samples. Ranking the territories of the region by the long-time annual average nitrate contamination levels allowed us to distinguish five districts, where the nitrate levels in fruit and vegetables exceeded 198.3 mg/kg. Such districts include Verkhnemamonsky District (236.39 mg/kg), Rossoshansky District (251.02 mg/kg), Repyovsky District (216.65 mg/kg), Khokholsky District (207.83 mg/kg), and Pavlovsky District (201.14 mg/kg).

DISCUSSION

The review of official statistics revealed the lack of full-fledged recording of various allergic rhinitis forms. Despite significant contribution of pollen allergens to the structure of aeroallergens, house dust and molds also contribute to the development of symptoms worsening the quality of human life and leading to substantial economic costs. Assessment of the spread of allergenic plants, meteorological conditions and the

correlation analysis of the above factors and the incidence of pollinosis demonstrated a significant correlation between the studied indicators. The analysis of contamination in the most important components of the environment enabled distinguishing the territories with high contamination rate of the media that were extremely important for maintaining human health and the ability to resist various aggressive exposures.

Aeropalinological analysis of the territory of Voronezh Region would significantly expand the study, however, it is difficult to perform due to technical restrictions. The reports of the researchers from the Krasnodar Krai and the Ryazan Region provide a detailed pollen monitoring [24, 25]. Studying pollen in the region is a promising direction to help the population to prevent pollinosis. In the process of scientific research on the topic, the reports of scientists studying the structure and problems of allergological services in their countries were found, which confirmed the relevance of the research topic [26, 27].

CONCLUSIONS

The study of the incidence of allergic rhinitis in the Voronezh Region and consideration of the factors affecting the incidence rate, diagnosis and recording of this disorder make it possible to use the findings to develop the hygienic practical guidelines on prevention of the studied disorder.

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SPECIALTY "PREVENTIVE MEDICINE": FROM APPLICANT TO SPECIALIST

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Preserving and strengthening the health of the population of the Russian Federation is impossible without ensuring sanitary and epidemiological welfare. Furthermore, the staff shortage of preventive medicine specialists is observed in a number of regions, along with the decline in popularity of this specialty among applicants manifesting itself in the lower number of applications and the lower average USE scores of admitted students together with the lower passing scores in educational institutions. The study was aimed to assess the social and psychological portrait of the student studying at the faculty of preventive medicine and his/her motivation for further professional activity. The anonymous online questionnaire survey of 153 students showed that only 57.5% of students made a conscious choice of profession, 54.3% remain confident in their choice throughout the learning process, 28.8% doubt their choice, and 16.9% would never do the same choice. A total of 34.0% respondents are concerned about the success of their employment. At the same time, the majority of students show good academic performance, while career orientation and competitiveness are the major factors that drive their successful study.

Keywords: preventive medicine, training of specialists, Rospotrebnadzor, medical students, applicants

Author contribution: Shepeleva OM — study concept, developing the research design, literature review, description of results, manuscript writing and formatting; Gerasimova ES — online questionnaire survey, data processing; Churilin MI — literature review, description of results.

Compliance with ethical standards: the online questionnaire survey was anonymous, it did not endanger the subjects or infringe their rights. When starting polling, the respondent was asked to give the consent to study participation. When the option "don't agree to participate in the study" was chosen, no further questions could be opened.

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СПЕЦИАЛЬНОСТЬ «МЕДИКО-ПРОФИЛАКТИЧЕСКОЕ ДЕЛО» — ОТ АБИТУРИЕНТА ДО СПЕЦИАЛИСТА

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Сохранение и укрепление здоровья населения Российской Федерации невозможно без обеспечения санитарно-эпидемиологического благополучия. При этом в ряде регионов наблюдается кадровый дефицит специалистов медико-профилактического дела, а в образовательных организациях — снижение популярности этой специальности среди абитуриентов, проявляющееся уменьшением числа подаваемых заявлений, снижением среднего балла ЕГЭ поступивших и проходных баллов. Целью исследования было изучить социально-психологический портрет студентов факультета медико-профилактического дела и их мотивацию к дальнейшей профессиональной деятельности. Анонимное онлайн-анкетирование 153 студентов показало, что осознанный выбор профессии сделали только 57,5% обучающихся, 54,3% сохраняют уверенность в своем выборе в процессе обучения, 28,8% сомневаются в сделанном выборе, а 16,9% никогда не повторили бы такой выбор. У 34,0% опрошенных выявлена обеспокоенность по поводу успешности будущего трудоустройства. При этом большинство обучающихся имеют хорошую успеваемость, а основными факторами, стимулирующими их к успешной учебе, являются карьероориентированность и конкурентоспособность.

Ключевые слова: медико-профилактическое дело, подготовка специалистов, Роспотребнадзор, студенты-медики, абитуриенты

Вклад авторов: О. М. Шепелева — концепция статьи, разработка дизайна исследования, работа с литературой, описание результатов, написание и оформление статьи; Е. С. Герасимова — онлайн-анкетирование, обработка результатов исследования; М. И. Чурилин — работа с литературой, описание результатов.

Соблюдение этических стандартов: онлайн-анкетирование было анонимным, не подвергало опасности участников и не ущемляло их прав. В начале анкетирования спрашивали согласие респондента на участие в исследовании. При выборе варианта «не согласна(ен) на участие в исследовании» дальнейшие вопросы не открывались.

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Training of specialists at the medical universities undergoes significant changes in the context of modernization of educational and healthcare systems. In today's reality, high demands that can be hardly met due to lower relevance of the specialty and lower quality of applicants are placed on the educational institutions as providers of skilled and competent specialists. While the interest of applicants in the clinical medicine specialties remains constant or even grows, the relevance of specialties 32.00.00 "Health Sciences and Preventive Medicine", including specialty 32.05.01 "Preventive Medicine" has been decreasing noticeably in recent years, despite the demand for specialists [1]. Admission to the

specialty "Preventive Medicine" is often based on the leftover principle [2], since applicants and students do not consider their future work as prestigious.

The Kursk State Medical University has been training specialists in this field since 1998, satisfying the need of its own and neighbouring regions for personnel. In recent years, a progressive decrease in the applicants' interest in the specialty has become relevant. This was especially evident during the admission campaign 2023 due to amendments to the "Procedure for Admission to Study in Accordance with the Higher Education Programs — Bachelor's Programs, Specialty Programs, Master's Programs" and introduction

of priority system at the stage of application for study [3]. Thus, the decrease in the number of applications for this specialty within the framework of general competition by 32.9% relative to the previous year was reported during the admission campaign 2023. Furthermore, among applicants, less than 12.0% marked "Preventive Medicine" as top priority, and the highest USE scores of applicants with such top priority was only 230. This, students with high scores gave top priority to the clinical medicine specialties.

The development goals of healthcare in the Russian Federation are increasing population, life expectancy, healthy life expectancy, decreasing mortality and disability rates, respect for the rights of citizens in the field of health protection, and ensuring state guarantees related to these rights [4]. These goals cannot be achieved without the population's adequate sanitary and epidemiological welfare ensured by specialists in preventive medicine. Training of highly qualified personnel is an essential condition for ensuring sanitary and epidemiological welfare, as reflected in the roadmap for the development and consolidation of the system of federal state sanitary and epidemiological surveillance for the years 2021–2028 [1, 5]. This task can be implemented only in case of close cooperation of the educational institutions and institutions of Rospotrebnadzor when conducting career guidance activities, selecting trained applicants, and communicating at the stage of educational program realization.

The study was aimed to create the social and psychological portrait of the student studying at the faculty of preventive medicine of the Kursk State Medical University and assess his/her motivation for professional activity.

METHODS

The study was conducted in October 2023 through anonymous online questionnaire survey performed using Yandex Forms (Yandex; Russia), which reduced the likelihood of intentional falsification of the results by the respondents aimed at getting approved by the academic staff. The study involved 153 1st–6th-year students studying at the faculty of preventive medicine of the Kursk State Medical University, which accounted for 92.0% of the total sample. Among them 34 (22.0%) were males and 119 (78.0%) were females. The sample was representative and characterized the overall structure of students studying at the faculty of preventive medicine.

The questions to be included in the questionnaire were selected based on the literature review. The questionnaire comprised three sets of questions: the first set was about the respondents' socio-economic status, the second was about professional self-determination, and the third was about personal characteristics.

Statistical data processing was performed by standard methods using the MyOffice Standard software package (New Cloud Technologies; Russia).

RESULTS

The questionnaire survey has yielded the following socio-economic characteristics: 43.1% of the respondents live in the student dormitory, 36.6% rent accommodation, 11.1% live with their parents, 9.2% have their own housing. A total of 4.6% respondents are married. The respondents have reported their financial status as good (46.4%) and satisfactory (40.5%); 7.2% have reported excellent and 5.9% have reported bad financial status. The majority of students (70.0%) fail to combine study with work. Slightly less than a third of respondents combine

educational activities with work: 5.0% (5th–6th-year students) work in the Center for Hygiene and Epidemiology as middle-level medical personnel, another 25.0% work in the areas not related to their future specialty. The vast majority of students admitted to the faculty are graduates of comprehensive school (8.0%), 12.4% are graduates of medical colleges, 0.6% already have higher education.

When assessing professional self-determination, it was found that slightly more than a half of students (57.5%) consciously, voluntarily chose their profession, 22.9% followed the advice of their parents, relatives or teachers, and one fifth (19.6%) came quite by accident, since the USE score was not enough for admission to the clinical medicine specialties. Furthermore, currently 77.8% of the respondents like their future specialty, 3.9% do not like it, while 18.3% of the respondents have not come to a firm conclusion.

When answering the question "Would you choose this specialty again?", 28.8% found it difficult to answer, 16.9% were sure they would never repeat the same choice, and 54.3% were sure that their choice was correct. Moreover, 34.0% of the respondents feel insecure about the possibility of future employment by specialty, 10.5% have never thought about the employment, and 55.5% of the respondents are confident in the prosperous outcome of employment. It should be noted that 42.4% of the student sample have entered the university to receive targeted training that guarantees their future employment.

When assessing educational process as a whole, only a tenth of respondents (10.5%) reported they did not like study at the university. Among causes of such negative responses (multiple selection), the respondents reported high workload (42.0%), didactic nature of teaching (9.0%), "poor" educational process organization (schedule, in-class lectures, "floating" start of intermediary classes) (23.0%). Among other causes, 10.5% of the respondents reported a large number of "unnecessary" academic disciplines and insufficient (in their opinion) duration of practical training.

As for their academic performance, 15.0% of the respondents reported it was excellent, 64.1% reported it was good, 20.9% reported it was satisfactory, which was confirmed by objective academic performance indicators. The average students' score for the last five years based on the interim assessment results is 4.2 ± 0.2 points ($M \pm \sigma$). Motivation for educational activity is provided in Fig. 1.

As is well-known, studies at the university go hand in hand with the socially useful and research activities. The survey results have shown that less than one third of the respondents have a proactive stance and are engaged in extracurricular areas of university life: 32.0% participate in community activities (volunteering, working in the trade union committee, student council, etc.), while 29.0% are engaged in research activities on their own initiative. The first place in the structure of low level of participation in the above activities is occupied by the lack of time reported by 36.0% of the respondents. No interest in public affairs is reported by 17.7% of the respondents, in research activity — by 26.2%; 9.2% of students believe that public affairs are futile, 5.2% believe that research activities are futile. Other reasons for community activities are reported by 37.1% of the respondents, while that for research activities are reported by 32.6%.

When characterizing psychological climate in the team and interpersonal relationships between students and students and teachers, we can say that these are beneficial. Thus, 96.7% of the respondents assessed their relationships with teachers as good or satisfactory, while poor relationships were reported only

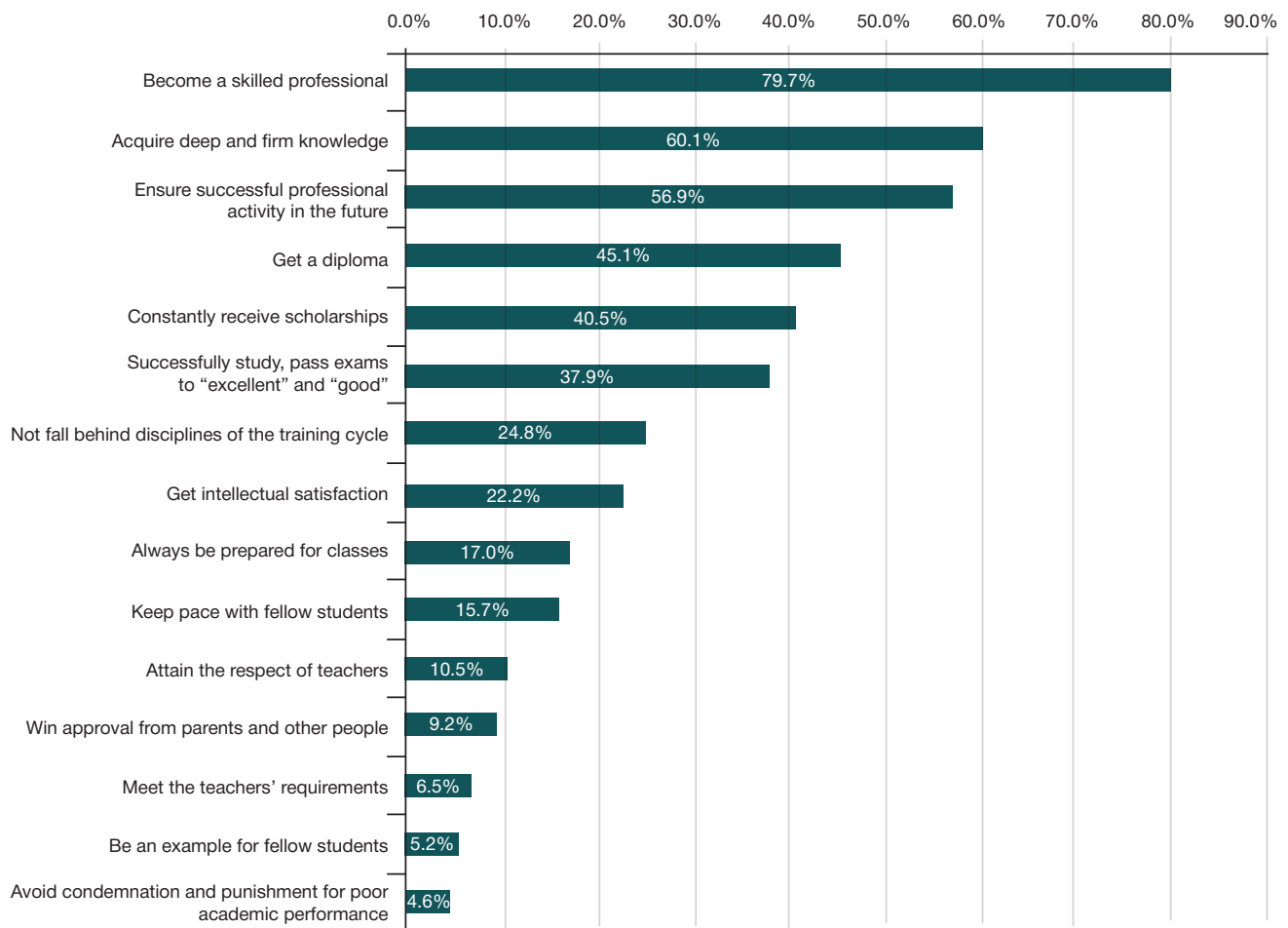


Fig. 1. Motivation for successful learning (multiple selection)

by 3.3%. The fact attracts attention that students appreciate more positive personal characteristics of teachers (multiple selection), such as sincerity, honesty, empathy (92.8%), while profound professional knowledge is ranked first by 58.8% of the respondents and pedagogical exaction is ranked first only by 14.4%. Only 2.0% of the respondents report poor relationships between students; furthermore, opinions of fellow students are important for 54.0% of the respondents, and nearly three-quarters of respondents (74.5%) rely on their help. The respondents believe that the main factors contributing to success in various spheres of life and to general well-being include the ability to adjust, good health, diligence, integrity, as well as proper goal setting (96.1–97.4% of the respondents), while social status, help of relatives, relationships, money are considered important by 75.8–81.0% of the respondents. Significance of various factors is provided in Fig. 2.

High-quality acquisition of knowledge is possible only with the properly organized leisure time. When assessing their leisure activity, the respondents were offered to choose up to three most frequent types of free time activities. According to the survey results, more than a half of students prefer to pursue a hobby (54.9%) and meet up with friends (54.2%) in their spare time; a small number of students (3.9–9.8%) prefer outdoor recreation or watching TV. The complete distribution pattern for the leisure activity types is provided in Fig. 3.

DISCUSSION

According to the questionnaire survey results, the socio-economic characteristics of the sample of students studying

at the faculty of preventive medicine are generally compliant with the data of similar studies involving medical students: the sample is represented by graduates of schools, females; the vast majority of nonresident students lives in the dormitories; about a third have their own income due to combining study with work; the vast majority is not married [6, 7].

The analysis of consciousness of the choice of specialty has shown that there is high percentage of casual people among students. Assessment of the impact of educational process on the attitude towards future profession has revealed an upward trend in the number of students who like the profession. However, the share of students concerned about their choice is higher than that among students of clinical medicine specialties [7]. This category of students requires special attention of both academic staff and potential employers, since targeted work with the category makes it possible to motivate students to stay in the profession.

The final result of professional self-determination, starting as early as at school, is largely dependent on the students' satisfaction with educational process. It should be noted that just a small portion of the respondents does not like to study at the university. The main cause of negative response to the educational process is represented by high workload that is typical for training at medical universities [7, 8]. Furthermore, the students are not satisfied with practical classes: both duration and process of practical training. Despite the fact that the educational program is compliant with the requirements of the federal state educational standard in terms of structure and size, real organization of practical training of future sanitary physicians and epidemiologists faces great difficulties

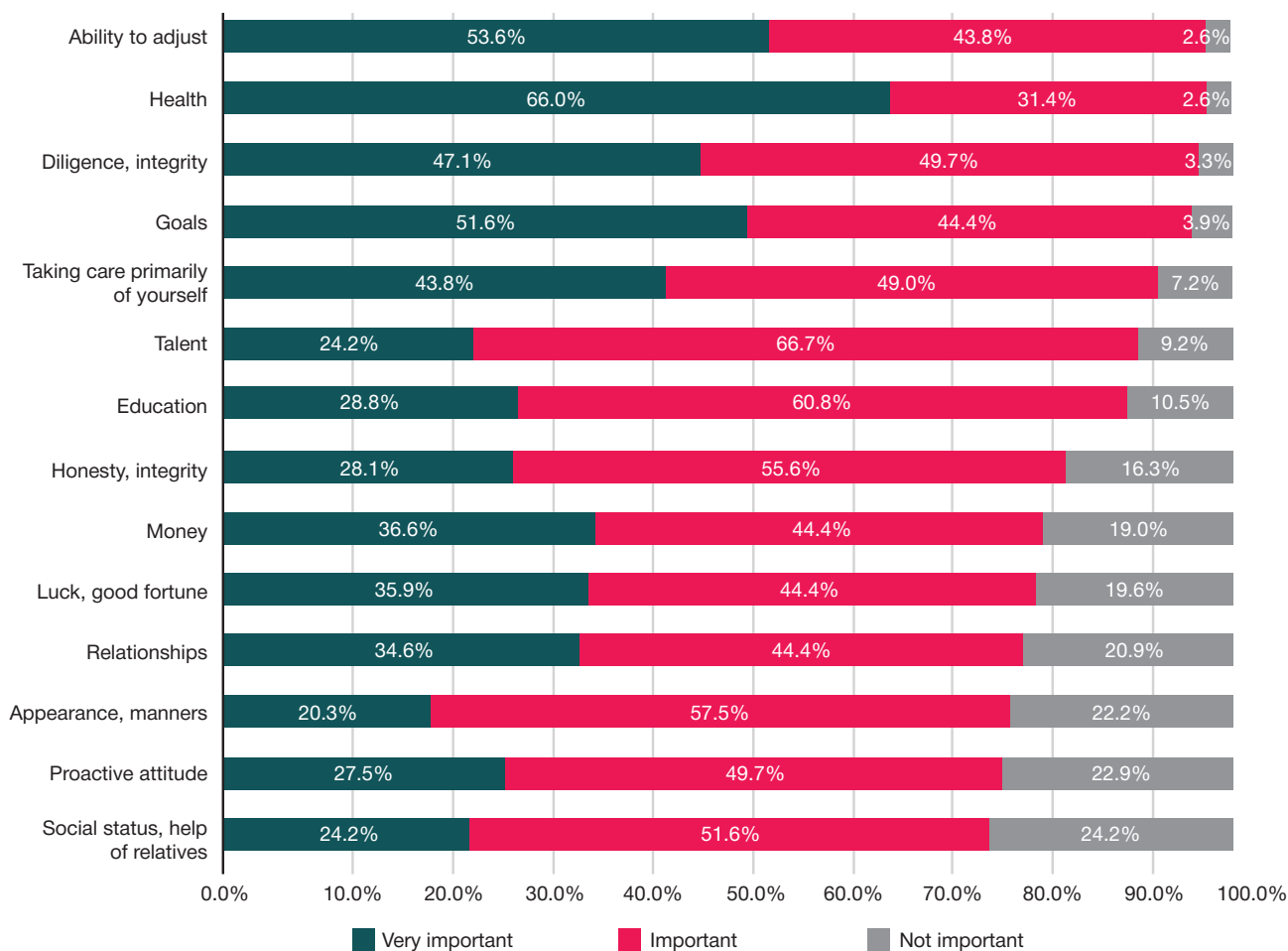


Fig. 2. Significance of various factors for success in life

due to current legislation on inspecting. Reduction of the overall number of inspections associated with moratorium on inspections is combined with the right of the inspected objects to restrict the access of individuals not listed in the order on inspection. Thus, students can be forced into the situation, when they are unable to take part in the on-site control and monitoring activities throughout practical classes and have to limit themselves to working with documents. The above limitations impose extra responsibility regarding the use of practice-oriented and simulation training methods during practical training on the educational institution.

When assessing the factors driving students towards successful learning, career orientation and future competitiveness attract attention, while approval from close and distant people plays no important role. Such characteristics are typical for the majority of Generation Z representatives, along with high levels of pragmatism and individualization [9]. Academic success of the majority of students is accompanied by little interest in the socially useful and research activities. On the one hand, this can be caused by the lack of time resulting from high educational workload, while on the other hand this can be explained by the Generation Z representatives' relative reticence and difficulty talking face-to-face, which limit social activity, as well as by inability to focus their attention for a long time against the background of strive for quick decision making and yielding the results [9], which is unusual for research work. Furthermore, the students largely rely on their own strength instead of outside assistance, when trying to achieve good results.

The study participants' predominant orientation towards the teachers' positive personal traits (kindness, empathy, sincerity,

tolerance) instead of expertise results from psychological characteristics of modern youth (high levels of sensitivity and anxiety, low levels of stress tolerance), as well as from the decline in authoritarian stance of the "know-it-all teacher" due to easy availability of information on the Internet [9, 10].

Respondents consider the main difficulty in organizing leisure time to be the lack of free time, which is typical for studying at a medical university. The leisure activity types are generally similar to that in other medical students [11].

CONCLUSIONS

The resulting social and psychological portrait of the student studying at the faculty of preventive medicine is indicative of career orientation in combination with the need for psychological comfort, good financial position, rapid achievement of results, as well as from the desire to be independent. The large share of casual people, who doubt the right choice of specialty, can lead to withdrawal from the profession both during training and after getting the diploma, which can further exacerbate the existing staffing shortages. High levels of responsibility of a specialist in preventive medicine, the lack of visualization of performance indicators, not always positive attitude of society towards the activities of the service run counter the beliefs of today's generation of young people [12]. The findings should be considered when planning career guidance work with potential applicants and students in order to motivate them to stay in the profession. Furthermore, the authorities should consider the change in psychological attitudes and values when planning targeted training of specialists,

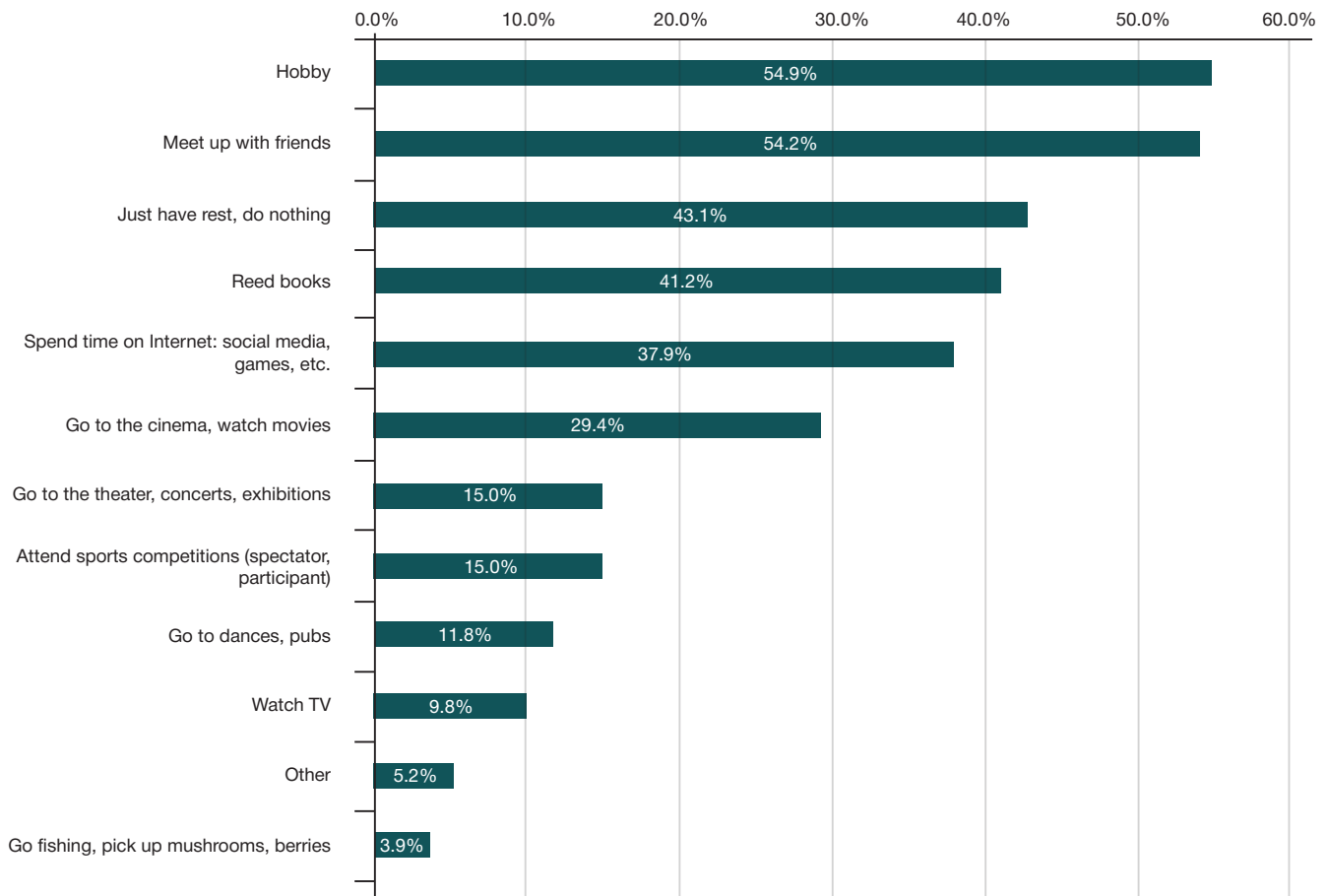


Fig. 3. Leisure activities (multiple selection)

as well as the issue of expansion of supportive measures for both employer-sponsored students and young specialists. Presumably, the experience of the Rural Doctor program

implementation should be considered to fill the shortage of personnel in the distant regions, to which young professionals go with great reluctance.

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PSYCHOPHYSIOLOGICAL FEATURES OF STUDENTS AT DIFFERENT RISK OF INTERNET-ADDICTIVE BEHAVIOR

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Internet addiction is a behavioral problem that is rapidly growing increasingly widespread, especially among higher education students. This study aimed to profile psychophysiological characteristics of students at different levels of risk of developing behavior-modifying internet addiction. We invited 261 students and established their levels of internet addiction using the Chen Internet Addiction Scale, then formed two groups: group 1 — students showing no signs of internet addiction; group 2 — students prone to internet addiction. Students' mental and social health and quality of life were assessed. Compared to the participants from group 1, group 2 students were found to exhibit 1.7 times more intense compulsive symptoms, 1.5-fold stronger withdrawal and tolerance symptoms, and had intrapersonal/health issues and time management problems that were 1.3 and 1.4-fold more grave, respectively; all these factors contributed to internet addiction. The risk of internet addiction in group 2 externalized as greater irritability (1.5-fold higher than in group 1), resentment (1.4-fold higher), feelings of guilt and hostility (1.3-fold more intense), verbal aggression (1.2-fold), stress (1.3-fold), anxiety and negative emotional experiences (1.2-fold), and 1.2 times lower quality of life in terms of its psychological component. The resulting data suggest the need for prevention measures designed to reduce the risk of internet addiction through management of negative emotional states in students with the help of socio-psychological inventory.

Keywords: students, internet addiction, Chen Internet Addiction Scale, aggressive and hostile reactions, anxiety, negative emotional experiences, stress, social health, quality of life

Author contribution: Setko NP — study design and concept, manuscript editing; Zhdanova OM — manuscript writing, collection and processing of the material, statistical processing; Setko AG — manuscript writing, editing; all authors — approval of the final version of the article, responsibility for integrity of all of its parts.

Compliance with ethical standards: the study was conducted in compliance with the principles of the Declaration of Helsinki (Fortaleza, 2013). Each participant of the study submitted a signed voluntary informed consent form.

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ПСИХОФИЗИОЛОГИЧЕСКИЕ ОСОБЕННОСТИ СТУДЕНТОВ С РАЗНЫМ УРОВНЕМ РИСКА ИНТЕРНЕТ-ЗАВИСИМОГО ПОВЕДЕНИЯ

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Интернет-зависимость — это поведенческая проблема, уровень распространенности которой стремительно увеличивается, особенно среди студенческой молодежи. Целью исследования было установить психофизиологические особенности студентов с разным уровнем риска интернет-зависимого поведения. У 261 студента выполнили диагностику интернет-зависимости по опроснику «Шкала интернет-зависимости Чена», после чего были сформированы две группы: 1-я группа — студенты без интернет-зависимого поведения, 2-я группа — студенты, склонные к формированию интернет-зависимости. Оценивали психическое и социальное здоровье, качество жизни студентов. Установлено, что у студентов 2-й группы склонность к интернет-зависимому поведению формировалась за счет увеличения в 1,7 раз выраженности компульсивных симптомов, а также симптомов отмены и толерантности — в 1,5 раза, внутриличностных проблем и проблем, связанных со здоровьем, — в 1,3 раза, проблем управления временем — в 1,4 раза по сравнению со студентами 1-й группы. При этом риск развития интернет-зависимости у студентов 2-й группы характеризовался повышением раздражительности в 1,5 раза, обиды — в 1,4 раза, чувства вины и враждебности — в 1,3 раза, вербальной агрессии — в 1,2 раза, стресса — в 1,3 раза, тревожности и негативных эмоциональных переживаний — в 1,2 раза, а также снижением психологического компонента качества жизни в 1,2 раза по сравнению со студентами 1-й группы. Полученные данные определяют необходимость профилактических мероприятий, направленных на снижение риска развития интернет-зависимости посредством социально-психологической коррекции негативных эмоциональных состояний у студентов.

Ключевые слова: студенты, интернет-зависимость, шкала интернет-зависимости Чена, агрессивные и враждебные реакции, тревожность, негативные эмоциональные переживания, стресс, социальное здоровье, качество жизни

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Over the past decades, internet and smartphones have grown increasingly relied on throughout the world, and became an important part of modern life [1]. According to the statistics, in 2021, almost 4.6 billion people accessed internet [2].

Used properly, internet gives quick and easy access to information, entertainment and social contacts, and simplifies communication. However, this environment is becoming not only a space of opportunities, but also that of risks, including

the risks of destructive and autodestructive behavior. Excessive and uncontrolled use of internet is associated with development of internet addiction and mental health problems [3]. Internet addiction is a behavioral problem that has gained greater scientific recognition over the past decade; some researchers call it "the 21st century epidemic" [4]. According to scientific data, Internet addiction is a non-chemical behavioral addiction stemming from human-machine (computer-internet) interaction with the following psychopathological symptoms: excessive use of internet associated with lack of control over screen time; neglect of work/study that degrades academic performance and productivity; irresistible obsessive desire to use internet; neglect of social life and search for social connections lacking in real life online [5–10].

Higher education students are particularly prone to developing behavior-modifying internet addiction. In medicine and healthcare, internet helps to practice evidence-based medicine, conduct research and training, access medical and online databases, treat patients in remote areas. The web is also used for academic and entertainment purposes. At the same time, limited or non-existent parental control, lifestyle of higher education students, use of internet in the context of studies (from preparations of projects to communication with peers and professors), its exam anxiety and stress relieve potential, as well as a primitive understanding of leisure time and lack of opportunities to realize intellectual and creative potential create risks of development of internet addiction.

This study aimed to profile psychophysiological characteristics of students at different levels of risk of developing behavior-modifying internet addiction.

METHODS

This was a cross-sectional study that involved 261 medical students of 5th and 6th years, 196 female and 65 male, conducted during the classroom studies period. To be included, participants had to sign the informed consent to examination. Chronic diseases and mental disorders were the exclusion criteria. The required sample size was not calculated in advance.

We used the Chen Internet Addiction Scale (CIAS) modified by K.A. Feklisov and V.L. Malygin [11] to assess the attitude of participants towards internet. The scale consists of 6 subscales that score compulsive symptoms (Com; obsessive desire to go online); withdrawal symptoms (Wit; peculiar to cessation of use of internet, associated with discomfort); tolerance symptoms (Tol; gauged by time online needed to achieve satisfaction); intrapersonal issues and health problems (IH); quality of time management (TM). Summed up, Com + Wit + Tol scores allow calculation of the integral (key) symptoms of internet addiction (IA-Sym), and IH + TM scores yield the internet addiction-associated problem indicator value (IA-Rp). The sum total of points scored on all CIAS subscales reflects the examinee's current status, which can be one of the following: 27 to 42 points — no internet addiction; 43 to 64 points — propensity to internet addiction/preaddictive stage; 65 points and above — diagnosed internet addiction.

Seeking to determine the specifics of the risk of internet addiction in group 1 (no internet addiction) and group 2 (prone to internet addiction), we analyzed the participants' mental and social health, and quality of life. The study did not include a control group of students suffering from internet addiction because they were too few.

To assess the participating students' mental health, we used the Buss-Durkee Hostility Inventory (1957) as standardized by A.A. Hwan, Yu.A. Zaitsev, Yu.A. Kuznetsova (2005).

To measure their anxiety, negative emotional experiences and cognitive activity in everyday and academic lives, we used the Spielberger State-Trait Anxiety Inventory as modified by A.D. Andreeva (1988). Their stress was gauged with the help of PSM-25 (Psychological Stress Measure scale). The participants' social health was explored with the help of E.V. Tsikalyuk questionnaire [12], which includes 25 questions in five blocks: block A — social adaptation, block B — relationships with others, block C — social activity, block D — attitudes to social norms, block E — value orientations; the scores are used to calculate the social health coefficient (Csh) by the following formula:

$$C_{sh} = (2 \cdot A + B - D - 2 \cdot E) / 25.$$

Furthermore, a score from 1.5 to 2 points means a high level of social health and a prosocial type of functioning; from 0.5 to 1.4 points corresponds to an average level of social health and a conformal type of functioning; from -0.4 to 0.4 points translates into a low level of social health and inert social functioning; from -1.4 to -0.5 points signals of poor social health, asociality; and score from -2 to -1.5 points alarms of social illness, antisociality. As for the quality of life, we evaluated it using the MOS-SF-36 questionnaire by J.E. Ware (1992), as modified by V.R. Kuchma, E.I. Shubochkina, E.G. Blinova et al. (2016). The resulting points could fall into one of three tiers: 100 to 70 points meant that the participant found the quality of life good, 70 to 50 — satisfactory, below 50 points — unsatisfactory.

For statistical data analysis employing parametric methods of medical statistics, we used StatTech v. 3.1.8 (StatTech; Russia). Kolmogorov-Smirnov test enabled verification of normalcy of distribution; the resulting data distributed normally, and were presented as arithmetic means (M) and arithmetic mean errors (*m*). Calculating the Student's *t*-test for independent samples, we compared selected means, and subsequently established the level of statistical significance (*p*). The differences were considered significant at $p \leq 0.05$. To uncover the relationship between the studied psychophysiological indicators and internet addiction criteria, we applied the Pearson's chi-squared test (*p*) and established the determination coefficient (*R*).

RESULTS

We found only 1.5% of the participating students to have internet addiction, with 44.5% of the sample prone thereto (group 2) and 54.0% showing no signs thereof (group 1). Group 2 had 1.5-fold greater CIAS scores than group 1 (51.4 ± 1.16 vs. 34.7 ± 0.83 points, $p \leq 0.05$). As for the internet addiction symptoms, the scores in group 2 were 1.6 times higher than in group 1 (30.7 ± 0.69 vs. 19.5 ± 0.61 points, $p \leq 0.05$), and the former also scored 1.4 more points for problems related to internet addiction than the latter (20.7 ± 0.70 vs. 15.2 ± 0.43 points, $p \leq 0.05$). Considering other indicators, in comparison to group 1, group 2 had the compulsive symptoms score 1.7 times higher, that describing withdrawal symptoms and tolerance — 1.5 times higher, and gained 1.3 times and 1.4 times more points for intrapersonal/health-related issues and time management problems, respectively (Fig. 1).

Likely, maladaptive use of internet triggered aggressive behavior in group 1 (78.7% of participants), while students from group 1, on the contrary, suppressed aggressive and hostile reactions (41.9%) (Fig. 2).

Therefore, compared to group 1, group 2 exhibited 1.5-fold higher level of irritability, 1.4-fold higher level of resentment,

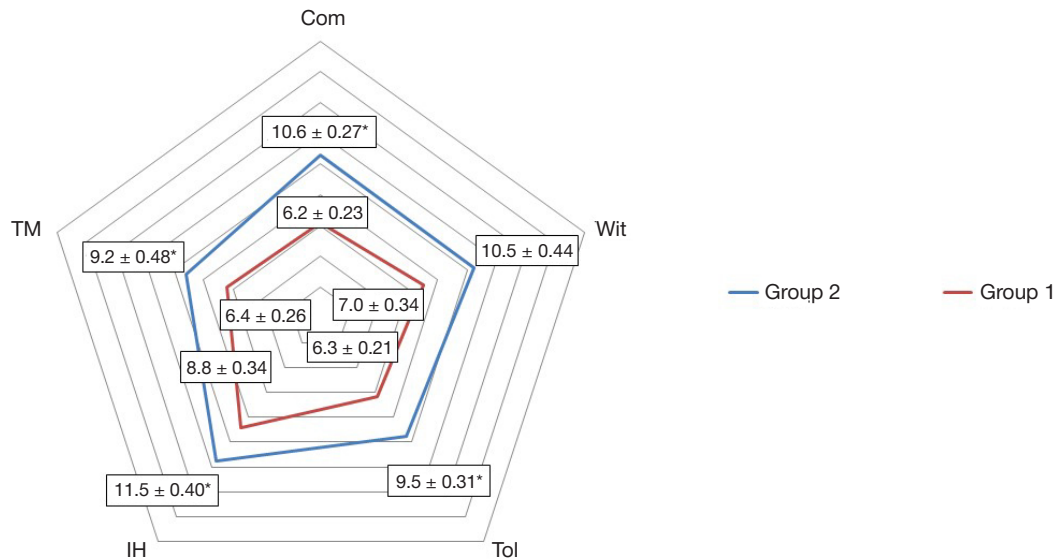


Fig. 1. Com — compulsive symptoms subscale; Wit — withdrawal symptoms subscale; Tol — tolerance symptoms subscale; IH — intrapersonal/health-related problems subscale; TM — time management subscale

1.3-fold higher level of guilt and hostility, 1.2-fold higher level of verbal aggression (Table 1).

Compared to group 1, group 2 had more students exhibiting high level of physical aggression (2.7 times more), high level of irritability (2.0 times more), high level of resentment (1.7 more), high level of guilt and indirect aggression (1.4 times more), and high level of verbal aggression (1.3 times more).

Moreover, compared to group 1, in group 2, we registered 15.1% higher level of anxiety in everyday life, 13.0% higher level of studies-related anxiety, 13.7% higher level of negative emotional experiences in everyday life, 13.3% higher level of studies-related negative emotional experiences (Table 2).

In group 2, 22.6% of students had a high level of everyday life anxiety and 48.1% — studies-related anxiety. In group 1, these figures were 6.7% (high level of everyday life anxiety) and 26.7% (high level of studies-related anxiety), respectively. As for everyday life negative emotional experiences, the shares of those that exhibited high level thereof were 37.0% in group 2 and 20.0% in group 1; studies-related negative experiences were reported to be high by 18.5% of group 2 participants and no one in group 1. These figures may explain why, compared to group 1, group 2 had 1.8 times less students exhibiting everyday life high cognitive activity, and 1.2 times less students highly active in their studies.

Considering aggression, anxiety and negative emotional experiences, group 2 scored 1.3 times more stress points than

group 1 (79.7 ± 6.32 vs. 62.5 ± 4.84 points, $p \leq 0.05$). From the viewpoint of the level of stress, 60.4% of group 2 students and 79.3% of group 1 students had low level thereof, 22.2% of group 2 students and 20.7% of group 1 students — moderate level, and as for high level of stress, it was established in 17.4% of group 2 students and no one in group 1.

One of the typical negative consequences of internet addiction is social isolation, deteriorating social functioning [4–7]. The scores reflecting social health did not differ significantly between the two groups: 0.8 ± 0.09 in group 2 and 1.0 ± 0.05 in group 1 ($p \geq 0.05$). This makes the overall social health of the sample average, with social functioning conformal, characterized by latent rejection of the social environment; it is also likely that the students' behavior tends to change under pressure exerted by their social group. However, despite most participants being average in terms of social health (77.8% of group 2 and 89.5% of group 1), only 5.6% and 10.5% of students of groups 2 and 1, respectively, had social functioning at a high level, i.e., capable of adapting easily in social environments, while 16.7% of group 2 students registered poor social health, indicating the risk of social maladjustment and social passivity of students.

The resulting objective data that describe the state of mental and social health of students are reflected in their subjective assessments of own health and quality of life in general. It was found that the quality of life indicators recorded in group 2 were

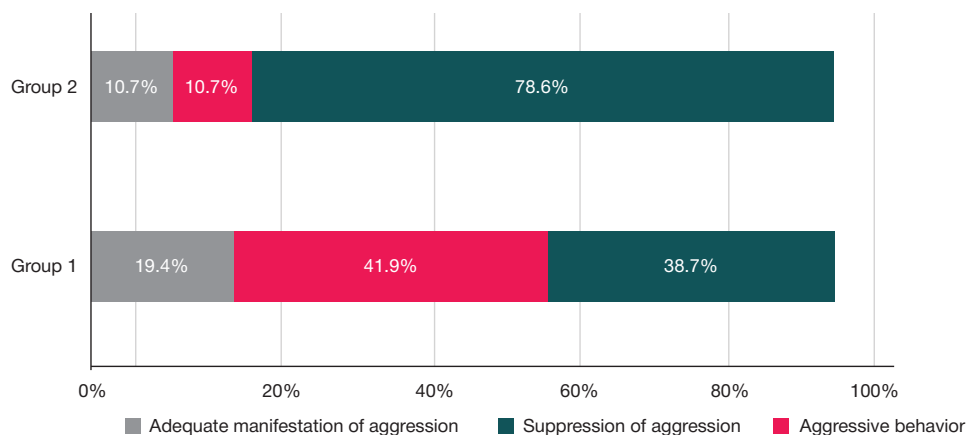


Fig. 2. Distribution of students by manifestation of aggression (%)

Table 1. Indicators of aggressive and hostile reactions, groups 1 and 2

| Indicators | Group | M ± m (points) | Degree of severity of aggressive and hostile reactions (%) | | |
|-----------------------------|-----------------|----------------|--|----------|------|
| | | | Low | Moderate | High |
| Physical aggression | 1 st | 3.7 ± 0.42 | 58.1 | 19.3 | 22.6 |
| | 2 nd | 3.8 ± 0.47 | 4.3 | 35.7 | 60 |
| Indirect aggression | 1 st | 3.3 ± 0.37 | 22.6 | 54.8 | 22.6 |
| | 2 nd | 3.7 ± 0.33 | 7.2 | 60.7 | 32.1 |
| Irritation | 1 st | 3.8 ± 0.48 | 19.3 | 35.5 | 45.2 |
| | 2 nd | 5.8 ± 0.37* | – | 10.7 | 89.3 |
| Negativism | 1 st | 2.0 ± 0.26 | 48.4 | 16.1 | 35.5 |
| | 2 nd | 2.0 ± 0.25 | 46.4 | 10.7 | 42.9 |
| Resentment | 1 st | 2.5 ± 0.38 | 41.9 | 38.7 | 19.4 |
| | 2 nd | 3.5 ± 0.37* | 14.3 | 53.6 | 32.1 |
| Suspicion | 1 st | 3.2 ± 0.30 | 16.2 | 41.9 | 41.9 |
| | 2 nd | 3.9 ± 0.37 | 3.6 | 50 | 46.4 |
| Verbal aggression | 1 st | 4.9 ± 0.37 | 9.7 | 41.9 | 48.4 |
| | 2 nd | 5.9 ± 0.42* | 7.2 | 32.1 | 60.7 |
| Guilt (autoaggression) | 1 st | 4.4 ± 0.31 | 16.2 | 29 | 54.8 |
| | 2 nd | 5.7 ± 0.33* | 7.1 | 17.9 | 75 |
| Hostility index | 1 st | 5.6 ± 0.60 | 6.5 | 22.6 | 71 |
| | 2 nd | 7.4 ± 0.65* | – | 10.7 | 89.3 |
| Aggressiveness index | 1 st | 11.9 ± 0.81 | – | 6.5 | 93.5 |
| | 2 nd | 13.4 ± 0.93 | – | 7.1 | 92.9 |
| Aggressive motivation level | 1 st | 12.4 ± 1.02 | | | |
| | 2 nd | 15.4 ± 1.00* | | | |

Note: * — $p \leq 0.05$ in comparison of the data describing both groups.

significantly inferior to those registered in group 1: on the pain intensity scale — by 13.0%, vitality scale — by 16.2%, social functioning scale — by 16.3%, role-based emotional functioning scale — by 33.0%, mental health scale — by 15.0%, integral psychological health scale — by 19.7% (Table 3).

A noteworthy fact is the two-fold difference in the number of students in groups 1 and 2 that considered their psychological health as unsatisfactory: 37.5% and 78.6%, respectively.

Analysis of the data given in Table 4 reveals a significant moderate correlation between compulsivity and irritability

score ($r = 0.68 \pm 0.097$) and scores reflecting resentment ($r = 0.67 \pm 0.097$), guilt ($r = 0.63 \pm 0.102$), verbal aggression ($r = 0.67 \pm 0.098$). Withdrawal symptoms scores correlated with those describing stress ($r = 0.52 \pm 0.112$), vitality ($r = -0.61 \pm 0.104$), role-playing emotional functioning ($r = -0.61 \pm 0.104$), mental health ($r = -0.60 \pm 0.105$), psychological component of health ($r = -0.66 \pm 0.098$). We identified a moderate correlation between the tolerance irritability scores ($r = 0.66 \pm 0.099$), guilt ($r = 0.60 \pm 0.105$), resentment ($r = 0.70 \pm 0.094$), hostility ($r = 0.68 \pm 0.096$), anxiety ($r = 0.57 \pm 0.116$) and negative

Table 2. Personal qualities indicators, groups 1 and 2

| Indicators | Group | M ± m (points) | Degree of severity (%) | | |
|--------------------------------|-----------------|----------------|------------------------|----------|------|
| | | | Low | Moderate | High |
| Everyday life | | | | | |
| Anxiety | 1 st | 18.5 ± 0.88 | 53.3 | 40 | 6.7 |
| | 2 nd | 21.8 ± 0.80* | 14.8 | 63 | 22.2 |
| Studies-related | 1 st | 31.2 ± 0.85 | 6.7 | 40 | 53.3 |
| | 2 nd | 29.7 ± 0.76 | 3.7 | 66.7 | 29.6 |
| Negative emotional experiences | 1 st | 20.1 ± 1.08 | 43.3 | 36.7 | 20 |
| | 2 nd | 23.3 ± 0.90* | 7.4 | 55.6 | 37 |
| Studies-related | | | | | |
| Anxiety | 1 st | 20.0 ± 1.09 | 30 | 43.3 | 26.7 |
| | 2 nd | 23.0 ± 0.68* | 18.6 | 33.3 | 48.1 |
| Studies-related | 1 st | 29.4 ± 0.98 | 3.4 | 53.3 | 43.3 |
| | 2 nd | 29.2 ± 0.78 | 3.7 | 59.3 | 37 |
| Negative emotional experiences | 1 st | 11.7 ± 0.44 | 63.3 | 36.7 | – |
| | 2 nd | 13.5 ± 0.73* | 40.7 | 40.7 | 18.6 |

Note: * — $p \leq 0.05$ in comparison of the data describing both groups.

Table 3. Quality of life indicators, groups 1 and 2

| Scales | Group | M ± m (points) | Satisfaction with quality of life (%) | | |
|-----------------------------------|-----------------|----------------|---------------------------------------|--------------|----------------|
| | | | Good | Satisfactory | Unsatisfactory |
| Physical functioning | 1 st | 93.1 ± 1.55 | 100 | – | – |
| | 2 nd | 94.6 ± 0.39 | 100 | – | – |
| Role-based physical functioning | 1 st | 78.1 ± 3.51 | 75 | 25 | – |
| | 2 nd | 69.6 ± 5.80 | 64.3 | 21.4 | 14.3 |
| Pain scale | 1 st | 91.3 ± 2.11 | 100 | – | – |
| | 2 nd | 79.4 ± 4.65* | 71.4 | 14.3 | 14.3 |
| General health status | 1 st | 63.0 ± 3.50 | 37.5 | 37.5 | 25 |
| | 2 nd | 64.2 ± 2.57 | 35.7 | 42.9 | 21.4 |
| Vitality scale | 1 st | 66.9 ± 3.14 | 50 | 37.5 | 12.5 |
| | 2 nd | 56.1 ± 2.68* | 14.3 | 57.1 | 28.6 |
| Social functioning scale | 1 st | 84.4 ± 2.92 | 87.5 | 12.5 | – |
| | 2 nd | 70.7 ± 3.15* | 57.1 | 28.6 | 14.3 |
| Role-based emotional functioning | 1 st | 70.9 ± 6.30 | 50 | 25 | 25 |
| | 2 nd | 47.5 ± 6.64* | 28.6 | 14.3 | 57.1 |
| Mental health | 1 st | 63.5 ± 3.08 | 25 | 50 | 25 |
| | 2 nd | 54.0 ± 2.85* | 14.3 | 42.9 | 42.9 |
| Physical component of health | 1 st | 54.6 ± 0.93 | – | 75 | 25 |
| | 2 nd | 52.8 ± 1.12 | – | 85.7 | 14.3 |
| Psychological component of health | 1 st | 48.7 ± 1.80 | – | 62.5 | 37.5 |
| | 2 nd | 39.1 ± 1.86* | – | 21.4 | 78.6 |

Note: * — $p \leq 0.05$ in comparison of the data describing both groups.

emotional experiences ($r = 0.62 \pm 0.103$), stress ($r = 0.62 \pm 0.103$), social health ($r = -0.61 \pm 0.104$), vitality ($r = -0.64 \pm 0.101$) and psychological component of health ($r = -0.62 \pm 0.103$). The scores reflecting intrapersonal problems correlated with everyday life ($r = 0.62 \pm 0.103$) and studies-related anxiety ($r = 0.67 \pm 0.103$), stress ($r = 0.63 \pm 0.102$), social health ($r = -0.65 \pm 0.101$), social functioning ($r = -0.67 \pm 0.098$), role-based emotional functioning ($r = -0.65 \pm 0.100$), mental health ($r = -0.66 \pm 0.099$) and psychological component of health ($r = -0.60 \pm 0.105$). Time management values correlated with social health ($r = -0.65 \pm 0.101$), vitality ($r = -0.68 \pm 0.096$), social functioning ($r = -0.67 \pm 0.098$), role-based emotional functioning ($r = -0.67 \pm 0.097$), mental health ($r = -0.67 \pm 0.097$) and psychological component of health ($r = -0.73 \pm 0.090$).

DISCUSSION

Multiple studies indicate that internet addiction has many negative consequences [6–10, 13–24]. The key health risks associated with maladaptive use of internet are eye strain (computer visual syndrome) and stress of the musculoskeletal system (pain in the neck, back, hands), involuntary rejection of the most important healthy lifestyle components (proper diet, physical activity, outdoor walks, sleep, leisure activities) [6–10, 13–21]. In addition, escape from the real life complicates interpersonal relationships, entails loss of friends, problems in family functions, and leads to social maladaptation of students [6–10]. The desire to spend more and more time online, neglecting educational activities, and an obsessive wish to use internet become the main reasons behind loss of interest in everyday life and studies, as well as poor academic performance [6–10]. Ultimately, excessive use of internet translates into mental health problems such as stress, anxiety, depression, and social dysfunction [22–24].

This study found that aptitude to internet addiction in group 2 was characterized by the development of compulsive

symptoms, which were 1.7 times more intense than in group 1; withdrawal symptoms and tolerance, which were 1.5 times stronger; intrapersonal issues and health-related problems, which were by 1.3 more severe; and time management problems, which were 1.4 times more complicated. Against the background of development of symptoms of internet addiction, more than half of the students of group 2 registered a high level of irritation (89.3%), verbal aggression (60.7%), feeling of guilt (75.0%); 22.0 to 48.1% of the participants had a high level of anxiety, 18.6% to 37.0% — experienced negative emotional experiences. High level of stress was registered in 17.4% of the students, 16.7% of them suffered social health deterioration, and for 78.6%, psychological component of the quality of life was declining.

Currently, there are only rudimentary internet addiction prevention efforts realized in Russia, especially concerning hygienic training and education. Young people are not aware of the basics of internet addiction prevention, and parents and teachers do not focus on the development of safe internet use skills in young people. In addition, the data from research activities and statistics have not been aggregated, i.e., it is impossible to assess the extent of internet addiction and the level of its severity among young people, which would allow identification of prevention priorities. The primary factor complicating the assessment of prevalence of internet addiction is lack of a unified classification of its types and degrees. As a result, the data collected in studies are very contradictory. For example, study [25] concludes that 2.3% of medical students show signs of internet addiction, and 13.9% of the sample had more serious respective problems. Another study [26] stated that 8.2% of the participating medical students had a pronounced and stable form of internet addiction. A study that involved medical students from Minsk has shown 62.5% of them to have internet addiction of low degree, 30.4% of average degree, and 4.4% of high degree [27]. In Moscow,

Table 4. Correlation of internet addiction criteria and psychophysiological indicators (units)

| Psychophysiological indicators | Internet addiction indicators | | | | | | | | |
|-----------------------------------|-------------------------------|-----------------|------------------|------------------|-----------------|------------------|-----------------|--------------------|-----------------|
| | Com | Wit | Tol | IH | TM | IA-Sym | IA-Rp | Overall score CIAS | |
| Physical aggression | 0.09 ± 0.131 | 0.10 ± 0.131 | 0.03 ± 0.131 | -0.06 ± 0.131 | 0.16 ± 0.130 | 0.09 ± 0.131 | 0.06 ± 0.131 | 0.08 ± 0.131 | |
| Indirect aggression | 0.12 ± 0.130 | 0.25 ± 0.127 | 0.13 ± 0.130 | -0.04 ± 0.131 | 0.12 ± 0.130 | 0.19 ± 0.129 | 0.05 ± 0.131 | 0.15 ± 0.130 | |
| Irritation | 0.68 ± 0.097* | 0.32 ± 0.240** | 0.66 ± 0.099* | 0.19 ± 0.129 | 0.31 ± 0.125*** | 0.68 ± 0.096* | 0.29 ± 0.126*** | 0.68 ± 0.097* | |
| Negativism | 0.03 ± 0.131 | 0.07 ± 0.131 | -0.13 ± 0.131 | -0.04 ± 0.131 | 0.01 ± 0.131 | 0.01 ± 0.131 | 0.01 ± 0.131 | 0.01 ± 0.131 | |
| Resentment | 0.67 ± 0.097* | 0.09 ± 0.131 | 0.70 ± 0.094* | 0.22 ± 0.128 | 0.27 ± 0.127*** | 0.67 ± 0.097* | 0.29 ± 0.126*** | 0.60 ± 0.105* | |
| Suspicion | 0.12 ± 0.130 | 0.04 ± 0.131 | 0.28 ± 0.126*** | 0.23 ± 0.128 | 0.32 ± 0.125*** | 0.12 ± 0.130 | 0.32 ± 0.124*** | 0.22 ± 0.128 | |
| Verbal aggression | 0.67 ± 0.098* | 0.13 ± 0.130 | 0.14 ± 0.130 | -0.03 ± 0.131 | 0.11 ± 0.131 | 0.20 ± 0.129 | 0.05 ± 0.131 | 0.16 ± 0.130 | |
| Feeling of guilt | 0.63 ± 0.102* | 0.28 ± 0.126*** | 0.60 ± 0.105* | 0.37 ± 0.122** | 0.32 ± 0.125** | 0.65 ± 0.100* | 0.60 ± 0.105* | 0.67 ± 0.098* | |
| Aggressiveness index | 0.22 ± 0.128 | 0.21 ± 0.128 | 0.13 ± 0.130 | -0.04 ± 0.131 | 0.18 ± 0.129 | 0.21 ± 0.128 | 0.07 ± 0.131 | 0.17 ± 0.129 | |
| Hostility index | 0.22 ± 0.128 | 0.03 ± 0.131 | 0.68 ± 0.096* | 0.25 ± 0.127*** | 0.32 ± 0.124** | 0.63 ± 0.102* | 0.34 ± 0.123** | 0.69 ± 0.095* | |
| Aggressive motivation level | 0.30 ± 0.125*** | 0.24 ± 0.128 | 0.23 ± 0.128 | 0.05 ± 0.131 | 0.25 ± 0.127*** | 0.29 ± 0.126*** | 0.18 ± 0.129 | 0.26 ± 0.127*** | |
| Anxiety | I | 0.28 ± 0.126*** | 0.18 ± 0.129 | 0.57 ± 0.116* | 0.62 ± 0.103* | 0.24 ± 0.128 | 0.61 ± 0.104* | 0.63 ± 0.102* | 0.64 ± 0.101* |
| | II | 0.15 ± 0.130 | 0.19 ± 0.129 | 0.18 ± 0.129 | 0.67 ± 0.103* | 0.12 ± 0.130 | 0.20 ± 0.129 | 0.23 ± 0.128 | 0.23 ± 0.128 |
| Studies-related | I | -0.15 ± 0.130 | -0.23 ± 0.128 | -0.16 ± 0.130 | -0.20 ± 0.129 | -0.19 ± 0.129 | -0.21 ± 0.128 | -0.23 ± 0.128 | -0.24 ± 0.128 |
| | II | -0.04 ± 0.131 | -0.04 ± 0.131 | -0.05 ± 0.131 | -0.01 ± 0.131 | -0.02 ± 0.131 | -0.02 ± 0.131 | -0.05 ± 0.131 | -0.01 ± 0.131 |
| Negative emotional experiences | I | 0.20 ± 0.129 | 0.16 ± 0.130 | 0.62 ± 0.103* | 0.07 ± 0.131 | 0.11 ± 0.131 | 0.22 ± 0.128 | -0.11 ± 0.131 | 0.19 ± 0.131 |
| | II | 0.19 ± 0.129 | 0.25 ± 0.127*** | 0.27 ± 0.126*** | 0.20 ± 0.129 | 0.18 ± 0.129 | 0.27 ± 0.126*** | 0.22 ± 0.128 | 0.27 ± 0.126*** |
| Stress | 0.33 ± 0.124** | 0.52 ± 0.112* | 0.62 ± 0.103* | 0.63 ± 0.102* | 0.30 ± 0.125*** | 0.64 ± 0.101* | 0.63 ± 0.102* | 0.67 ± 0.098* | |
| Social health | -0.21 ± 0.128 | -0.15 ± 0.130 | -0.61 ± 0.104* | -0.65 ± 0.101* | -0.65 ± 0.101* | -0.30 ± 0.126*** | -0.65 ± 0.100* | -0.64 ± 0.101* | |
| Physical functioning | 0.09 ± 0.130 | -0.07 ± 0.130 | 0.09 ± 0.130 | -0.20 ± 0.130 | -0.08 ± 0.130 | -0.09 ± 0.130 | -0.16 ± 0.130 | -0.01 ± 0.130 | |
| Role-based physical functioning | 0.06 ± 0.130 | -0.11 ± 0.131 | -0.14 ± 0.130 | -0.24 ± 0.130 | -0.24 ± 0.131 | -0.11 ± 0.130 | -0.26 ± 0.131 | -0.24 ± 0.130 | |
| Pain scale | 0.15 ± 0.129 | 0.13 ± 0.130 | 0.11 ± 0.130 | 0.22 ± 0.130 | 0.09 ± 0.131 | 0.15 ± 0.132 | 0.17 ± 0.130 | 0.18 ± 0.130 | |
| General health status | -0.07 ± 0.12 | -0.13 ± 0.13 | -0.10 ± 0.12 | -0.18 ± 0.13 | -0.18 ± 0.13 | -0.11 ± 0.11 | -0.20 ± 0.13 | -0.15 ± 0.11 | |
| Vitality scale | -0.51 ± 0.113* | -0.61 ± 0.104* | -0.64 ± 0.101* | -0.34 ± 0.124** | -0.68 ± 0.096* | -0.62 ± 0.103* | -0.69 ± 0.096* | -0.64 ± 0.101* | |
| Social functioning scale | 0.24 ± 0.127*** | -0.32 ± 0.125** | -0.35 ± 0.123* | -0.67 ± 0.098* | -0.67 ± 0.098* | -0.34 ± 0.124** | -0.65 ± 0.100* | -0.70 ± 0.094* | |
| Role-based emotional functioning | 0.22 ± 0.128 | -0.61 ± 0.104* | -0.35 ± 0.123*** | -0.65 ± 0.100* | -0.67 ± 0.097* | -0.60 ± 0.105* | -0.65 ± 0.100* | -0.68 ± 0.097* | |
| Mental health | -0.21 ± 0.128 | -0.60 ± 0.105* | -0.31 ± 0.125* | -0.66 ± 0.099* | -0.67 ± 0.097* | -0.58 ± 0.107* | -0.69 ± 0.095* | -0.64 ± 0.101* | |
| Physical component of health | 0.11 ± 0.130 | -0.11 ± 0.130 | -0.13 ± 0.130 | -0.25 ± 0.127*** | -0.17 ± 0.129 | -0.13 ± 0.130 | -0.24 ± 0.128 | -0.18 ± 0.129 | |
| Psychological component of health | -0.29 ± 0.126*** | -0.66 ± 0.098* | -0.62 ± 0.103* | -0.60 ± 0.105* | -0.73 ± 0.090* | -0.67 ± 0.098* | -0.65 ± 0.100* | -0.63 ± 0.102* | |

Note: * — $p \leq 0.001$ (high level of statistical significance); ** — $p \leq 0.01$ (average level of statistical significance); *** — $p \leq 0.05$ (low level of statistical significance); Com — compulsive symptoms subscale; Wit — withdrawal symptoms subscale; Tol — tolerance symptoms subscale; IH — intrapersonal issues and health-related problems subscale; TM — time management subscale; IA-Sym — key symptoms of internet addiction; IA-Rp — problems related to internet addiction; I — in everyday life; II — studies-related.

internet addiction was detected in 9.2% of the participating medical students, and 28.65% used internet excessively. In the Udmurt Republic, internet addiction was diagnosed in 1.7% of the invited higher education students, signs thereof (average level internet addiction) in 25.7% of students, and 73.7% of those that took part in this study were announced to have no addiction [27]. Different internet addiction prevalence figures indicate that registration and evaluation of this condition, and the respective criteria, are still a problem, which points to the need to systematize the said criteria and use a unified scientifically based methodology when diagnosing internet addiction.

CONCLUSIONS

Our results indicate that aptitude for internet addiction is associated with negative changes in mental and social health and quality of life of students. They suggest the need for internet addiction screenings among higher education students and vocational school students, such screenings allowing to identify both at-risk students and internet-addicted students, and ensure timely preventive measures aimed at correcting psychological and social factors influencing development of addictive behaviors.

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RANKING OF TERRITORIES IN THE VORONEZH REGION BY THE INCIDENCE RATES RESULTING FROM CHEMICAL LOAD

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Numerous studies conducted by domestic and foreign researchers report the influence of environmental pollution on shaping morbidity of a population. The study was aimed to rank the territories of the Voronezh Region by the incidence rates probably resulting from chemical pollution of atmospheric air, drinking water, soils in residential areas recorded in 2018–2022. The districts were divided into three groups based on the long-time annual average incidence rates. The degree of correlation between the disease entities and the chemical environmental factors was determined through correlation analysis. The findings have shown that the city of Voronezh and Pavlovsky District are the territories at risk of the disorders with the etiology that is likely to be associated with chemical air pollution. The territories at risk of the disorders that are likely to be associated with chemical pollution of drinking water include Kashirsky, Kantemirovsky, Olkhovatsky, Ternovskiy, Khokholskiy districts, while the territories at risk of the disorders that are likely to be associated with chemical pollution of soils in residential areas include the city of Voronezh, Borisoglebskiy city district, Liskinskiy and Rossoshanskiy districts. The situation observed in the above administrative territories requires in-depth study of the degree of the impact of chemical factors on public health and identification of the sources of these factors. The findings can be used to develop the guidelines on minimization of the adverse effects of chemical environmental factors on public health in the region.

Keywords: hygiene, chemical load, public health, ranking of territories

Author contribution: Mehantyevev II — study concept and design, data acquisition; Enin AV — analysis and interpretation of the results, literature review, manuscript draft preparation. Both authors reviewed the results and approved the final version of the manuscript.

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РАНЖИРОВАНИЕ ТЕРРИТОРИИ ВОРОНЕЖСКОЙ ОБЛАСТИ ПО ЗАБОЛЕВАЕМОСТИ НАСЕЛЕНИЯ, ОБУСЛОВЛЕННОЙ ХИМИЧЕСКОЙ НАГРУЗКОЙ

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В многочисленных исследованиях отечественных и зарубежных ученых отмечено влияние загрязнения окружающей среды на формирование заболеваемости населения. Целью работы было ранжировать территории Воронежской области по показателям уровня заболеваемости, вероятно обусловленной влиянием химического загрязнения атмосферного воздуха, питьевой воды, почвы селитебных территорий, за 2018–2022 гг. Районы разделили на три группы по среднепогодному уровню заболеваемости. Степень взаимосвязи нозологических форм с химическими факторами окружающей среды установили с помощью корреляционного анализа. По результатам проведенного исследования установлено, что в Воронежской области «территориями риска» по заболеваниям, этиологически вероятно связанным с химическим загрязнением атмосферного воздуха, являются г. Воронеж и Павловский район. К «территориям риска» по нозологиям, вероятно обусловленным химическим загрязнением питьевой воды, отнесены Каширский, Кантемировский, Ольховатский, Терновский, Хохольский районы, а к «территориям риска» по заболеваемости, вероятно обусловленной химическим загрязнением почвы селитебных территорий, — г. Воронеж, Борисоглебский городской округ, Лискинский и Россосанский районы. Ситуация на указанных административных территориях требует углубленного изучения степени влияния химических факторов на здоровье населения и выявления их источников. Результаты исследования могут быть использованы для разработки рекомендаций по минимизации вредного влияния химических факторов окружающей среды на состояние здоровья населения региона.

Ключевые слова: гигиена, химическая нагрузка, здоровье населения, ранжирование территорий

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Health preservation and improvement provide the basis for the development of the state [1]. In numerous studies, domestic and foreign researchers report the influence of environmental pollution on shaping morbidity of a population [2–9]. Thus, the papers by a number of researchers report the development of cardiovascular, endocrine, digestive system, respiratory tract, skin disorders, malformations and cancer resulting from atmospheric air pollution [10–12]. In particular, the situation in the Voronezh Region is discussed, where predominance of the contribution of chemical atmospheric air pollution by motor vehicles over the contribution of industrial enterprises

is observed, as in many other regions [13, 14]. The papers by many researchers report the impact of drinking water contamination with arsenic, manganese and other substances on public health in Dagestan, Far East and other regions of our country [15–18]. Some papers are focused on the Voronezh Region, where natural factors of drinking water pollution prevail (iron, total hardness, manganese, boron, fluorine), but anthropogenic influence, associated mainly with contamination of drinking water with nitrates, is also possible [19, 20]. The paper [21] discusses the issues of direct (oral) intake of hazardous substances from soils of residential areas by children and its impact

Table. Assessment scale for overall incidence among individuals aged 18 and older (number of cases per 1000 population)

| Incidence | 18 years of age and older |
|-----------|---------------------------|
| Low | 1323.59 and below |
| Medium | 1323.59–1559.35 |
| High | 1559.35 and above |

on pediatric morbidity. Thus, the relevance of the issue of the chemical environmental pollution impact on morbidity of a population grows with the development of industry, transport, and agriculture.

The study was aimed to rank the territories of the Voronezh Region by the incidence rates probably resulting from chemical pollution of atmospheric air, drinking water, soils in residential areas.

METHODS

The study involved the data provided by the Center for Hygiene and Epidemiology in the Voronezh Region on the morbidity of a population and the results of laboratory testing of atmospheric air, drinking water, soils in residential areas of the Voronezh Region for the years 2018–2022.

The ranking method represented the procedure involving determination of the long-time annual average incidence per 1000 pediatric (under the age of 14 years) and adult (18 years and older) population; calculation of standard deviations (σ) from median values; dividing the values obtained into three groups (low, medium, high incidence rate). To determine the degree of the association between the disease development and the chemical factors of atmospheric air, drinking water, and soils of residential areas, the paired correlation coefficients were calculated. We assessed statistical significance with the likelihood of statistical error below 5% ($p < 0.05$). Calculations were performed using the MyOffice software package (New Cloud Technologies; Russia).

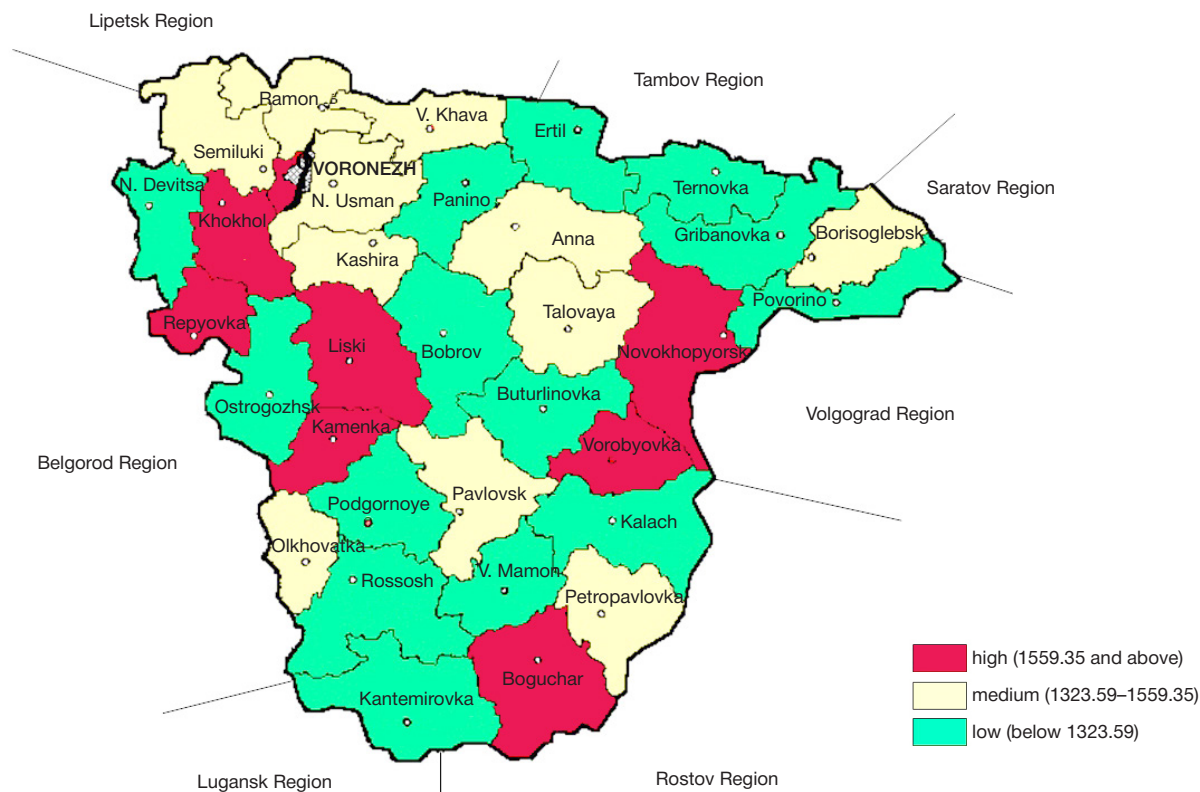
RESULTS

The ones related to environmental factors were selected in the general list of the disease classes and distinct disease entities considered based on the literature data. The list consisted of 13 parameters: overall incidence; diseases of blood and blood-forming organs and certain disorders involving the immune mechanisms; ischaemic heart diseases; asthma, status asthmaticus; pneumonia; diabetes mellitus; diseases of the nervous system; cerebrovascular diseases; allergic rhinitis (pollinosis); contact dermatitis; urolithiasis; congenital malformations, deformations and chromosomal abnormalities; malignant neoplasms.

We plotted assessment scales for the pediatric and adult incidence rates, based on which the territories showing consistently high incidence rate, i.e. territories at risk, were identified. The assessment scale for overall incidence of individuals over the age of 18 is provided in the Table, while ranking of territories by these indicators is presented on the map (Fig. 1).

Thus, high overall incidence among adults was reported in eight studied administrative territories out of 33, specifically in Bogucharsky, Vorobyovsky, Kamensky, Liskinsky, Novokhoporsky, Repyovsky, Khokholsky districts and the city of Voronezh. Overall incidence among children was high in the Borisoglebsky city district, Petropavlovsky, Repyovsky, Semiluksky districts and the city of Voronezh, i.e. in five territories of the region out of 33.

It should be noted that high incidence of several diseases was reported for the majority of studied districts of the Voronezh

**Fig. 1.** Overall incidence among adults (number of cases per 1000 population)

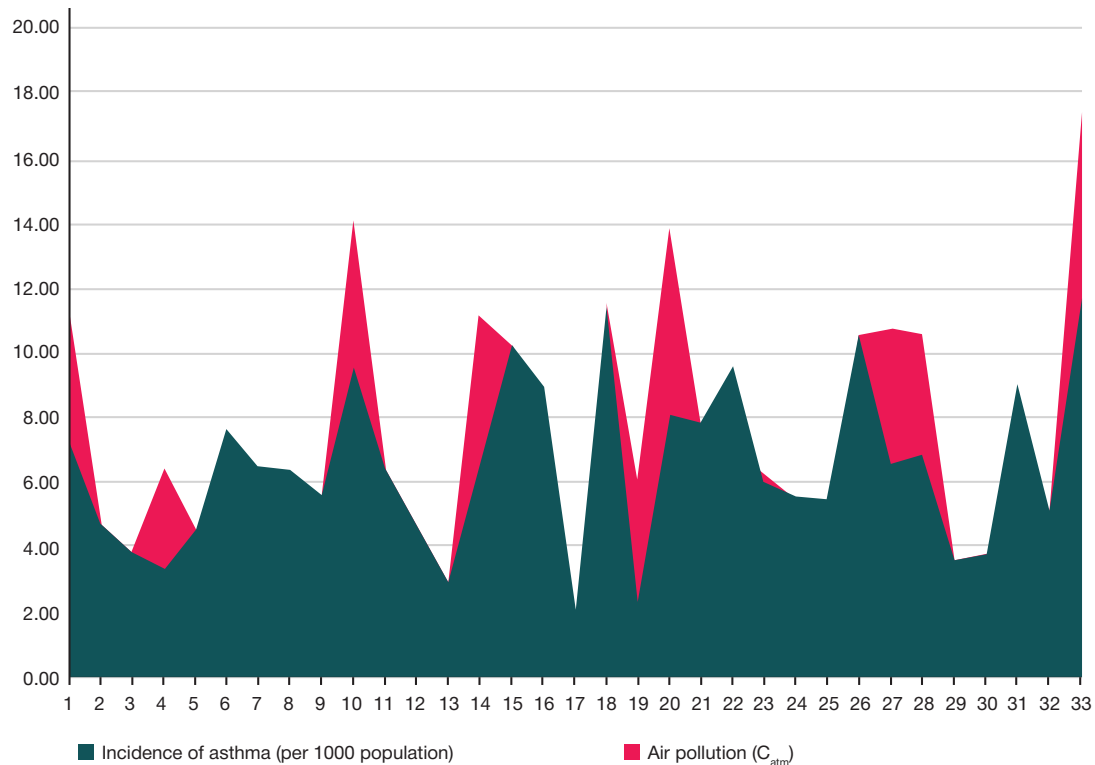


Fig. 2. Correlation between pediatric incidence of asthma and atmospheric air pollution

Region. Thus, high pediatric incidence of six disorders is reported for the city of Voronezh, Semiluksky, and Kalacheyevsky districts, while that of five disorders is reported for Bobrovsky, Petropavlovsky, Rossoshansky, and Ternovsky districts. High incidence of three disorders among adults is registered in the city of Voronezh. High adult incidence of five disease entities is reported for Verkhnemamonsky, Repyovsky, Novokhoporsky, and Ertilsky districts.

Analysis of the correlation with the atmospheric component of chemical load revealed a strong significant correlation of the pediatric (children under the age of 14) incidence of asthma (correlation coefficient $r = 0.76$, $t_{est} = 6.5 > t_{crit} = 1.96$, $p < 0.05$) (Fig. 2) and a moderate significant correlation of the adult incidence of nervous system diseases (correlation coefficient $r = 0.38$, $t_{est} = 2.25 > t_{crit} = 1.96$, $p < 0.05$). Moderate significant correlations of the pediatric and adult incidence of contact dermatitis with the water component of the load are reported ($r = 0.41$, $t_{est} = 2.52 > t_{crit} = 1.96$ and $r = 0.34$, $t_{est} = 2.03 > t_{crit} = 1.96$, respectively, $p < 0.05$). Moderate significant correlations of the component of industrial pollution of soils with the pediatric incidence of cerebrovascular diseases ($r = 0.4$, $t_{est} = 2.48 > t_{crit} = 1.96$, $p < 0.05$) and nervous system diseases ($r = 0.34$, $t_{est} = 2.01 > t_{crit} = 1.96$, $p < 0.05$) are revealed.

Based on the earlier conducted ranking of the territories of the Voronezh Region, the city of Voronezh and Pavlovsky District were considered to be the territories at risk based on the chemical atmospheric air pollution; the city of Voronezh, Bobrovsky, Kantemirovsky, Kashirsky, Olkhovatsky, Ternovsky, Khokholsky districts were the territories at risk based on the drinking water pollution; the city of Voronezh, Borisoglebsky city district, Liskinsky, Podgorensky, Rossoshansky districts were considered to be the territories at risk based on chemical pollution of soils in residential areas.

Our study has shown that the territories at risk based on the atmospheric component of chemical load, specifically the city of Voronezh and Pavlovsky District, are also the territories with high pediatric incidence of asthma and high adult incidence

of nervous system disorders in the studied period. Among territories with high chemical load based on the drinking water components, the territories with high pediatric incidence of contact dermatitis are represented by Kashirsky, Olkhovatsky, and Ternovsky districts, while the territories with high incidence of contact dermatitis among adults are represented by Kantemirovsky, Kashirsky, Khokholsky districts. Among territories with high levels of chemical contamination of soils in residential areas, in the studied period the territories with high pediatric incidence of nervous system disorders included the city of Voronezh, Borisoglebsky city district, and Rossoshansky District, while the territories, for which pediatric incidence of cerebrovascular diseases was reported, included the city of Voronezh, Liskinsky and Rossoshansky districts. Thus, it is likely that the emergence of the above disease entities in the discussed territories is associated with the effects of chemical contamination of atmospheric air, drinking water, and soils in residential areas.

DISCUSSION

The Voronezh Region is a territory showing high levels of industrialization and agricultural development. In the city of Voronezh there are numerous enterprises, among which the largest are JSC II – VASO, JSC Voronezhsintezkauchuk, etc.; there is a highly developed network of roads. In the studied period, excesses of the annual average and maximum single maximum permissible concentrations of hazardous substances in the atmospheric air were identified in the city (2 MPCam for formaldehyde; more than 1 MPCam for ozone; more than 1 MPCam, up to 3 MPCams for phenol; more than 1 MPCam for soot).

In Pavlovsky District, there is one of Europe's largest granite mining and processing enterprises, JSC Pavlovsk Nerud. The federal highway M4-Don passes through the territory of the region. In the studied period, excesses of the annual average and maximum single maximum permissible concentrations of hazardous substances in the atmospheric air were identified

in the district (more than 3 MPCam for formaldehyde; more than 3 MPCtwa, up to MPCms for sulfur dioxide; more than 1 MPCam for phenol). Thus, high morbidity rate resulting from chemical atmospheric air pollution is quite natural for these territories.

The earlier studies of the impact of the drinking water chemical contamination on the morbidity of a population in the region revealed moderate significant correlations between the adult incidence of urolithiasis and the total hardness of water (correlation coefficient $r = 0.42$); between the adult incidence of the diseases of the skin and subcutaneous tissue and the levels of iron in drinking water (correlation coefficient $r = 0.35$); the issue of the nitrate pollution of water sources in rural areas (both centralized and decentralized) was addressed, several cases of methemoglobinemia in children under one year of age were identified [22]. Our study has not confirmed the relationship between urolithiasis and the impact of drinking water. However, the incidence of skin disorders and the issue of nitrate pollution in certain rural areas are still relevant. Thus, in the Kashirsky District, for which high incidence of contact dermatitis among both children and adults has been reported, excesses of the annual average and maximum single maximum permissible concentrations of nitrates in the drinking water (up to 2 MPCam, more than 4 MPCms) have been simultaneously revealed in the studied period. The condition of soils to the great extent reflects the condition of other media, such as atmospheric air [23]. In the Voronezh Region, excesses of maximum single maximum permissible concentrations of benzo[a]pyrene in the soils

of residential areas were reported for the city of Voronezh (more than 3 MPCms) and Rossoshansky District (1.5 MPCms) in the studied period, the main sources of which could be vehicle emissions and asphalt road pavement. It is noteworthy that 80% of territories of the region with high levels of chemical soil pollution are urban areas. In the only district considered to be the territory at risk based on chemical contamination of soils, where there are no urban areas (Podgorensky District), there is no benzo[a]pyrene among the priority components of chemical soil pollution.

CONCLUSIONS

The analysis of data for the years 2018–2022 has shown that the city of Voronezh and Pavlovsky District are the territories at risk of the disorders with the etiology that is probably associated with chemical air pollution. The territories at risk of the disorders probably associated with chemical contamination of drinking water include Kashirsky, Kantemirovsky, Olkhovatsky, Ternovskiy, Khokholskiy districts. The territories at risk of diseases probably associated with chemical contamination of soils in residential areas include the city of Voronezh, Borisoglebskiy city district, Liskinskiy and Rossoshanskiy districts. The situation observed in these administrative territories requires in-depth study of the degree of the impact of chemical factors on public health and identification of the sources of these factors aimed at making managerial decisions on minimization of the adverse effects of chemical environmental factors on public health in the region.

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PULSE-WIDTH MODULATION AS A NEW HYGIENIC FACTOR DETERMINING THE VISUAL COMFORT OF MODERN SCREENS

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The information revolution and intensive development of electronic devices take place in the recent decades. Furthermore, not so long ago such a hygienic factor, as the display luminance pulse-width modulation (PWM) capable of causing visual discomfort (PWM symptoms) in individuals with increased sensitivity to visual load, has become relevant. The main complaints include eye pain, headache, sometimes nausea, up to the inability to use such screens. Moreover, this characteristic can be peculiar not only to LED (AMOLED, etc.), but also to IPS displays due to the presence of the LED backlight layer. No regulation of the issue has led to the emergence of online resources on PWM and the problem of visual impairment, where users verify the data on their own, which suggests the relevance of the subject selected. The paper reports theoretical aspects of PWM, technical characteristics of displays with PWM; the approaches to PWM measurement are described; the possible ways to reduce visual discomfort are discussed. Furthermore, the paper describes the method to measure PWM of displays using a photo camera with the exposure time set to 1/20 s, along with the method testing results. It has been shown that further research focused on assessing the effects of PWM on vision and the development of the method for hygienic assessment of monitors and smartphone screens with PWM are required.

Keywords: pulse-width modulation, displays, screens, monitors, visual discomfort, visual fatigue, PWM symptoms

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ШИРОТНО-ИМПУЛЬСНАЯ МОДУЛЯЦИЯ КАК НОВЫЙ ГИГИЕНИЧЕСКИЙ ФАКТОР, ОПРЕДЕЛЯЮЩИЙ ЗРИТЕЛЬНЫЙ КОМФОРТ СОВРЕМЕННЫХ ЭКРАНОВ

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В последние десятилетия происходят информационная революция и интенсивное развитие электронных устройств. При этом относительно недавно актуальным стал такой гигиенический фактор, как широтно-импульсная модуляция (ШИИМ) свечения дисплеев, которая может вызывать зрительный дискомфорт (ШИИМ-синдром) у людей с повышенной чувствительностью к зрительным нагрузкам. К основным жалобам можно отнести боль в глазах, головные боли, иногда чувство тошноты, вплоть до невозможности пользования такими экранами. При этом указанная характеристика экрана может быть свойственна не только LED (AMOLED и др.), но и IPS-дисплеям, в связи с наличием слоя светодиодной подсветки. Отсутствие регулирования этого вопроса привело к появлению Интернет-ресурсов, посвященных ШИИМ и проблеме нарушения зрения, где пользователи уточняют информацию самостоятельно, что свидетельствует об актуальности выбранной темы. В настоящей работе рассмотрены теоретические аспекты ШИИМ, технические характеристики дисплеев с ШИИМ, описаны подходы к ее измерению, представлено обсуждение возможных путей снижения зрительного дискомфорта. Помимо этого приведены описание методики измерения ШИИМ дисплеев с помощью фотоаппарата с выдержкой, установленной на 1/20 с, и результаты апробации методики. Показана необходимость дальнейших исследований по оценке влияния ШИИМ на зрение и разработке методики гигиенической оценки ШИИМ-мониторов и экранов смартфонов.

Ключевые слова: широтно-импульсная модуляция, дисплеи, экраны, мониторы, зрительный дискомфорт, зрительное утомление, ШИИМ-синдром

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In the recent years, despite significant advances in the development and design of electronic devices, thanks to which the technical characteristics of even low-end devices have reached a decent quality determining high processing speed and large storage capacity that eventually have almost completely rid users of inconvenience when using computers and smartphones, the screen pulsation or the so-called pulse-width modulation (PWM) has turned out to be an unexpected factor causing severe visual discomfort in individuals showing increased sensitivity to visual load. This issue is extensively studied by both domestic [1–6] and foreign authors [7–11].

There are no data on the prevalence of PWM symptoms among both children and students in the available scientific literature, however, according to the popular science sources, the prevalence of PWM symptoms is 10–20% [12], which requires further investigation.

When describing the technical details, it should be noted that there are two methods to change screen brightness. The first approach is based on changing the screen luminance,

when the light emitted by the source is continuous. The second approach is based on using PWM, when the light emitted by the screen has certain pulsation frequency. This means that there is some backlight flicker frequency (for example, 120 Hz), which, depending on the pulse length, i.e. the time for that the light-emitting diodes (LEDs) are turned on (on-off time ratio), determines the resulting light intensity of screen. The differences between the approaches are illustrated by Fig. 1.

The PWM symptoms can represent eye pain, eye fatigue, spasm of accommodation, headache, and nausea making it impossible to use the screen with PWM. In case of prolonged exposure, failure of the visual system adaptation causing temporary visual impairment can be observed.

It is important to consider that an LCD screen consists of liquid crystals not emitting, but only transmitting light. The liquid crystal layer has its own refresh rate (this parameter is usually specified in the screen technical characteristics). The underlying layer of LED backlight, in contrast, emits its own light, which is what leads to the emergence of PWM. This means that

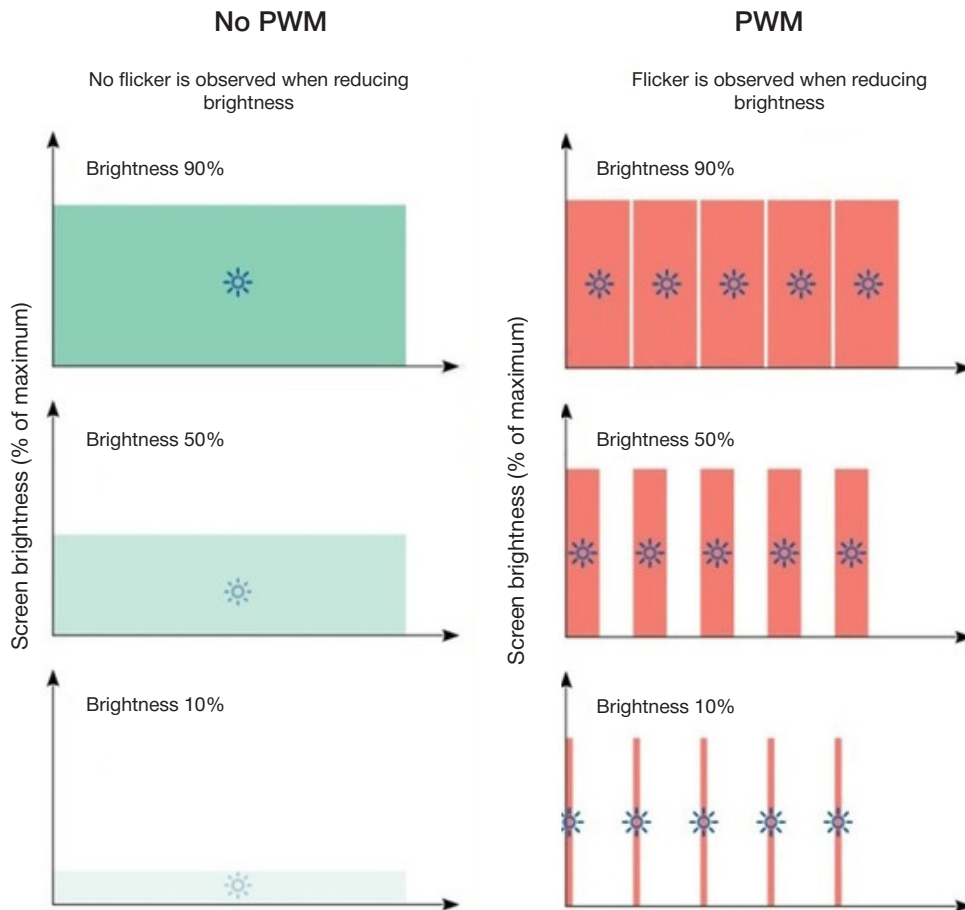


Fig. 1. Comparison of different techniques to change the screen brightness — through changing luminance (on the left) and applying PWM (on the right). The figure is taken from the free source [13].

the cause of PWM in LCD screens is the backlight flicker [14], not the screen refresh rate. Furthermore, manufacturers do not publish this parameter for commercial reasons, thereby creating a certain risk for the susceptible population when buying screens.

We have not found the reason, why the PWM technology is used in modern screens, since, as it was mentioned above, not all parameters are specified in the technical characteristics of screens. There is a number of opinions actively discussed on forums, such as 4PDA [15]: that in the recent years manufacturers have set the goal to create the screen that can be used in bright outdoor light and that such an innovation has significantly increased the screen brightness characteristics. Moreover, high screen brightness is associated with the characteristic noise of electromagnetic origin. Thus, to reduce the voltage resulting in such noise, manufacturers have probably taken the path of reducing the flicker rate, and that causes uncomfortable sensations in some proportion of the population.

The other, more grounded version is the change of the backlight technology from luminescent to LED, which has led to the emergence of PWM [14].

From a physiological point of view, PWM can be compared with the critical flicker fusion frequency (CFFF), when the eye stops recognizing pulsation with increasing frequency, and the estimated threshold value is about 60 Hz. Furthermore, there is a term “transient twinkle perception” (TTP) showing that the human eye is capable of recognizing a more high-frequency flicker under certain conditions [14].

The literature provides the data suggesting that the recommended safe PWM threshold should not drop below 200 Hz. Otherwise, such screens can cause visual discomfort [14].

GOST 33393–2015 “Buildings and structures” [16] provides a standard value of light pulsation in the workplace, which is 300 Hz. Furthermore, on sale there are more expensive screens with the PWM exceeding 2000 Hz that cause no visual discomfort. This probably represents a technical solution to the problem.

The author does not set a goal to substantiate the screen pulsation standards. However, it can be concluded that the screen PWM values of 100–120 Hz are undesirable and can cause visual discomfort in the susceptible part of the population. The paper provides the author’s opinion about the main available methods to assess PWM that is based on the results of testing the PWM measurement method by taking pictures of the screen in dynamics and the literature data.

Methods to determine PWM of the screen

The method developed by enthusiasts and distributed via Internet [17], which can be also found on the web-site of photographer Anatoly Lupashin, is of interest. In accordance with the method, screens of various designs (Huawei MateBook D14, HP Pavilion 14-ec002ur, Xiaomi 11 Light 5G NE, iPhone 11, 23-inch AOC monitors) with the table displayed were used to determine PWM (Fig. 2). The Canon EOS 2000D camera with the exposure time set to 1/20 s was used to perform shooting in motion (horizontal motion along the screen) aimed to obtain blurred vertical lines of the diagnostic table (Fig. 2). Then the image of vertical lines of the diagnostic table was visually assessed. When there was pulsation, the alternating light and darkened bands corresponding to the phases of the light-emitting diode pulsation of the screen could be seen

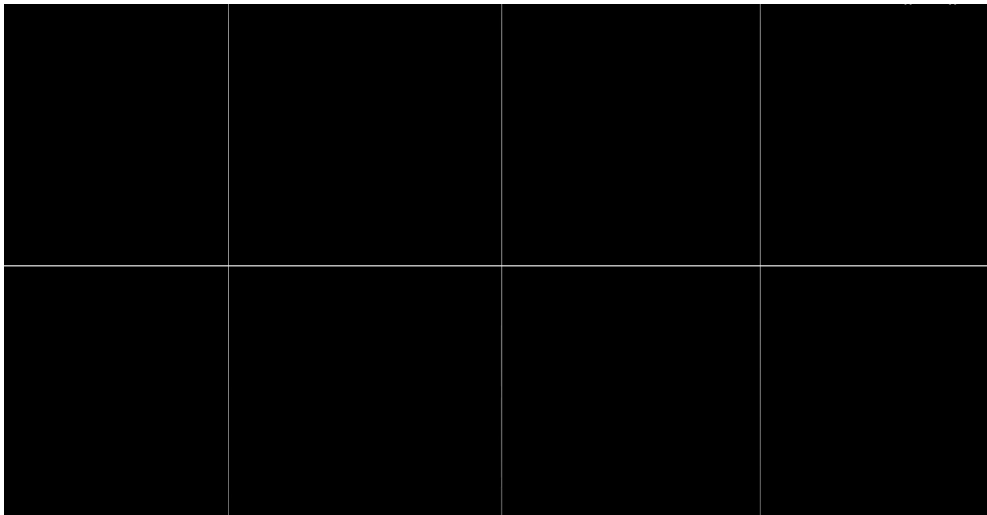


Fig. 2. Example of the table for PWM determination by taking pictures in dynamics

on the vertical lines. To quantify PWM, the number of bands was multiplied by the exposure time (20) to obtain the number of pulses per second (Hz).

Determining PWM of the screen is an important problem. The pulsation coefficient (C_p) is calculated using the following formula:

$$C_p = \frac{E_{max} - E_{min}}{2E_{av}}$$

where E is luminosity (lx). This means that the coefficient considers luminosity values only (maximum, minimum and average) and does not consider the oscillation frequency, therefore, this method involving the use of luminometer-pulsometer is unsuitable for assessment of PWM.

Ideally, PWM should be assessed using an oscilloscope with a photosensor capable of plotting the screen luminosity oscillation curve. Unfortunately, such expensive units are not included in the list of devices for hygienic assessment of video display terminals (VDT). In this regard, in our case it was difficult to access such equipment. Furthermore, it is hard to find equipment of this type (oscilloscopes with photosensors) in the free market. There are papers (for example, the post published

on Yandex Zen [18]) reporting that users have manufactured photosensors for smartphones on their own, however, this requires certain technical competence.

The lack of information about the presence of PWM in the data sheets of devices, as well as the method for hygienic examination of this factors, has led to the emergence of forums and websites focused on “combating PWM” (RTINGS.com), where enthusiasts test screens for PWM by themselves and people, who have faced the problem of PWM, acquire information about the comfort of their desired device for vision, because in this category of users buying the screen with PWM can result in discomfort and inability to use the screen.

There are simple methods to determine PWM, such as the “pencil test” involving “waving” pencil in front of the screen or taking a video of the screen in the slow mode, which reveals the characteristic bands on the screen. However, these methods do not allow PWM quantification.

The author has tested a PWM measurement method involving taking pictures of the screen in dynamics using the available equipment. As a result, PWM values not exceeding 120 Hz (about 100 Hz) were obtained for the screens causing a subjective sensation of visual discomfort (Huawei MateBook

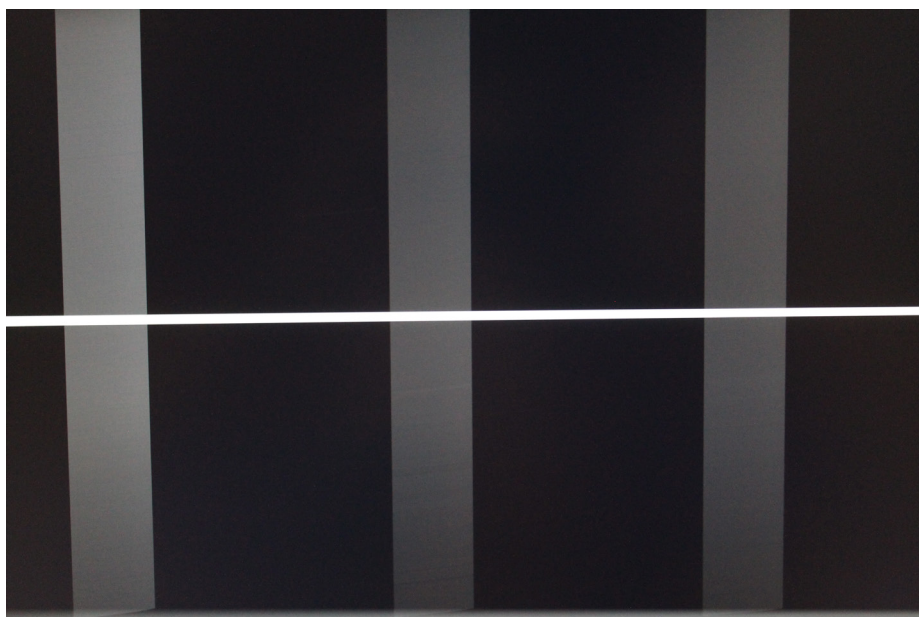


Fig. 3. Example of taking pictures in dynamics (23-inch AOC office monitor) — no PWM

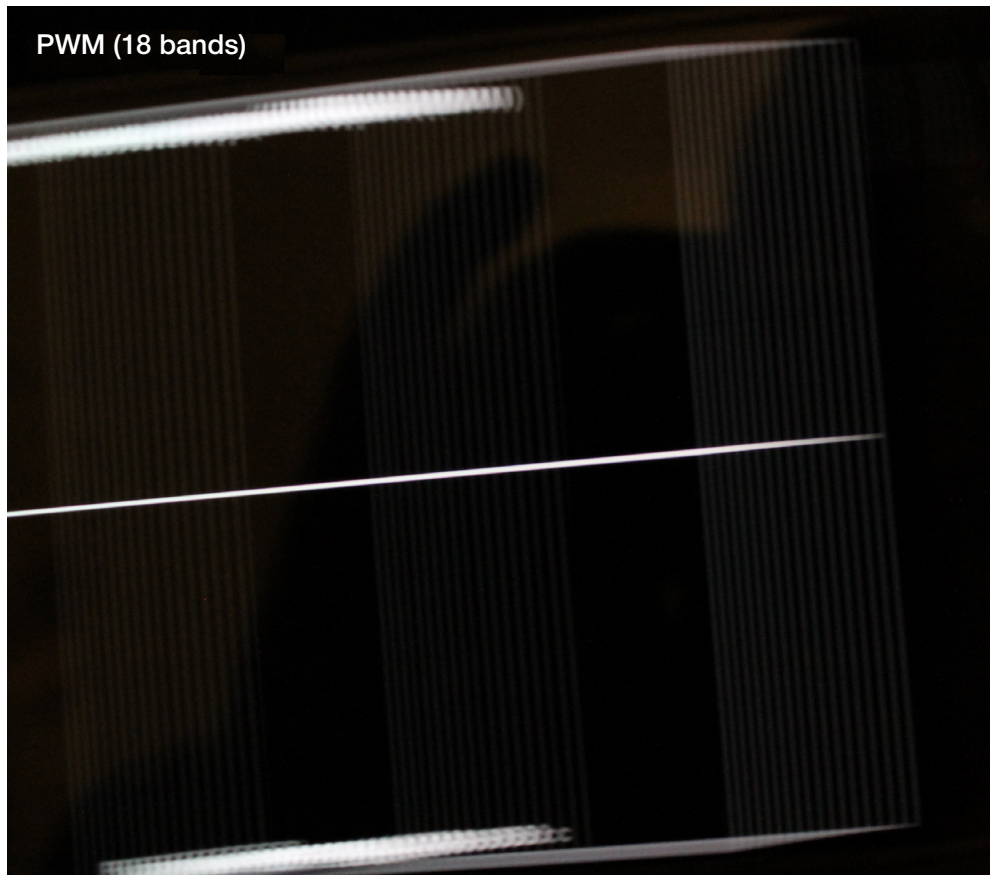


Fig. 4. Example of taking pictures in dynamics (Xiaomi 11 Light 5G NE) on an enlarged scale — PWM of 18 bands (360 Hz)

D14, HP Pavilion 14-ec002ur). Furthermore, there was no PWM at all or PWM exceeding 300 Hz reported for the screens characterized by subjective visual comfort (Fig. 3, 4).

Measures to reduce visual discomfort caused by PWM

The main measure is correct selection of monitor or replacement of the already existing device (if there are complaints). When using a laptop, it is recommended to connect an external screen. However, there are some other approaches that are not effective enough.

The method of increasing brightness to 100% can be found on many web-sites on “combating PWM”. This, on the contrary, makes the light emitted by LEDs almost continuous and reduces pulsation, while the screen brightness is adjusted (reduced) at the expense of the contrast parameter. However, such an approach is not always effective. For example, increasing brightness to 100% on the Huawei MateBook D14 laptop led to the emergence of pronounced PWM and subjective sensation of eye pain. This suggests that, despite positive feedback from the Internet users, the approach cannot be used for all screen types.

Another approach is based on reducing the screen luminance through setting a dark theme of the system and browser. This also does not ensure a 100% efficiency of reducing visual discomfort, reducing it to some extent only.

Switching to the eye-protection mode of the monitor and reducing screen time are the important measures.

It is preferable to buy displays with the Flicker-Free [3], DC Dimming technology that smooth PWM [2] or the “office” displays with reduced brightness and contrast designed for the long-term use.

It is important to note that PWM is not the only factor determining visual discomfort. A combination of factors can lead to the fact that devices with PWM and relatively equal pulsation rate can be subjectively perceived differently. Perhaps, an important role in this is played by the blue light, image brightness and contrast. It is well known that adjustment of brightness and contrast is one of the methods to reduce the PWM negative effects [19]. Furthermore, for example, polarizing films represent an additional factor of the screen design capable of affecting vision [15]. It is polarizing films pasted on the screens and special filter goggles that have helped some users reduce visual discomfort, which also requires further investigation [15].

Based on the foregoing it can be concluded that the likelihood of visual discomfort is low when using a screen with conventional design, while the use of the innovative screen containing LEDs is associated with the risk of severe visual discomfort, and the leading factor is PWM.

Thus, currently, LEDs are being introduced into screen designs everywhere, while the issue of the LEDs hygienic assessment remains unresolved. It is important to avoid the situations, when in pursuit of a high-quality image the technology causing visual discomfort in the susceptible population group is implemented. In this regard, further research in this field is necessary, along with comprehensive assessment of the factors determining the visual comfort of today's screens, since different factors can potentiate each other (for example, the combination of pulsation with high brightness and contrast (sharpness) of the screen, blue light), thereby causing severe visual discomfort.

CONCLUSION

Pulse-width modulation (PWM) of modern screens is a relevant hygienic factor that causes visual discomfort in the population

group susceptible to visual load. Moreover, the number of domestic papers on the issue is extremely low; it is necessary to conduct research focused on the issue. Due to complaints, it is necessary to oblige the display manufacturers to specify the PWM parameter in the product technical documents at the legislative level. Furthermore, there is a need to study the prevalence of PWM symptoms among both students and children. Such studies combined with the analysis of technical

information will make it possible to purchase safe equipment for school education. There is a need for hygienic studies aimed to substantiate the risk associated with exposure to PWM light emission of displays for the visual system. In the future it is recommended to develop the method and criteria for assessment of the PWM displays used by children and adolescents to be used in combination with assessment of other factors affecting visual comfort.

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