

RUSSIAN BULLETIN OF HYGIENE

SCIENTIFIC MEDICAL JOURNAL

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ADDRESS Ostrovityanov St. 1, Moscow, 119997, Russia

Indexed in RSCI. IF 2018: 0,5

Open access to archive



Issue DOI: 10.24075/rbh.2025-02

The mass media registration certificate PI series № FS77-80908 dated April 21, 2021

Founders: Burdenko Voronezh State Medical University (Voronezh, Russia)

Pirogov Russian National Research Medical University (Moscow, Russia).

Publisher: Pirogov Russian National Research Medical University; address: Ostrovityanov Street 1, Moscow 119997 Russia

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Approved for print 30.06.2025
Circulation: 100 copies. Printed by Print.Formula
www.print-formula.ru

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Журнал включен в РИНЦ, IF 2018: 0,5

Здесь находится открытый архив журнала



DOI выпуска: 10.24075/rbh.2025-02

Свидетельство о регистрации средства массовой информации серия ПИ № ФС77-80908 от 21 апреля 2021 г.

Учредители: Воронежский государственный медицинский университет им. Н.Н. Бурденко (Воронеж, Россия);

Российский национальный исследовательский медицинский университет имени Н.И. Пирогова (Москва, Россия)

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Подписано в печать 30.06.2025
Тираж 100 экз. Отпечатано в типографии Print.Formula
www.print-formula.ru

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THE DURATION OF PHYSICAL ACTIVITY AND NIGHTTIME SLEEP IN THE DAILY ROUTINE OF A MODERN SCHOOLCHILD

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Both in Russia and abroad, physical activity, screen time, and nighttime sleep are considered important and controllable daily routine factors that influence a schoolchild's general physical and mental state and health. This study aimed to explore the specifics of the daily routine of schoolchildren living in different regions of the Russian Federation (RF). We analyzed data collected by surveying schoolchildren and their parents in the context of implementation of the "Strengthening Public Health" Federal Project in 2023–2024; the data described durations of some regular activities in the daily routines of the 2nd, 5th, and 10th grade schoolchildren living in the Russian Federation ($n = 254,881$). Russian schoolchildren are in school for an average of 5–7 hours every day (86.3% [95% CI: 86.2–86.4]). The proportion of children who comply with the recommendations of the World Health Organization (WHO) and engage in physical activity for at least 60 minutes per day was 58.5% [95% CI: 58.3–58.7]. It was established that the share of children practicing physical activity in sufficient amounts decreases with progression through the grades. For a significant proportion of children, the duration of their nighttime sleep is insufficient (86% [95% CI: 85.78–86.22] of 2nd grade schoolchildren, 23.3% [95% CI: 23.14–23.58] of fifth graders, and 49.2% [95% CI: 48.8–49.6] of 10th grade schoolchildren). The analysis allowed identifying the regions of the Russian Federation where the greatest shares of children whose daily routines are inadequate. Thus, it can be noted that, despite an average workload at school, a significant number of Russian schoolchildren do not use their free time optimally in terms of physical activity and adequate sleep.

Keywords: survey, schoolchildren's daily routine, physical activity, nighttime sleep duration

Author contribution: Novikova II — study planning, manuscript editing; Zubtsovskaya NA — data analysis, interpretation, literary review, manuscript authoring.

Compliance with ethical standards: the study was approved by the Ethics Committee of the Novosibirsk Research Institute of Hygiene of Rospotrebnadzor (protocol No. 1 of January 11, 2024); all participants submitted the signed informed consent forms.

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Received: 02.11.2024 **Accepted:** 14.01.2025 **Published online:** 16.06.2025

DOI: 10.24075/rbh.2025.126

ПРОДОЛЖИТЕЛЬНОСТЬ ДВИГАТЕЛЬНОЙ АКТИВНОСТИ И НОЧНОГО СНА В БЮДЖЕТЕ ВРЕМЕНИ СОВРЕМЕННОГО ШКОЛЬНИКА

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Как в России, так и за рубежом уделяют большое внимание физической активности, экранному времени и ночному сну как управляемым факторам режима дня школьника, оказывающим существенное влияние на самочувствие и здоровье ребенка. Целью работы было определить особенности режима дня школьников, проживающих в разных субъектах Российской Федерации (РФ). Для анализа использовали данные опроса школьников и их родителей, проведенного в ходе реализации Федерального проекта «Укрепление общественного здоровья» в 2023–2024 гг., о продолжительности режимных моментов обучающихся 2-х, 5-х, 10-х классов, проживающих на территории РФ ($n = 254\,881$). Согласно опросу, российские школьники ежедневно в среднем находятся в школе в течение 5–7 ч (86,3% [95% ДИ: 86,2–86,4]). Удельный вес детей, выполняющих рекомендации Всемирной организации здравоохранения (ВОЗ) и ежедневно уделяющих физической активности не менее 60 мин в день, составил 58,5% [95% ДИ: 58,3–58,7]. Установлено, что с переходом в старшие классы количество детей с достаточной физической активностью снижается. У значительной части детей отмечают дефицит продолжительности ночного сна (у 86% [95% ДИ: 85,78–86,22] обучающихся 2-х классов, у 23,3% [95% ДИ: 23,14–23,58] пятиклассников и у 49,2% [95% ДИ: 48,8–49,6] обучающихся 10-х классов). Анализ позволил определить регионы РФ, где больше всего детей с нарушениями режима дня. Таким образом, можно отметить, что при средней загруженности учебными занятиями в школе значительная часть российских школьников не оптимально использует бюджет свободного времени в отношении физической активности и достаточности сна.

Ключевые слова: анкетирование, режим дня школьников, физическая активность, продолжительность ночного сна

Вклад авторов: И. И. Новикова — планирование исследования, редактирование рукописи; Н. А. Зубцовская — анализ, интерпретация данных, литературный обзор, написание рукописи.

Соблюдение этических стандартов: исследование одобрено этическим комитетом ФБУН «Новосибирский НИИ гигиены» Роспотребнадзора (протокол № 1 от 11 января 2024 г.), от всех участников исследования получено письменное информированное согласие.

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Статья получена: 02.11.2024 **Статья принята к печати:** 14.01.2025 **Опубликована онлайн:** 16.06.2025

DOI: 10.24075/rbh.2025.126

A modern schoolchild's daily routine features a heavy workload associated with studying and prolonged use of electronic devices (mobile phone, tablet, computer), which leads to physical inactivity, less time spent outdoors, and deteriorating quality and duration of sleep. All of the above factors increase static and visual loads and strain regulatory systems, which predicts erosion of both physical and mental health of the child [1–5].

For a schoolchild, an essential prevention tool is a rationally compiled daily routine that alternates hygienically regulated periods of work and rest, sufficient physical activity and night sleep, daily walks in the fresh air, balanced and rational nutrition [1, 5].

This study aimed to explore the specifics of the daily routine of schoolchildren living in different regions of the Russian Federation (RF).

PATIENTS AND METHODS

We analyzed survey data collected in the context of implementation of the "Strengthening Public Health" Federal Project in 2023–2024. The data described durations of some regular activities in the daily routines of schoolchildren aged 7 through 17 years, living in the RF ($n = 254,881$). In particular, the study focused on the duration of everyday physical activity of children, the time spent on school-related studying and extracurricular education, and the duration of nighttime sleep. The standard frequencies and durations of high (sports games, competitions, aerobics) and moderate intensity (outdoor games, physical education, cycling, swimming) physical activity for children aged 5–17 years were determined as per the recommendations of the World Health Organization (WHO, 2020) [6].

Microsoft Excel (Microsoft; USA) software was used for statistical processing of the data. The nominal data are given as relative incidence of the studied indicators (n (%)) with a 95% confidence interval. The statistical significance of the differences in relative indicators was assessed using the Pearson Chi-square method (χ^2). The differences were considered significant at $p = 0.01$.

RESULTS

The majority of schoolchildren stay at school for 5–7 hours (86.3% [95% CI: 86.2–86.4]); 6.4% of respondents spend there 8–9 hours, with most of them residing in the Central (10.8%; $\chi^2 = 112.6$; $p < 0.01$) and Northwestern (7.1%; $\chi^2 = 125.4$; $p < 0.01$) Federal Districts. Less than half a percent — 0.2% — admitted to spending 10 hours at school, with the maximum number of such schoolchildren registered in the Siberian and Far Eastern Federal Districts (0.5%).

A survey of parents about their children's daily physical activity revealed regions where this indicator differs from the average. In the RF, the average share of children attending high-intensity sports activities (sports games, competitions, aerobics) three or more times a week was 21.6% [95% CI: 21.45–21.76]. Approximately the same number of children

attended sports clubs twice a week, and had at least 60 minutes of physical activity per day (18%). The share of children who engage in outdoor games and other such types of physical activity for at least 60 minutes per day was 18.9%. On average, 15% of children did not attend sports clubs. This indicator was higher than the average in the Kabardino-Balkarian Republic (23.4%), Krasnoyarsk Region (22.6%), Irkutsk Region (22.5%), Novgorod Region (21.9%), Chechen Republic (21.2%), Republic of Sakha (Yakutia) (21.0%). The mean share of children who practice physical activity for less than 60 minutes a day no more than 2–3 times a week was 9.7%, and 7.5% of children were physically active for less than 60 minutes a day.

These results allowed identifying groups of children with different levels of physical activity. Central and Southern Federal Districts had the highest proportion of children who were sufficiently (at least 60 minutes per day) and highly physically active: 61.2% and 60.5%, respectively, while the average for the Russian Federation is 58.5% [95% CI: 58.3–58.7] (Fig. 1).

The responses related to the physical activity levels given by schoolchildren of 2nd, 5th, and 10th grades indicate that the share of those having sufficient amounts thereof decreases with progression through the grades. The threshold of sufficiency was overcome by 63.6% [95% CI: 63.2–64.0] of second graders, 57.6% [95% CI: 57.44–57.92] of 5th grade pupils, and 53.5% [95% CI: 53.1–53.9] of 10th grade schoolchildren. As for low levels of physical activity, such were typical for 27.4% [95% CI: 27.0–27.8] of 2nd grade pupils, 32.9% [95% CI: 32.78–33.1] of fifth graders, and 37% [95% CI: 36.6–37.4] of 10th grade schoolchildren.

On average, 39.7% of schoolchildren in the RF attend extracurricular classes in the school they study in. The largest number of children enrolled in such programs directly at school was registered in the Chukotka Autonomous Okrug (59%), Republic of Sakha (Yakutia) (56%), Amur Region (53%), Belgorod Region (52%), Republic of Crimea (51%), and Sakhalin Region (51%) (Fig. 2).

Hygiene standards prescribe different durations of night sleep to different ages of children [7]. Schoolchildren aged 8–10 years should have at least 10 hours of night sleep. Eighty-

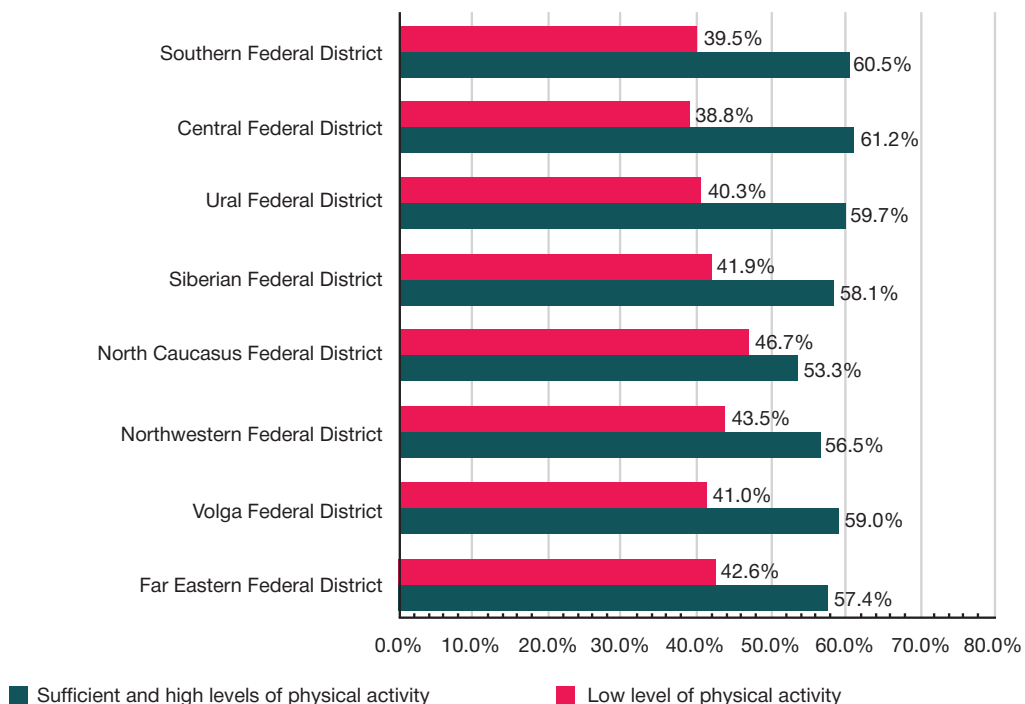


Fig. 1. The level of physical activity, schoolchildren of grades 1–11, physical education, dancing, and sports clubs factored in

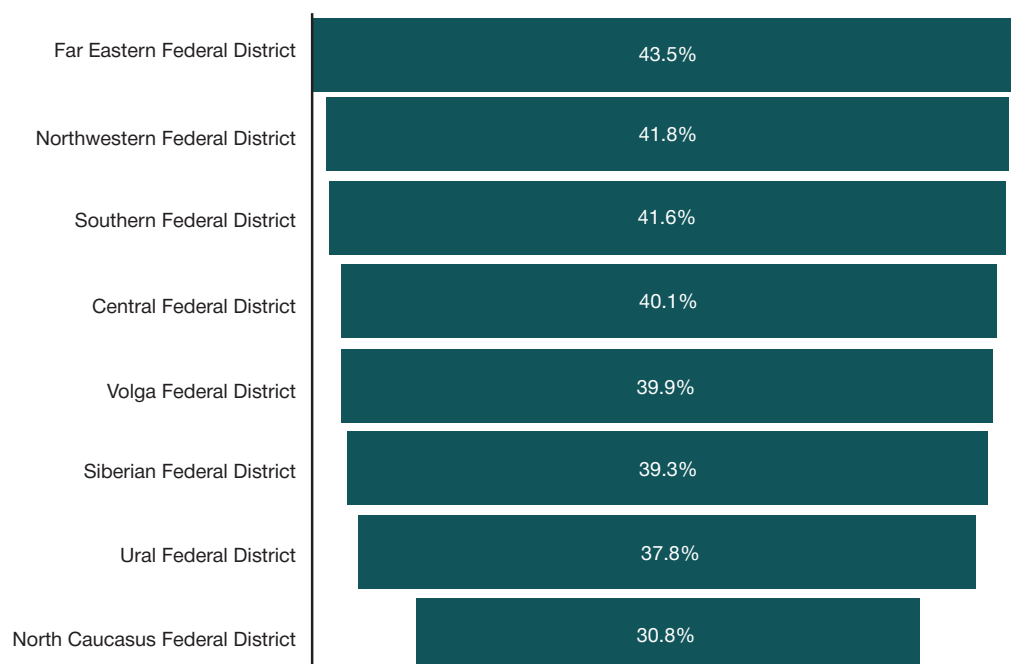


Fig. 2. The proportion of children attending extracurricular classes, clubs, and sports sections in a general education organization

six percent of the respondents noted that on a weekday, their 2nd grade children sleep less than 10 hours at night. For children aged 11–14, the duration of a night's sleep should be at least 9 hours, and 76.7% of the respondents confirmed that their fifth graders sleep as much. The norm for children aged 15 and above is 8 to 10 hours of nighttime sleep; only 50.8% of 10th grade pupils admitted to fulfilling this norm. Thus, it can be said that a significant part of school-age children do not follow the night sleep duration recommendations (86% [95% CI: 85.78–86.22] of 2nd grade pupils, 23.3% [95% CI: 23.14–23.58] of fifth graders, and 49.2% [95% CI 48.8–49.6] 10th grade schoolchildren).

The analysis revealed regions with a low proportion of children having sufficient night sleep duration: 2nd grade students — in Republic of Ingushetia (2.5%), Nenets Autonomous Okrug (2.6%), Tambov Region (3.8%), Republic of Mordovia (4.1%), Sakhalin Region (5%), Voronezh Region (5%); 5th grade students — in Republic of Dagestan (55.7%); 10th grade students — in Nenets Autonomous Okrug (22.1%), Altai Republic (29.1%).

DISCUSSION

The survey of parents of Russian schoolchildren revealed trending disruptions of the modern children's daily routines, which is consistent with the literature data. There is another study that reported similar results: low levels of physical activity for 28–36% of schoolchildren, and growth of this figure along with progression through the grades [8]. Other papers by Russian researchers note that modern schoolchildren tend to spend more time studying, using electronic devices, and watching television to the detriment of walking, physical activity, and sleep [8–10]. There is evidence that 44–47.1% of school-age children today enjoy less sleep than they should [11, 12].

A similar survey conducted in the US revealed that most children and adolescents there sleep as recommended (86%), but take advice on the sufficient levels of physical activity and screen time much less enthusiastically, with 23% and 33%, respectively, complying with the respective standards. Overall, only 9% of children and adolescents there follow all the daily routine guidelines; in Canada, the share of fully complying children is 17.5%, in Australia — 14.9%. It was found that taking up the three core recommendations (about increasing physical activity, reducing screen time, and ensuring optimal sleep duration) was associated with a lower 72% chance of obesity. Similar results were registered for other health indicators, cardiometabolic risk, and cognitive functions [13–16]. Previous works by foreign researchers thoroughly investigated the effect of sufficient sleep on the prevention of development of mental disorders in children [17–19].

CONCLUSIONS

According to the survey, on average, Russian schoolchildren spend 5–7 hours in school every day (86.3% [95% CI: 86.2–86.4]). On the national level, the proportion of children who follow WHO recommendations and engage in at least 60 minutes of physical activity per day was 58.5% [95% CI: 58.3–58.7]; 21.6% [95% CI: 21.45–21.76] of children attend high-intensity physical activity classes at (sports clubs) least three times a week. It was established that the share of children practicing physical activity in sufficient amounts decreases with progression through the grades. A significant proportion of children do not comply with with recommendations on the duration of night sleep, which can lead to mental health disorders. Thus, it can be noted that, despite an average workload at school, a significant number of Russian schoolchildren do not use their free time optimally in terms of physical activity and adequate sleep.

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HYGIENIC ASSESSMENT OF TRAINING CONDITIONS FOR RESCUE TECHNICIANS IN A MODERN COLLEGE

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College students spend most of their time in educational institutions. The quality of the college internal environment has a significant impact on the students' health, performance, and well-being. In terms of hygiene, the most significant are the microclimate parameters and lighting in classrooms. The study aimed to evaluate the major parameters of microclimate and lighting in classrooms and compare these with the subjective assessment of learning conditions by students obtained by conducting a questionnaire survey. A total of 369 adolescents studying at the Protection in Emergency Situations faculty and mastering the profession of rescue technician took part in the survey. The study has shown that hygienic conditions in the educational institution, specifically microclimate in classrooms, have a significant effect on the students' well-being and performance. It is important to comply with the standards for microclimate parameters in classrooms and to carry out timely measures for renovation and improvement of educational institutions to prevent health problems and deviations.

Keywords: student learning conditions, microclimate parameters, college, rescue technician, secondary vocational education

Author contribution: Sokolovskaya AV — data acquisition, literature review, figures; Kazaeva OV — study planning, manuscript writing; Kuchumov VV — data analysis and interpretation; Gruzdev EE — statistical data processing.

Compliance with ethical standards: the study was approved by the Ethics Committee of the Pavlov Ryazan State Medical University (protocol No. 1 dated 12 September 2022).

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Received: 08.11.2024 **Accepted:** 25.02.2025 **Published online:** 16.06.2025

DOI: 10.24075/rbh.2025.127

ГИГИЕНИЧЕСКАЯ ОЦЕНКА УСЛОВИЙ ОБУЧЕНИЯ ТЕХНИКОВ-СПАСАТЕЛЕЙ В СОВРЕМЕННОМ КОЛЛЕДЖЕ

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Большую часть своего времени студенты колледжа проводят в стенах образовательного учреждения, качество внутренней среды которого оказывает значительное влияние на состояние здоровья, работоспособность и самочувствие обучающихся. С гигиенических позиций наиболее значимыми в этом аспекте являются параметры микроклимата и освещенность в учебных кабинетах. Целью исследования было оценить основные параметры микроклимата и освещенности в учебных кабинетах и сопоставить их с субъективной оценкой условий обучения студентами, которая была получена методом анкетирования. В опросе приняли участие 369 подростков, обучающихся на факультете «Защита в чрезвычайных ситуациях» и осваивающих профессию техника-спасателя. В ходе исследования установлено, что гигиенические условия в образовательном учреждении, в частности микроклимат в учебных кабинетах, значимо влияют на самочувствие и работоспособность обучающихся. Для профилактики нарушений самочувствия и отклонений в состоянии здоровья важно соблюдать нормативы параметров микроклимата в учебных кабинетах, своевременно проводить мероприятия по ремонту и благоустройству образовательных учреждений.

Ключевые слова: условия обучения студентов, параметры микроклимата, колледж, техник-спасатель, среднее профессиональное образование

Вклад авторов: А. В. Соколовская — сбор данных, подготовка обзора литературы, графических изображений; О. В. Казаева — планирование исследования, работа с рукописью; В. В. Кучумов — анализ, интерпретация данных; Е. Е. Груздев — статистическая обработка данных.

Соблюдение этических стандартов: исследование одобрено локальным этическим комитетом ФГБОУ ВО РязГМУ Минздрава России (протокол № 1 от 12 сентября 2022 г.).

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Статья получена: 08.11.2024 **Статья принята к печати:** 25.02.2025 **Опубликована онлайн:** 16.06.2025

DOI: 10.24075/rbh.2025.127

According to the state statistics and scientific research results, a negative trend of the children and adolescent health status parameters has been observed in Russia throughout almost three decades [1]. Optimal microclimate parameters ensure the conditions of stay in educational institutions that are safe for adolescent health [2]. Human thermoregulation depends on the ambient air temperature and velocity. Low temperature and air velocity cause chills, and in some cases these can cause hypothermia. In contrast, high temperature causes hyperthermia and decreased performance [3, 4].

The direct exposure to ultraviolet light streaming through an uncurtained window can lead to suppression of cognitive functions and loss of consciousness. Air humidity affects the upper respiratory tract epithelial cells. When the values are low, drying of the mucous membrane and, as a consequence, contamination with pathogenic microorganisms occurs [4–6].

Lighting conditions provide the basis for visual perception of information. Natural light in classrooms is predominantly left-side. Artificial light is even, fluorescent lamps are used as light sources. When the illumination level is too low or too

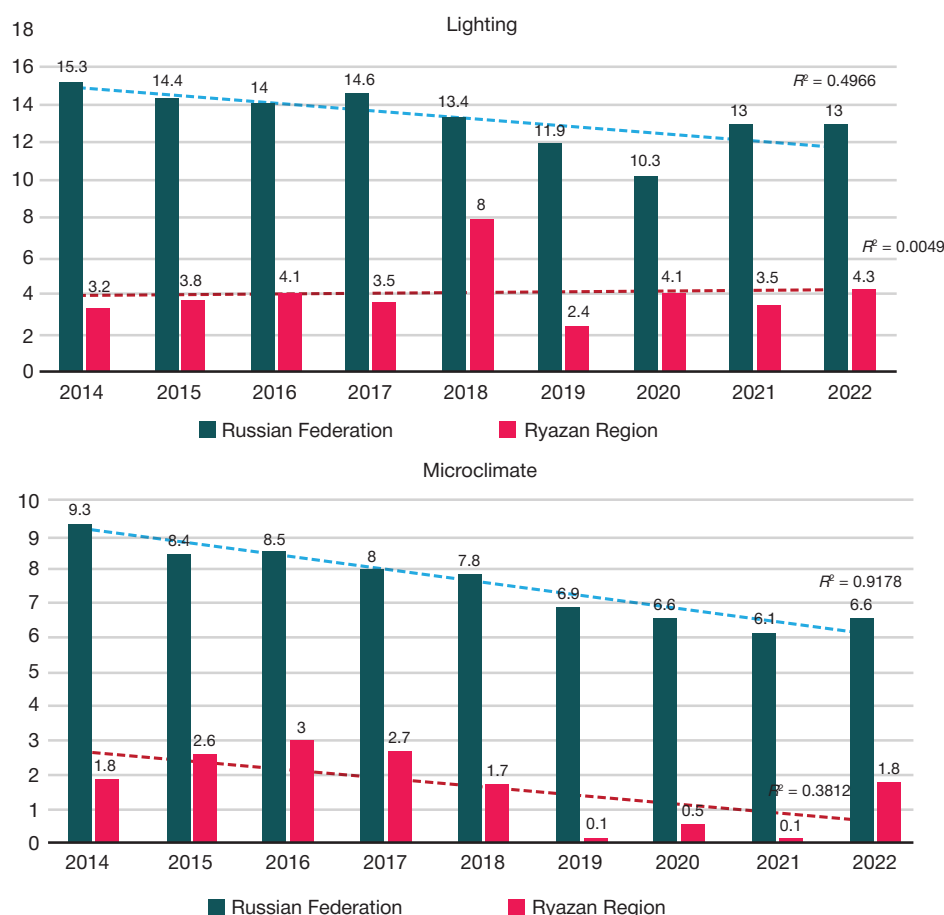


Fig. Share of children's and adolescent institutions noncompliant with the hygienic standards based on physical factors with the growth and decline rates (%)

high, the visual apparatus becomes tired many times faster due to constant stress and adaptation. Poor or insufficient lighting is the cause of eye disorders: myopia and hypermetropia. Thus, in terms of hygiene, the classroom internal environment parameters play a vital role in preservation of the students' well-being, performance, and health [6, 7].

According to the data of the State Report "On the State of Sanitary and Epidemiological Well-Being of the Population in the Russian Federation in 2022" [8] published by the Federal Service for Surveillance on Consumer Rights Protection and Human Wellbeing for the years 2014–2022, the lighting and microclimate indicators in the surveyed children's and adolescent institutions, which did not meet hygienic standards, changed. Thus, the share of institutions with the lighting indicators noncompliant with the hygienic standards in the Ryazan Region shows a positive growth rate (+34.38%), while the rate of decline is typical for the Russian Federation (–15.03%). The share of institutions with the measured microclimate indicators noncompliant with the hygienic standards in the Russian Federation decreases (rate of decline –29.03%) (Figure).

Since the issue has been and remains relevant, the study aimed to evaluate the major parameters of microclimate and lighting in college classrooms and compare these with the subjective assessment of learning conditions by students.

METHODS

The Ryazan College named after Hero of the Soviet Union N. N. Komarov was the object of the study of the students' learning conditions conducted within the framework of the research project "Hygienic Assessment of the Learning Conditions

of Adolescents in a Modern College and the Ways to Optimize These". Currently, more than 1000 people attend the college; among them almost 300 students are future rescuers.

We studied classrooms for students majoring in Protection in Emergency Situations that were located on the 2nd, 3rd, and 4th floors. Microclimate parameters (air temperature, relative humidity, and velocity) were measured using the TKA-PKM device combining anemometer and thermohygrometer (60) (TKA Scientific Instruments LLC; Russia) in three points of each classroom (diagonally, 0.5 m away from the interior and exterior walls and heating devices) at three heights (0.1 m, 0.6 m, and 1.7 m), in the hall at the height of 0.1 m, 1.1 m, and 1.7 m. (calibration certificate No. S-VT/05-07-2022/172754900 (2022), No. S-VT/01-08-2023-266773265 (2023)). A total of 243 microclimate parameter measurements were performed in 2022, and 261 measurements were performed in 2023. Artificial lighting levels were measured using the TKA-PK device combining thermohygrometer, luxmeter, UV radiometer (42) (TKA Scientific Instruments LLC; Russia) in five points of each classroom by the envelope method on the horizontal work surfaces of tables (calibration certificate No. S-VT/05-07-2022/16971761 (2022), No. S-VT/03-08-2023/267293917 (2023)). A total of 135 artificial lighting level measurements were performed in 2022, and 141 measurements were performed in 2023. The measurement devices were provided by the Center of Hygiene and Epidemiology in the Ryazan Region. Measurements were performed twice: in 2022 and 2023 (before and after renovation), during the cold season (in December).

Recording of subjective sensations associated with their well-being by students was performed using the questionnaire (Google form), in which the students were offered to specify, what they did not like in the classrooms. A total of 170 students

Table 1. Standard microclimate and lighting parameter values according to SanPiN 1.2.3685-21

Indicator	SanPiN 1.2.3685-21
Temperature, °C	18–24
Relative humidity, %	40–60
Air velocity, m/s	no more than 0.1
Artificial lighting (on desktops), lx	at least 300

were through the questionnaire survey in 2022, and in 2023 it was 199 students.

In 2022, the college was subjected to renovation involving replacement of glazing and entrance. Furthermore, cosmetic repair of vertical surfaces, replacement of floor coverings, replacement of fluorescent lamps and vertical blinds were performed. Hygienic indicators were assessed based on SanPiN 1.2.3685-21 “Hygienic Standards and Requirements for Ensuring Safety and (or) Harmlessness to Humans from Environmental Factors” [9]. Permissible levels of air microclimate and artificial lighting indicators in the learning spaces and classes are provided in Table 1.

Statistical analysis of the results obtained was performed using the Statistica 12.0 software package (StatSoft; USA). Student's *t*-test was used, and the results were presented as the mean and standard deviation ($M \pm \sigma$). Statistical analysis of the questionnaire survey data (percentage distribution of students based on their subjective assessment of the learning conditions and the prevalence of the students' complaints on the classroom environment) was conducted using the nonparametric chi-squared test (χ^2) at $p < 0.05$.

RESULTS

The measured microclimate parameter values were not in all sites compliant with the standards. In 2022, the lowest air temperature was 17.3 °C in the corner near the cold exterior wall and 17.5 °C in the center of the classroom for teaching the “automated control and communication system”. Furthermore, air temperature in the classrooms for teaching “metrology and standardization” and “emergency rescue tactics” was noncompliant with the permissible values: 17.7 °C and 17.9 °C, respectively. Other measured values were acceptable. The highest measured air temperature (23.9 °C) was reported for the classroom for teaching the “emergency rescue equipment”. The average air temperature value was 20.81 ± 1.74 °C. The proportion of the air temperature noncompliant with the hygienic standards is 11.1%.

In 2023, the analysis of microclimate parameter values showed that the lowest measured temperature was observed in the classroom for teaching the “emergency rescue equipment”: 19.3 °C in the corner near the cold exterior wall. The highest temperature was reported for two classrooms: one for teaching “organization of protection of the population and territory” and the “basics of performing firefighter work” in the corner near the interior wall — 24.0 °C. Both the lowest and the highest temperature were within the permissible microclimate parameter range. The average air temperature value was 22.63 ± 1.17 °C.

The microclimate indicators measured in the halls were within the permissible range (minimum air temperature — 22.3 °C, maximum air temperature — 22.7 °C); air velocity was 0.13 m/s. The average air temperature value was 22.46 ± 0.15 °C, while that of air relative humidity was $21.95 \pm 0.31\%$.

The vertical temperature difference and air velocity were compliant with the hygienic standards in both 2022 and 2023. Air humidity in all classrooms was noncompliant with the hygienic standards. In 2022, the minimum value was 23.3% in the classroom for teaching the “emergency rescue equipment” and 30.0% in the classroom for teaching the “automated control and communication system” (average value $30.13 \pm 3.22\%$). In 2023, the minimum air relative humidity was recorded in the classroom for teaching the “emergency rescue equipment”: it was 15.1%. The maximum air relative humidity value was recorded in the classroom for teaching the “emergency rescue tactics”: it was 34.7% (average value $25.06 \pm 5.31\%$).

In 2022 and 2023, measurement of overall artificial lighting revealed no deviation from the hygienic standard. In 2022, the lowest measured value was recorded in the classroom for teaching the “medical and biological foundations of life safety”: it was 320 lx (the last desk in the row most distant from the window). The highest lighting values (513 and 515 lx on the first desks of the rows 1 and 3, respectively) were recorded in the classroom for teaching the “emergency rescue equipment”. The average artificial lighting value was 431.84 ± 53.94 lx.

In 2023, the minimum value was 313 lx in the classroom for teaching the “emergency rescue tactics” (on the last desk of the 3rd row), and the maximum value of 540.33 lx in the classroom for teaching the “automated control and communication system”. The average artificial lighting value was 440.75 ± 67.83 lx. The average lighting in the halls was 390.17 ± 58.69 lx. No significant differences in microclimate and lighting parameters between the years 2022 and 2023 were revealed (at $p < 0.05$).

In 2022, the questionnaire survey involving 170 students was conducted, and in 2023 a total of 199 students were surveyed. The percentage distribution of students based on the results of the subjective assessment of learning conditions is provided in Table 2.

There are significant differences in answers between the years. This suggests that the microclimate and lighting indicators improved considerably after renovation, the same as the overall estimate of learning conditions.

The questionnaire, the students were offered to complete, contained the following question: “What do you dislike about classrooms?” The answers are provided in Table 3.

Table 2. Percentage distribution of students based on the results of the subjective assessment of learning conditions and the likelihood of differences in answers

Learning conditions	2022, % of individuals	2023, % of individuals	<i>p</i>
Comfortable	23.5	43.5	0.000065
Satisfactory	41.2	50.6	0.050911
Unsatisfactory	35.3	5.9	< 0.00001

Table 3. Prevalence of complaints of the classroom environment among students in 2022 and 2023

Complaints	2022, % of individuals	2023, % of individuals	<i>p</i>
Low air temperature (cold)	26.47	13.07	0.000938*
High air temperature (hot)	12.35	10.55	0.561636
Draught	16.47	21.11	0.279303
Background noise	14.71	16.08	0.749219
Insufficient lighting	12.35	1.51	0.000022*
Uncomfortable furniture	11.18	16.08	0.18707
Extraneous smells and other complaints	5.29	6.53	0.634962
No complaints	1.18	15.07	0.000003*

Note: * — significant differences in answers between 2022 and 2023.

The values for the answer options “low air temperature (cold)”, “insufficient lighting”, and “no complaints” show no significant differences. Ambient temperature and insufficient lighting adversely affect the students’ well-being, increasing the risk of health problems. Significant differences between the answers show that in 2023 the microclimate learning conditions became more beneficial relative to 2022, which reduced the risk of disorders in the future rescue technicians.

DISCUSSION

Hygienic conditions in the classroom depend directly on the internal features of facilities, renovation quality, and livability. Microclimate conditions in the studied educational institution can be considered satisfactory. In 2022, before the college building renovation, the majority of students assessed the learning conditions as unsatisfactory (35.3%; $p = 0.000065$). In particular, 26.47% of students reported low temperature (13.07% in 2023; $p = 0.000938$), 12.35% — high temperature in the classrooms (10.55% in 2023) and insufficient lighting (1.51% in 2023; $p = 0.000022$). The number of students satisfied with the learning conditions was lower in 2022 (1.18%), than in 2023 (15.07%, $p = 0.000003$).

Noncompliance of microclimate parameters with the hygienic standards, specifically low air temperature and humidity, increase the risk of the adolescent body cooling, can cause deterioration of well-being, lead to health problems and reduced performance [10–12].

The growing adolescent body is highly susceptible to adverse environmental factors. The sanitary and hygienic conditions, under which training is conducted, affect the adolescents’

health status. Considering the specifics of training in the college [13] associated with the students’ future profession, the issue of creating such a microclimate of classrooms, in which the work of students would be most active and effective, becomes a priority.

Most people assign the function of protecting and promoting health to the healthcare system only. However, it should be noted that hygienic learning conditions (including microclimate parameters of classrooms) depend primarily on the educational institution managers [14, 15].

CONCLUSIONS

Significant differences in the students’ questionnaire survey results revealed through comparison with the results obtained when measuring the lighting and microclimate parameters suggest a significant relationship between the educational environment hygienic conditions and the well-being of future rescue technicians. Based on the percentage distribution of students by on the subjective assessment of learning conditions, where in 2023, 20.0% more students considered learning conditions comfortable, than in 2022 (only 5.9%), a conclusion can be drawn about considerable effectiveness of the educational institution renovation. It is necessary to continuously monitor the major microclimate and lighting indicators in educational institutions in order to ensure timely prevention of the environmental factor deterioration. Receiving regular information on the measurement results and taking appropriate measures will contribute to the timely improvement of learning conditions and, as a result, maintaining the health of students.

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FEATURES OF OCCUPATIONAL MORBIDITY DYNAMICS AT THE REGIONAL LEVEL

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To make managerial decisions on the prevention of occupational and morbidity, it is necessary to track how health status of the working population depends on the degree of occupational risk. This study aimed to identify the features of the long-term dynamics of occupational morbidity at the level of production facilities (various industries) in the Voronezh region. The assessment of the level of occupational pathology was based on the type of economic activity, the administrative-territorial affiliation of the region's constituent, nosological forms, and factors of the workflow. We have identified the main patterns of occupational morbidity dynamics; in 2021–2022, its growth was primarily driven by the biological factor. With the companies/establishments being unready to face the new occupation-related risk factors, there emerge previously unregistered occupational morbidities that largely incapacitate the affected individuals.

Keywords: occupational risk, harmful production factor, occupational morbidity rate, characteristics of production factors

Author contribution: Kamenev VI — collection and analysis of the material, test authoring and formatting; Popov VI — study concept and design, editing; Stepkin Yul — text authoring, editing.

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Received: 14.03.2025 **Accepted:** 01.04.2025 **Published online:** 18.06.2025

DOI: 10.24075/rbh.2025.128

ОСОБЕННОСТИ ДИНАМИКИ ПРОФЕССИОНАЛЬНОЙ ЗАБОЛЕВАЕМОСТИ НА РЕГИОНАЛЬНОМ УРОВНЕ

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Для принятия управленческих решений по профилактике профессиональной и производственно-обусловленной заболеваемости необходим мониторинг зависимости уровня отклонений в состоянии здоровья работающего населения от степени профессионального риска. Целью работы было выявить особенности многолетней динамики профессиональной заболеваемости на уровне объектов различных отраслей промышленности Воронежской области. Уровень профессиональной патологии оценивали в зависимости от вида экономической деятельности, административно-территориальной принадлежности объекта региона, по нозологическим формам и факторам трудового процесса. Установлены основные закономерности динамики профессиональной заболеваемости, рост которой в 2021–2022 гг. обусловлен прежде всего биологическим фактором. Неготовность учреждений к появлению новых факторов риска в профессии ведет к возникновению ранее не зарегистрированной профессиональной заболеваемости с высокой степенью утраты трудоспособности.

Ключевые слова: риск в профессии, вредный производственный фактор, уровень профессиональной заболеваемости, характеристика факторов производства

Вклад авторов: В. И. Каменев — сбор и анализ материала, оформление и написание текста; В. И. Попов — концепция и дизайн исследования, редактирование; Ю. И. Стёпкин — написание текста, редактирование.

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Статья получена: 14.03.2025 **Статья принята к печати:** 01.04.2025 **Опубликована онлайн:** 18.06.2025

DOI: 10.24075/rbh.2025.128

The WHO global plan of action for workers' health mentions that the working population accounts for half of the world's total population. According to Rosstat (Russian Statistics Agency), in 2023, 61.3% of the population of the Russian Federation were working. The current national priorities set by the state policy are fully aligned with the studies that investigate the working conditions and focus on the prevention of occupational diseases and preservation of health of the workers manning Russia's industrial production sector [1].

Preservation of health of the able-bodied citizens is the economic basis of society [2]. The specifics of conditions of work have a significant impact on the health and occupational morbidity of the working population. In the era of scientific and technological progress, the number and dangerousness of various factors associated with the industrial production activities have increased significantly, despite the mechanization, automation and robotization of various fields of human life [3].

Labor has been and remains one of the most important social factors and the basis of human existence. The health of the population in general and its working part in particular is assessed by medical and demographic indicators,

characteristics of physical development, morbidity, and disability [4, 5]. Occupational morbidity is one of the main indicators that characterizes the health of the working people.

When the working day exceeds 12 hours, the deterioration of the conditions of work, which is primarily reflected in the physiological indicators, adds to the person's accumulated fatigue. In all trades and industries, overtime brings dissatisfaction of the staff, which can translate into workplace accidents and increase the risk of occupational pathologies.

It has been established that the prevalence of various types of occupational diseases depends, in the first place, on the type of harmful factors peculiar to the working environment and the labor process that affect the employees; these factors are determined by the specifics of the industry, working conditions, intensity and time of exposure to them [6–9].

All types of industrial production have certain occupational diseases. This problem is also relevant in agriculture, where workers are exposed to a wide range of production factors: hard manual labor, adverse microclimatic conditions, and vibrations from the mechanisms used. In general, agriculture is one of the most difficult and dangerous fields [10, 11]. The effects

of working conditions, for example, in greenhouses, and how they are understood and interpreted by the workers themselves [12], are relevant issues, as they affect the quality of life.

Occupational safety is one way to reduce work-related illnesses and injuries [13]. It is a set of measures designed to make the conditions of work favorable and harmless. A comprehensive solution to the problem of occupational disease prevention, occupational safety and health must be merged with occupational hygiene, which is reflected in the active regulations (special assessment of working conditions (SAWC), hygienic requirements for conditions of work).

Currently, one of the key areas of occupational hygiene and medicine is the minimization of occupational risks in the context of actively changing legislation [14]. The methodology of risk assessment was used to assess the association of diseases with professions [15]; it shows the level of the occupational morbidity risk depending on the degree of deviation from the hygienic norms.

This study aimed to identify the features of the long-term dynamics of occupational morbidity at the level of production facilities (various industries) in the Voronezh region.

Using the 2019–2023 reports filed in the statistical form #24 "Number of people with newly diagnosed occupational diseases (poisoning)," we analyzed the incidence of occupational diseases in the Voronezh region.

This paper presents the analysis of the features of occurrence of occupational pathologies, and the measures taken to prevent them based on disease investigation reports and the results of SAWC.

We also used information from the reports "On the sanitary and epidemiological situation in the Voronezh region" released by Rospotrebnadzor's (Russian Federal State Agency for Health and Consumer Rights) agency in the Voronezh Region. The reports cover years 2019 through 2023. It is known that the level of occupational morbidity is directly linked to the quality of working conditions [15].

According to Voronezhstat (statistical agency of Voronezh), in 2023, 28.9% of the region's able-bodied population worked in hazardous conditions (14.7% of them were women). These data are based on the results of SAWC and industrial laboratory control efforts.

The analysis of laboratory and instrumental studies conducted as part of the state sanitary and epidemiological supervision program at the region's production facilities and various establishments and institutions revealed that the maximum permissible concentration (MPC) of chemicals of the hazard classes 3 and 4 was exceeded in 0.06% of cases, and that for dust and aerosols — in 1.04% of cases. The values exceeding those considered normal by the hygienic standards were recorded at chemical factories. The main reason for the deviation from the MPC is the imperfection of technological processes.

The analysis of occupational morbidity at the facilities and establishments did not reveal a set periodicity and a characteristic pattern in its dynamics (Table 1).

The key factors are the thoroughness of preventive examinations and the trade or industry the facility or establishment operates in.

In 2020, there is a rise in occupational morbidity associated with the COVID-19 pandemic. In 2020–2021, the most

common reasons behind morbidity were biological by nature. For example, in 2020, 17 cases of occupational diseases out of 21 were caused by the exposure to the COVID-19 agent, and in 2021, there were 20 such cases out of 30, ending in fatalities.

Medical professionals exhibit no vigilance regarding the possibility of getting sick while in professional capacity, which is a reason for concern. This lack of preparedness for the new infection translated into a high incidence of COVID-19 among them. Overall, the last 10 years saw both occupational and general morbidity grow among medical workers [10].

It should be noted that occupational morbidity in the Voronezh region is lower than generally in the Russian Federation. For example, in 2023, the relative occupational disease incidence in the Russian Federation was 0.96 per 10,000 employees, which is 3.5 times higher than in the Voronezh region.

As for the economic sector, the highest rates were registered in agriculture, where the common ailments are the diseases associated with largely manual labor and working in a fixed and unnatural position (as milkmaids do). The people employed in this field were typically diagnosed with a musculoskeletal system pathology (lumbosacral radiculopathy).

Occupational morbidity continues to be registered in the employees of the aircraft manufacturing enterprises, where the main adverse factors are high-frequency noise and local vibration.

Under the top-level nosologies, both absolute and relative indicators exhibit a downward trend. The incidence of work-related illnesses is decreasing in the country overall, but this does not it stops to exist.

For example, there has been no cases registered at small businesses, although physiological examinations of their staff revealed their exposure to such adverse factors as overtime (sometimes 12–15 hours per shift), and general lack of the proper work and rest balance. The conditions of work are poor at the microclimatic level (for example, high or low environment temperatures in smaller shops and logistics hubs) [16, 17].

From the hygienic point of view, the adverse factors at chemical factories are multicomponent chemicals released into the air of the work area, as they create risks for the health of workers; however, there are no occupational diseases registered at such facilities, which may indicate high effectiveness of preventive measures.

In the context of nosologies, long-term dynamics are characterized by the diseases caused by noise, vibration, and physical exertion, which are registered every year (Table 2).

Riveting assemblers and mechanics of IL-VASO mechanical works are exposed to noise and vibration; the common diagnoses at these facilities are vibration disease and sensorineural hearing loss, both work-related illnesses.

As for medical professionals, the occupational morbidity among them is still often associated with contacts with tuberculosis patients. The sporadic incidence of the respective pathology is seen in tuberculosis dispensaries every year; the main reasons are the improper use personal protective equipment during medical and preventive procedures, predisposition to the infectious agent, and imperfection of disinfection measures.

Occupational diseases are registered when the affected individuals seek medical assistance, which points to the low quality of preventive medical examinations or absence thereof.

Table 1. Occupational morbidity, industrial facilities and establishments of the Voronezh region, 2019–2023 (per 10,000 employees)

2019	2020	2021	2022	2023
0.15	0.3	0.46	0.19	0.27

Table 2. Dynamics of occupational morbidity (cases in absolute numbers)

Indicators	2019	2020	2021	2022	2023
Occupational diseases, total	10	21	30	12	17
From vibration	2	2	4	3	2
From noise	5	1	4	5	5
From exposure to chemicals and dust	2	–	1	–	–
From physical exertion	–	1	–	–	7
From exposure to a pathogenic infectious agent	1	17	21	4	3

We have established a clear connection between such diseases and disability; there were three cases (female patients) in 2023. The reasons behind permanent disability are irregular attendance of medical examinations, refusal to visit a doctor when the first signs of the disease appear, and lack of proper prevention programs at work.

Another problem is the tendency to attend medical examinations only when the workplace is labeled hazardous based on SAWC. Such assessments are conducted only every 5 years, and the quality of the involved laboratory tests is low. Between the assessments, the changes in the status of health of the workers are not monitored, which disallows timely implementation of preventive and corrective measures aimed at improving working conditions and reducing occupational risks.

The conditions of work do not always reflect the level of occupational morbidity in a workplace [4, 18, 19].

Fewer registrations of occupational diseases is associated with poorly executed medical examinations, the exclusion of physiological parameters from SAWC, including shift-based nature of employment and irregular working hours. In addition, the working conditions of self-employed individuals are not controlled and depend on their personal ability to organize them.

Morbidity depends on the accountability of managers and officials for the organization of a disease prevention system.

The approaches to noise registration are a subject of arguments, too: SAWC investigates only the equivalent noise level and skips the analysis of frequencies, while it is possible to have some of them exceeding the norm without violation of the maximum permissible level (MPD) [19–21].

There are petrochemical industry facilities in the (Voronezhsintezkauchuk), but work-related diseases

have not been registered there for many decades, which points to a highly effective prevention system, including special preventive nutrition following exposure to organic chemical compounds, as well as regulated breaks and a rational work and rest regime.

CONCLUSION

Responsible managers of organizations need to improve their preventive efforts aimed at reducing the risk of occupational diseases. A responsible and realistic approach to the certification of workplaces by the conditions of work should contribute to the prevention of occupational morbidity [22–24].

The special assessment of working conditions (SAWC) substantiates reasonable solutions of the matters of evaluation of working conditions, providing benefits and compensations [24, 25], but this approach does not involve a hygienic assessment. There is no practice of assessing the noise by frequencies, nor are the physiological parameters regulating the intensity of labor are fully normalized. The frequency of SAWC is once every 5 years, provided there are no violations of hygiene and working conditions. However, even when the maximum permissible concentrations are exceeded insignificantly, but this deviation is persistent, in the production environment, the health of the employees may deteriorate. The maximum permissible concentration cannot cause the disease, but when the respective content is slightly above it, there is a risk of occupational pathology.

High levels of occupational risk [25–27] necessitated the development of a risk-based program that includes priority areas and ways to prevent damage to workers' health.

The morbidity prevention system should factor in the complexity of the problem [28–30].

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CORRELATION BETWEEN BEHAVIORAL FACTORS, PHYSICAL ACTIVITY, AND ACADEMIC PERFORMANCE OF MEDICAL STUDENTS

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Young adults suffer from high educational load when studying at the medical university. University training proceeds under the dynamically changing conditions. Psychological discomfort, low physical activity, noncompliance with the principles of rational nutrition, harmful habits can negatively affect both students' physical health and their academic performance. The review of scientific papers published in the international and Russian databases, eLibrary, PubMed, Cyberleninka, in 2019–2024 is provided. Analysis of the papers will allow us to choose the best health preservation practices. Information about the correlation between behavioral factors, academic performance and health of medical students is essential for prevention programming. The development of exercises considering personal preferences in physical activity can positively affect academic performance, reduce psycho-emotional discomfort, thereby reducing the risk of professional burnout after graduation from the university.

Keywords: academic performance, students, lifestyle, physical activity, medical university

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Received: 01.11.2024 **Accepted:** 01.11.2024 **Published online:** 18.06.2025

DOI: 10.24075/rbh.2025.129

ВЗАИМОСВЯЗЬ ПОВЕДЕНЧЕСКИХ ФАКТОРОВ, ФИЗИЧЕСКОЙ АКТИВНОСТИ И УСПЕШНОСТИ ОБУЧЕНИЯ В МЕДИЦИНСКОМ ВУЗЕ

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Во время обучения в медицинском вузе молодые люди сталкиваются с высокой учебной нагрузкой. Обучение в вузе происходит в динамически изменяющихся условиях. Психологический дискомфорт, низкий уровень физической активности, несоблюдение принципов рационального питания, вредные привычки могут негативно влиять как на физическое здоровье, так и на успешность обучения студентов. Представлен обзор научных статей, опубликованных в международных и российских базах данных eLibrary, PubMed, КиберЛенинка в 2019–2024 гг. Анализ публикаций позволит отобрать лучшие практики здоровьесбережения. Сведения о взаимосвязи поведенческих факторов и успешности обучения в медицинском вузе и здоровья необходимы для составления программ профилактики. Разработка упражнений с учетом индивидуальных предпочтений в физической активности может благоприятно отразиться на успешности обучения, уменьшить психоэмоциональный дискомфорт, тем самым снизив риск профессионального выгорания после окончания учебного заведения.

Ключевые слова: успешность обучения, студенты, образ жизни, физическая активность, медицинский вуз

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Статья получена: 01.11.2024 **Статья принята к печати:** 01.11.2024 **Опубликована онлайн:** 18.06.2025

DOI: 10.24075/rbh.2025.129

Health preservation during training is relevant for students in all countries. The learning process is accompanied by alteration of social conditions and lifestyle [1, 2].

Today, it seems urgent to maintain the contingent of students in medical universities due to the shortage of doctors in the Russian Federation. It is traditionally believed that academic load associated with mastering medical specialties, especially in junior students, is considerably higher compared to the workload of students with other directions of training [3].

Health deterioration can be one of the causes of academic performance reduction leading to termination of training. It is well-known that behavioral factors associated with lifestyle are considered to play an important role in health preservation under changing conditions [4].

The lack of motivation to learn and the increasing psychological discomfort represent the factors both reducing academic performance during training and leading to leaving the profession after graduation from the higher educational institution [5].

Investigation of the effect of health preservation indicators on academic performance in specialists mastering the postgraduate training programs is also relevant [6].

The study aimed to assess and summarize information about the effect of health preservation indicators on academic performance in medical students.

The review of scientific papers published in the international and Russian databases, E-Library, PubMed, Cyberleninka, in 2019–2024 was conducted.

Most papers are focused on assessing the correlation between academic performance and the young adults' health and lifestyle indicators during training. It is difficult to assess the effect of health preservation indicators on the academic performance of student youth due to its multifaceted nature.

Deterioration of the health indicators that are somehow associated with lifestyle, poor nutrition, excessive intake of fast food and carbonated beverages, insufficient sleep, reduced motor activity, increased psycho-emotional load due to learning intensity, as well as spending much time staring at the computer monitor, tablet or phone is more and more often reported in today's adolescents [7].

Reduced physical activity in adolescents is reported all over the world. And yet, regular physical activity is a potent method to adjust adolescents' body weight and prevent non-communicable diseases in the future [8].

Knowledge of primary school students and their parents about hygiene is insufficient, which can reduce academic performance during training. The questionnaire survey of 322 primary school students and 487 parents showed that it was difficult to answer the question about permissible amounts of sugar and sugar-sweetened beverages on the daily diet for 68.3% of students and 70% of parents. Only 70% of students and 75% of parents specified the normal amount of salt in the diet correctly [9].

In the initial years of university, young adults demonstrate low adherence to the principles of rational nutrition. And yet, nutrition, being a modifiable aspect of healthy lifestyle, is more and more often considered as a prerequisite for successful learning. Thus, assessment of nutritional status in 663 Malaysian university students revealed the correlation between adherence to rational nutrition and academic performance [10, 11].

A systematic review assessing the students' adherence to the Mediterranean Diet showed that the decrease in consumption of fruit and vegetables, as well as the increase in consumption of sugar-sweetened beverages were negatively correlated to the average academic score in students [12].

Consumption of products with high content of low-quality fat, sugars can result in mental fatigue. Thus, assessment of the answers related to the daily diet of 161 students attending the medical university in Florida (USA) showed that students with higher academic scores more often answered that they did not consume fast food (63%), than students with lower academic scores (33%) [13].

Inclusion of fish and seafood, along with foods with high protein content in the diet can improve cognitive functions in young adults and have a beneficial effect on the learning process [14].

However, insufficient consumption of foods with high protein content is typical for student youth. Gender differences in food choices may also be observed [15].

Catering also has an effect on academic performance. Inclusion of breakfast in the daily routine can positively affect learning. Breakfast with loved ones has a beneficial effect on the young adults' psycho-emotional state [16].

Students master various programs when studying at the medical university. Young adults study principles of rational nutrition within the framework of hygienic training. Complementing the classes with the easy-to-memorize visuals, check-lists can improve the training process and thereby ensure the long-term storage of knowledge about the basics of nutrition in the future physicians [17].

Physical activity improves memory consolidation processes, brings the sleep-wake cycle back to normal, contributing to adaptation to training [18].

Assessment of academic performance in 379 female students of medical colleges in Saudi Arabia showed that students, who reported their physical activity status as low, had lower academic scores [19].

Physical activity status can change during training. The analysis of physical activity levels in young adults studying at the University of Munich (Germany) showed that more than a half of respondents reported the decrease in their physical activity during training [20].

At the same time, after graduating from the medical university, when being through the postgraduate education program, the physical activity status of graduates continues to decline, but the risk of professional burnout increases [21].

The data on the influence of various methods and physical activity complexes on adaptation and academic performance are controversial; the development of exercises for optimization of lifestyle indicators is currently relevant [22, 23].

Harmful habits have a negative effect on both students' health and their academic performance. Assessment of the risk factors of non-communicable diseases in 2036 medical students in Tomsk (1st to 6th year) showed that the rate of smoking reached 16.7%. The rate of alcohol consumption significantly increased in senior students compared to junior students [24].

Besides the fact that smoking negatively affects physical health and represents a serious medical and social issue, it also can negatively affect the young adults' academic performance. When conducting the questionnaire survey of 411 being through bachelor programs in universities of Canada, smoking was conducted as a predictor of bad marks [25].

In addition to low average academic score, medical students with the smoking experience of 2–3 years more often have academic debts. The increase in cigarette smoking is significantly correlated to the larger number of absences and debts [26].

Educational load can increase psychological discomfort in medical students. Anxiety can increase when the students' schedule is inconvenient, especially in individuals with the evening chronotype. It is traditionally believed that students of morning type demonstrate higher academic performance when mastering theoretical subjects, than students of evening type [27].

Psychological well-being is essential for training at the medical university. Comprehensive assessment and optimization of appropriate factors are a priority [28].

CONCLUSION

The accumulated knowledge about the impact of behavioral factors on academic performance in medical students should be taken into account when developing the programs for individual and mass prevention. Optimization of psycho-emotional state, motivation to learn in students can be realized through ensuring regular physical activity considering personal preferences. The development of personalized exercises can make it possible to improve academic performance of medical students, thereby reducing the risk of professional burnout after graduation.

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THE SPECIFICS OF USE OF ELECTRONIC DEVICES BY PRESCHOOL CHILDREN AT HOME AND THE ROLE OF PARENTAL MEDIATION

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Due to the development of digital technologies and their growing availability to all categories of the population, the age of children who regularly use electronic devices decreases. This article summarizes the results of the studies investigating the use of electronic devices by preschool children and describes the role of parents in organizing this type of activity for them. The data were collected from papers published from 2017 through 2024 and available in eLibrary, CyberLeninka, and PubMed. The analysis of the data revealed that most parents lack the skills needed to teach children to use electronic devices safely, and their awareness of the associated health disorders and preventive measures is insufficient. Therefore, the experience of using electronic devices by children, including preschoolers, may be negative, which necessitates efforts aimed at counseling parents and educating them about digital safety and the rules of controlling the relationship of their children with such devices.

Keywords: preschool children, electronic devices, digital environment, role of parents, awareness, skill development

Author contribution: Markelova SV — study concept, data analysis and interpretation, manuscript editing; Reshetnikova IO, Darishchev SA — data collection and analysis, manuscript drafting.

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Received: 22.12.2024 **Accepted:** 25.04.2025 **Published online:** 19.06.2025

DOI: 10.24075/rbh.2025.130

ОСОБЕННОСТИ ИСПОЛЬЗОВАНИЯ ЭЛЕКТРОННЫХ УСТРОЙСТВ ДЕТЬМИ ДОШКОЛЬНОГО ВОЗРАСТА В ДОМАШНИХ УСЛОВИЯХ, РОЛЬ РОДИТЕЛЬСКОГО ПОСРЕДНИЧЕСТВА

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Развитие цифровых технологий, их доступность всем категориям населения определяют снижение возраста детей, регулярно использующих электронные устройства. В статье представлена обобщенная информация о результатах исследования особенностей использования электронных устройств детьми дошкольного возраста, описана роль родителей в организации этого вида деятельности детей. Сбор литературных данных проводили с использованием баз данных научных электронных библиотек eLibrary, КиберЛенинка, PubMed. Область поиска — 2017–2024 гг. Анализ литературных данных выявил отсутствие у большинства родителей навыков приобщения детей к безопасному использованию электронных устройств, недостаточную информированность родителей о возможных нарушениях здоровья и мерах профилактики. Указанные обстоятельства могут быть причиной формирования отрицательного опыта использования электронных устройств детьми, в том числе дошкольного возраста, и требуют проведения информационно-консультационной работы с родителями дошкольников по вопросам цифровой безопасности и правилам знакомства детей с электронными устройствами.

Ключевые слова: дети дошкольного возраста, электронные устройства, цифровая среда, роль родителей, информированность, сформированность навыков

Вклад авторов: С. В. Маркелова — концепция, анализ и интерпретация данных, редактирование рукописи; И. О. Решетникова, С. А. Дарищев — сбор и анализ данных, написание черновика рукописи.

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Статья получена: 22.12.2024 **Статья принята к печати:** 25.04.2025 **Опубликована онлайн:** 19.06.2025

DOI: 10.24075/rbh.2025.130

The development of digital technologies and their application in all spheres of life translates into availability of electronic devices to all categories of the population, including preschool children [1]. Basic and additional education programs rely on such devices to a significant degree. They allow learning social skills [2, 3] and ensure the child develops harmoniously in the context of the accelerating digitalization of society [4]. Parents are directly involved in introducing preschool children to the world of digital technologies; by their own example, they show children how such technologies are used, and, to the best of their understanding, teach the respective rules of use and critical thinking skills applicable to the process of consumption of digital content. Thus, the parents' knowledge and skills pertaining to the safe employment of electronic devices are the basis for the respective skills that their preschool children are developing. Other important factors are the nature and degree of influence of electronic devices on the health

of children and adolescents, including functional state of their vision and the nervous and musculoskeletal systems [5–8].

When exceeding the allowed time for using electronic devices becomes a routine practice, significant changes may occur in the body's organs and systems that promote chronic diseases. Understanding the nuances of how children use such devices as well as the specifics of development of the related skills would enable designing effective strategies aimed at minimizing health risks and consolidating the positive effects of children's interaction with digital technologies.

This study aimed to summarize the existing knowledge about the role of parents in the process of development of skills of use of digital devices by their preschool children.

The article analyzes the available data describing the frequency and duration of use of electronic devices by preschoolers, the degree of parental control over how, for what, and when children interact with such devices, provides information

about the reasons of giving them to children, and outlines their reactions to the attempts to take the devices away. The data were collected from papers published from 2017 through 2024 and available in eLibrary, CyberLeninka, and PubMed.

The analysis of the available related literature revealed that the subject has not been investigated sufficiently, which necessitates further studies looking into the reasons why preschoolers disobey the electronic devices safe use rules and supporting the development of the effective ways to prevent health disorders in this cohort and children in general.

The papers on the subject published thus far show that the frequency of use of electronic devices by preschool children has increased significantly in the past decades. The reasons behind this phenomenon are the development of technology in general, the increasing availability of digital devices in everyday life, and their growing attractiveness in the eyes of preschoolers. Currently, the mean age of the first stable contact with smart devices is 3.5 years. As of 2024, the number of children who started using electronics before they reached school age has doubled in the last four years. Every second (53%) child is initiated with such devices before the age of two, and 4.5% of children receive one before turning 6 months old. On weekdays, 64% of children count approximately an hour of screen time, and the remaining 36% — up to 3 hours. On weekends, about 8% of preschoolers use electronic devices for more than three hours [2]. Every third (28.1%) preschool child accesses the Internet, and the rest of them use electronic devices for offline activities, viewing already downloaded cartoons and playing games. As for the type of electronic devices themselves, the devices of choice for most preschoolers are tablets, smartphones, and laptops. According to surveys, children aged 3–6 are more likely to prefer tablets (12.2%) than smartphones (9.4%) or laptops (8.6%), as tablets combine the convenient aspects of both of them, featuring a larger and brighter screen and being easy to transport [9]. Given the affordability of electronic devices, a considerable number of these preschool children (from 23.5 to 49%, according to various sources) have a tablet of their own [1, 3]. The main type of activities they indulge in are watching cartoons and other entertainment videos for children (about 94%), and playing mobile games (about 72%). Research shows that preschoolers' preferences in digital games change with age from simple object manipulation games (ages up to 3 years) to story-based RPGs (ages from 4–6 years). The aspect of cybersecurity aspect is particularly important in the context of children browsing online resources. Almost every second child aged 5–7 years has encountered hazards on the Internet, the most common of which have to do with technical and content components, including uninitiated video playback, intrusive banners, frightening or obscene content, and infection of devices with malware [9].

Public opinion research shows that parents realize the dual role of electronic devices: they can be a practical learning and entertainment tool, or turn into a source of threats to the child's mental and physical health [1–3]. In this connection, monitoring the use of such devices should become an important component of the process of upbringing, because preschoolers are unable to control their gadget addiction — they will use electronic devices until they get bored. The parents may enforce the screen time limits and oversee the quality of the content that children access, thus mitigating the risk of exposure of the child to age-inappropriate information preventing early problems with the visual analyzer. Technologically, they can use special applications and built-in functions (parental control) to set the said limits and content filters, ensuring their children stay safe while using electronic devices. Secondly, supervision

from parents helps children to learn the basics of digital literacy and use electronic devices responsibly. Discussing the rules of electronic device application and explaining potential threats, parents help children develop critical thinking and the ability to make their own decisions in the digital realm. Such communication helps children understand how important it is to maintain a balance between online activity and real life. In addition, this sort of control has a positive effect on family ties, as joint discussion of topics related to electronic devices improves the general quality of communication and enhances intergenerational understanding. Parents and children learn to hear each other better, which fosters a more trusting and open atmosphere in the family.

However, research shows that half (43.8%) of parents give an electronic device to their children spontaneously, and a quarter (24.8%) do it consciously, believing that they are useful. The majority (64.4%) of parents admit that they do so to take a break from their child. Only one in ten (11.4%) parents offers educational applications, the rest turn on cartoons and games [10, 11].

As for the attitude of parents towards the use of electronic devices by their children, the studies revealed three stances: "unlimited" (42%), "normal" (46%) and "prohibitive" (13%). Parents practicing the prohibitive stance do not allow their children to use any electronic devices. Those from the normal stance cohort allowed using one specific electronic device, be it a tablet, phone, or computer. The unlimited stance is self-descriptive: children see no restrictions when it comes to electronic devices. Most parents allow their children no more than one or two hours of screen time a day, with the process mainly controlled by mothers. Electronic devices are mainly used to consume age-appropriate entertainment content, such as cartoons and computer games, and to use educational applications that help in preparing for school. Parents can increase screen time as needed to complete educational activities that are important for the positive development of children [11, 12].

Data from other literary sources indicate that Russian parents of preschoolers largely prefer a restrictive approach to their children's media activity. Two thirds of parents (60%) reported that they limit their children's screen time, and a third (35%) actively participates in choosing the content and explains their children which media resources are safe and which are not. Only half (54.4%) of children hear the rules of using electronic devices from their parents, one in five (21.7%) receive this information from older siblings, and one in three (30%) children learns how to use electronic devices on their own. Only 22.2% of children easily put down electronic devices when asked to do so by their parents, with 52.8% of children doing this reluctantly. A smaller proportion of parents practice joint use of electronic devices, as they typically have their own business to attend to and only give the children electronic devices as a temporary distraction [13, 14].

A significant number of parents give ambiguous answers to questions about their children's access to electronic devices, which indicates that they do not have a clear screen time strategy for their children [14].

CONCLUSION

The analysis of the previously published studies reveals that the culture of electronic device usage is low in families with preschoolers, and parents act irresponsibly due to their incompetence in the matters of digital safety. The possible reasons behind this situation is the low level of awareness of parents about health risks associated with electronic devices,

and lack of accessible, reliable and complete information about how to use them safely [15]. Thus, the issues of digital safety of the population in general and preschoolers in particular should form the basis of the hygienic training programs for both children and their parents, as well as those involved in the processes of upbringing and education. This work

should be integrated into the overall system of education to ensure it is supported by a methodological foundation and is carried out consistently and systematically. The involvement of parents of preschoolers will help to improve their digital security competencies and encourage them to strengthen control over how their preschool children use electronic devices.

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OCCUPATIONAL BURNOUT SYNDROME AMONG MEDICAL UNIVERSITY STUDENTS AND GENERAL PRACTITIONERS

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Occupational burnout (OB) negatively affects the quality of medical care provided. The subject of occupational hygiene among medical students combining studying and work has not been investigated sufficiently. This study explores OB in medical university students and general practitioners who actively use information and communication technologies in their daily activities. The goal was to look into the features of OB in these cohorts, identify the main risk factors, and give burnout prevention and mitigation recommendations. We examined 140 general practitioners (94 females, 46 males) aged 27–75 years (mean age 46.16 years [95% CI: 35.49–56.83]). As for students, the participants were from the Pirogov University, 39 female and 25 male, aged 20–25 years (mean age 22.42 years [95% CI: 22.23–22.61]). To assess the risks of burnout, we used the Boyko questionnaire and Maslach Burnout Inventory (MBI). The survey revealed clinically significant signs of OB in 96% of general practitioners and 16% of working students. According to the MBI's emotional exhaustion subscale the corresponding scales of the Boyko questionnaire, OB was significantly more prevalent among working students than among their peers who did not work (mean MBI scores 14.6 [95% CI: 10.8–18.4] and 12.7 [95% CI: 8.34–17.06], respectively, $p = 0.00362$; mean Boyko questionnaire scores 89.1 [95% CI: 72.9–105.3] and 74.7 [95% CI: 69.8–79.6], respectively, $p < 0.00001$). Both tools show the clinical signs of OB to be significantly more severe among general practitioners than in the cohort of working students ($p < 0.00001$). It has been proven that students who combine work and study face a higher risk of OB due to increased academic and additional workloads, along with elevated stress levels.

Keywords: performance of medical professionals, overwork, occupational burnout syndrome, secondary employment, students, job, medicine

Author contribution: Kaminer DD — research, its results processing and description, article authoring and formatting; Selezneva MA — research, its results processing and description; Kozelsky AS — description of the results of the research, literature selection and review, manuscript authoring.

Compliance with ethical standards: the experimental study was conducted in compliance with the applicable regulations (the Declaration of Helsinki, version of 2013). The study was approved by the Ethics Committee of the Pirogov Russian National Research Medical University of the Ministry of Health of the Russian Federation (Minutes No. 192 of January 27, 2020).

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Received: 01.04.2025 **Accepted:** 12.05.2025 **Published online:** 23.06.2025

DOI: 10.24075/rbh.2025.131

СИНДРОМ ПРОФЕССИОНАЛЬНОГО ВЫГОРАНИЯ У СТУДЕНТОВ МЕДИЦИНСКОГО УНИВЕРСИТЕТА И ВРАЧЕЙ-ТЕРАПЕВТОВ

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Синдром профессионального выгорания (СПВ) отрицательно влияет на качество оказываемой медицинской помощи. Наблюдается дефицит исследований по гигиене труда работающих студентов медицинских вузов. Представленное исследование посвящено изучению СПВ у студентов медицинского университета и врачей-терапевтов, активно использующих информационно-коммуникационные технологии в повседневной деятельности. Целью исследования было изучить особенности проявлений СПВ у работающих студентов медицинского университета и врачей-терапевтов, выявить основные факторы риска и привести рекомендации по профилактике и снижению уровня выгорания. Обследованы 140 врачей-терапевтов (94 женщины и 46 мужчин) 27–75 лет (средний возраст 46,16 лет [95% ДИ: 35,49–56,83]). Из студентов Пироговского университета в исследовании приняли участие 39 девушек и 25 молодых людей 20–25 лет (средний возраст 22,42 года [95% ДИ: 22,23–22,61]). Для оценки рисков выгорания использовали опросник по В. В. Бойко, опросник профессионального выгорания Маслач (MBI). У 96% опрошенных врачей-терапевтов и 16% работающих студентов по результатам анкетирования выявлены клинически значимые признаки СПВ. По шкале эмоционального истощения MBI и шкалам опросника Бойко распространенность СПВ значимо выше в группе работающих студентов, чем в группе неработающих студентов (средний балл по шкале MBI — 14,6 [95% ДИ: 10,8–18,4] и 12,7 [95% ДИ: 8,34–17,06] соответственно, $p = 0,00362$; по шкале Бойко — 89,1 [95% ДИ: 72,9–105,3] и 74,7 [95% ДИ: 69,8–79,6] соответственно, $p < 0,00001$). Согласно результатам опросников MBI и Бойко, выраженность клинических признаков СПВ у врачей-терапевтов значительно выше, чем у работающих студентов ($p < 0,00001$). Доказано, что у студентов, предпочитающих работать во время обучения, выше риск развития СПВ, что связано с повышенными учебными и дополнительными рабочими нагрузками, а также с повышенным уровнем стресса.

Ключевые слова: работоспособность врачей, переутомление, синдром профессионального выгорания, вторичная занятость, студенты, трудоустройство, медицина

Вклад авторов: Д. Д. Каминер — проведение исследований, обработка и описание результатов исследования, написание и оформление статьи; М. А. Селезнева — проведение исследований, обработка и описание результатов исследования; А. С. Козельский — описание результатов, работа с литературой, написание рукописи.

Соблюдение этических стандартов: экспериментальное исследование проводили с соблюдением необходимых нормативных актов (Хельсинкской декларации 2013 г.). Исследование одобрено этическим комитетом ФГАОУ ВО «Российский национальный исследовательский медицинский университет имени Н. И. Пирогова» Минздрава России (протокол № 192 от 27 января 2020 г.).

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Статья получена: 01.04.2025 **Статья принята к печати:** 12.05.2025 **Опубликована онлайн:** 23.06.2025

DOI: 10.24075/rbh.2025.131

Occupational burnout syndrome (OB) is a serious problem in modern society, especially in the areas associated with high emotional and psychological stress [1–10]. Medical care, which involves constant interaction with patients, responsible decision-making, and working under pressure, is one of activities most susceptible thereto. There are two key groups that require special attention: medical university students who are just starting their professional career, and practicing general practitioners who face high workloads on a daily basis [2, 3, 10]. Current generations of medical students have some special traits, including secondary employment, i.e., combining work and studying at the university [11–14]. Many researchers note that the number of working students is growing today [11], which calls for a comprehensive analysis of this cohort. The relevance of the work stems not only from the effect of OB on the psychosomatic health of medical students but also from the syndrome's impact on their theoretical and practical preparedness for future work, as well as from the increasing quality demands in medical care and the growing burden on the healthcare system [2, 3, 10]. It is assumed that medical students may experience burnout during their education, which negatively affects their motivation and professional development.

General practitioners, manning the front line of the medical care system, can suffer performance deterioration and emotional exhaustion due to the burnout, with subsequent worsening of the quality of services provided [15–17]. The concept of "emotional burnout" was first proposed by H.J. Freudenberger in 1974 [16]. He described this phenomenon as a condition linked to fatigue and frustration, manifesting in physical and emotional exhaustion and associated with professional dissatisfaction and elevated stress levels. Modern medicine has the burnout syndrome included in the ICD-10 as Z73.0. There are three key symptoms thereof: emotional exhaustion (EE), which encompasses depression, psychological fatigue, loss of energy, and decreased emotional responsiveness; depersonalization (DP), manifesting in a formal, detached and indifferent attitude towards patients; reduced professional efficacy (RPE), characterized by a negative assessment of one's own professional qualities, a feeling of incompetence, and inability to work effectively [15, 18–23].

This study aimed to investigate the features of OB in working medical students and general practitioners, identify

the main risk factors, and give burnout prevention and mitigation recommendations. The results of this work can be used to improve the psychological well-being of medical professionals and students, and to enhance the quality of medical education and care.

METHODS

The study included 140 general practitioners (94 females and 46 males) aged 27–75 years (mean age 46.16 years [95% CI: 35.49–56.83]). As for students, the participants were from the Pirogov University, 39 females and 25 males, aged 20–25 years (mean age 22.42 years [95% CI: 22.23–22.61]). In addition, we recruited 20 students who did not combine work and study, 14 females and 6 males (mean age 22.43 ± 0.2 years [95% CI: 22.23–22.63]).

The questionnaire "Degree of Chronic Fatigue" (A.B. Leonova and I.V. Shishkina, revision of 2003) was used to assess concentration and performance during the working day and week, as well as to identify the preclinical symptoms of fatigue.

To assess the risks of burnout, we used:

- V.V. Boyko emotional burnout scale;
- Maslach Burnout Inventory (MBI) adapted for medical professionals (Bekhterev Psychoneurological Institute, 2007).

The collected data were processed using descriptive and comparative statistical methods. We applied the descriptive methods to all the indicators: calculated the arithmetic mean, standard error, and minimum and maximum values for quantitative variables, frequency and percentage of the total number for qualitative variables. The data series were presented as \bar{x} [95% CI: LL–UL], where:

- \bar{x} is the mean;
- [95% CI: LL–UL] is the 95% confidence interval, which defines the range where the true mathematical expectation of the general population lies with a 95% probability.

For statistical analysis, we used the Kruskal–Wallis test for independent groups (as applicable to the distribution of the sample population) and the Mann–Whitney test for independent groups. The software selected for processing was Statistica 12.0 for Windows (StatSoft; USA), which was also used to determine the exact values of the corresponding confidence probability (p) and significant differences in the arithmetic means.

The level of emotional exhaustion among general practitioners (MBI results)

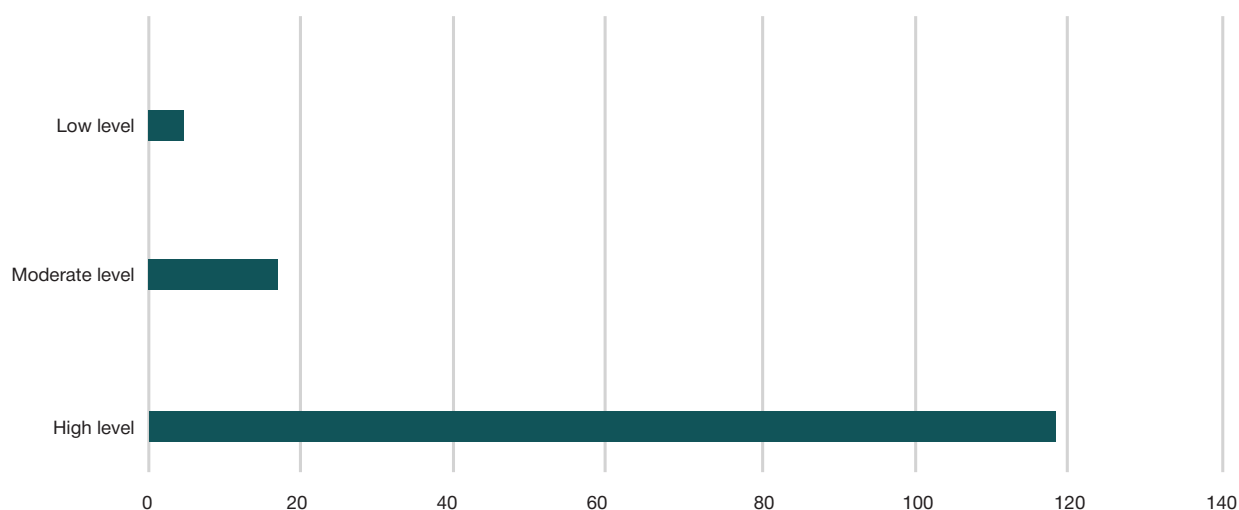


Fig. 1. The levels of emotional exhaustion among general practitioners using information and communication technologies in their daily clinical practice (MBI results)

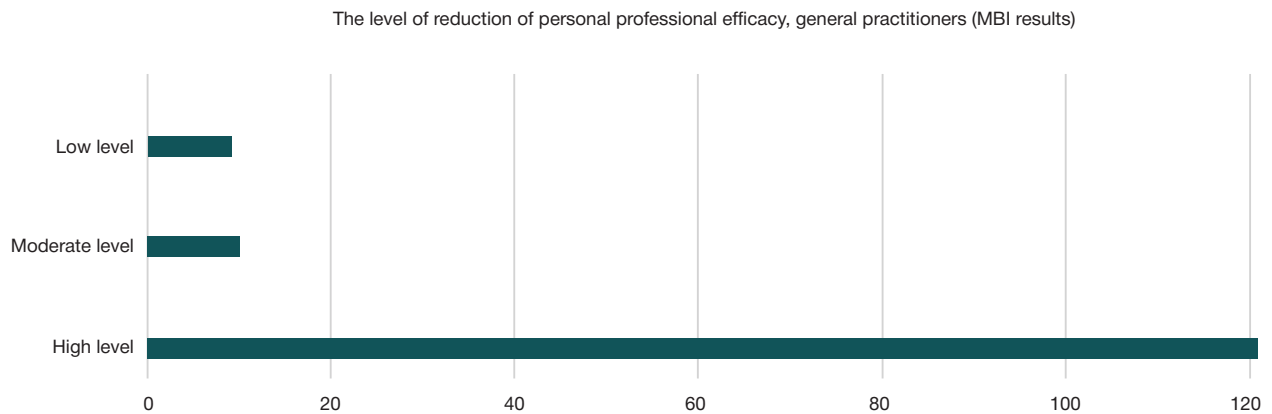


Fig. 2. Indicators of reduction of personal professional efficacy, general practitioners (MBI results)

RESULTS

According to the collected data, all respondents (doctors and students) use various information and communication technologies (ICTs) in their work. MBI results revealed that most general practitioners ($n = 118.84\%$ [95% CI: 78.0–90.0]) using ICTs in daily clinical practice have a high level (more than 26 points) of emotional exhaustion. Twelve percent ($n = 17$) [95% CI: 6.6–17.4] of the respondents from this cohort were moderately exhausted, and only 4% ($n = 5$) [95% CI: 0.75–7.25] showed a low level of emotional exhaustion (Fig. 1).

Among general practitioners, the analysis of the MBI results revealed the occupation-related emotional exhaustion level to be at 38.9 [95% CI: 29.1–48.7] points. The depersonalization score in this cohort was 23.1 [95% CI: 18.8–27.4] points, with all respondents ($n = 140$) exhibiting a high level of this indicator (over 10 points).

The next indicator was professional efficiency. The results of the MBI revealed that most general practitioners ($n = 121$) (86% [95% CI: 80.25–91.75]) had it reduced highly (scored less than 33 points), while 8% ($n = 10$) [95% CI: 3.5–12.5] exhibited moderate reduction (scored 34–39 points), and 6% ($n = 9$) [95% CI: 2.07–9.93] became only slightly less effective than usual (Fig. 2). As for the reduction of the personal professional efficacy, the scores for the respective indicators were 27.9 ± 6.1 points [95% CI: 21.8–34.0].

The results of analysis of data collected using the Boyko questionnaire showed that the majority of the participating general practitioners ($n = 107$, 76% [95% CI: 68.9–83.1]) had clinically significant signs of OB, while in 24% ($n = 33$) [95% CI: 16.9–31.1] the burnout symptoms were moderately severe (Fig. 3). The aggregate emotional burnout indicator score, which factors in all the three phases, stress, resistance, and exhaustion, was 214.4 ± 41.0 points [95% CI: 207.61–221.19].

Thus, the majority of the participating general practitioners had clinically significant symptoms of OB.

In the student group, 64 participants (76% [95% CI: 66.9–85.1]) were working, most of them in medicine (Fig. 4).

According to the MBI results, 16% ($n = 10$) [95% CI: 7.02–24.98] of working students exhibited signs of OB (Fig. 5).

Within this cohort, working students significantly more often exhibited clinical signs of OB (as per the related MBI scale) than their non-working peers: mean scores of 14.6 [95% CI: 10.8–18.4] and 12.7 [95% CI: 8.34–17.06], respectively; Mann–Whitney test $U = 362$, $p = 0.00362$. As for the depersonalization and professional efficacy indicators, there were no significant differences between working and non-working students: mean scores 10.6 [95% CI: 8.23–12.92] and 11.65 [95% CI: 9.91–13.39], respectively; $U = 460$, $p > 0.06$). The comparative analysis of all the Boyko questionnaire scales revealed that working students had clinical signs of OB significantly more often than non-working students: mean scores of 89.1 [95% CI: 72.9–105.3] and 74.7 [95% CI: 69.8–79.6], respectively; $U = 48$, $p < 0.00001$.

Thus, it was established that students who combine work and study face a higher risk of OB due to increased academic and additional workloads, along with elevated stress levels.

The results of comparative analysis of the severity of clinical signs of OB in general practitioners, working and non-working students, as collected using MBI, revealed that general practitioners had significantly higher scores on the scales of emotional exhaustion, depersonalization, and reduced professional efficacy than students (Kruskal–Wallis test $H = 156.6$, $p < 0.00001$; $H = 156.7$, $p < 0.00001$; $H = 112.6$, $p < 0.00001$, respectively). A similar analysis was conducted using the data collected with the Boyko questionnaire, and it showed similar results: general practitioners had significantly more pronounced clinical signs of OB than students ($H = 158.8$, $p < 0.00001$).

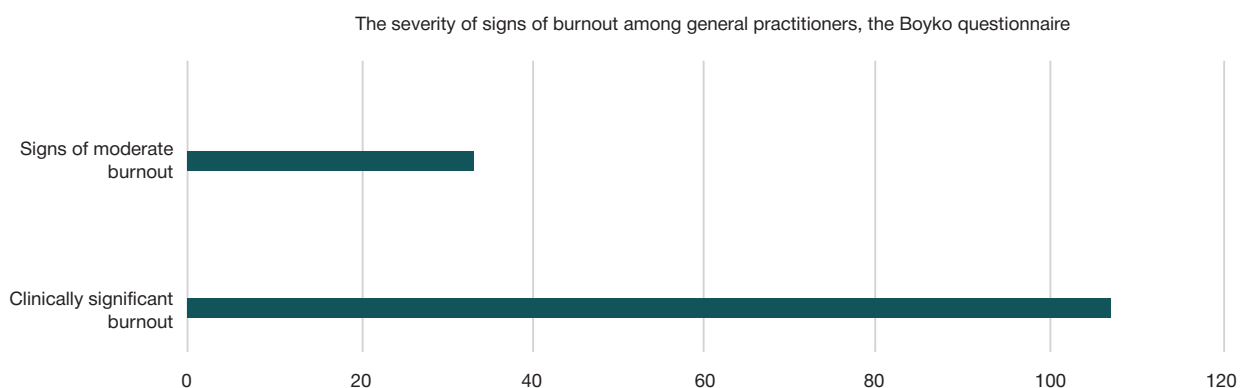


Fig. 3. Burnout indicators for general practitioners, all scales, the Boyko questionnaire

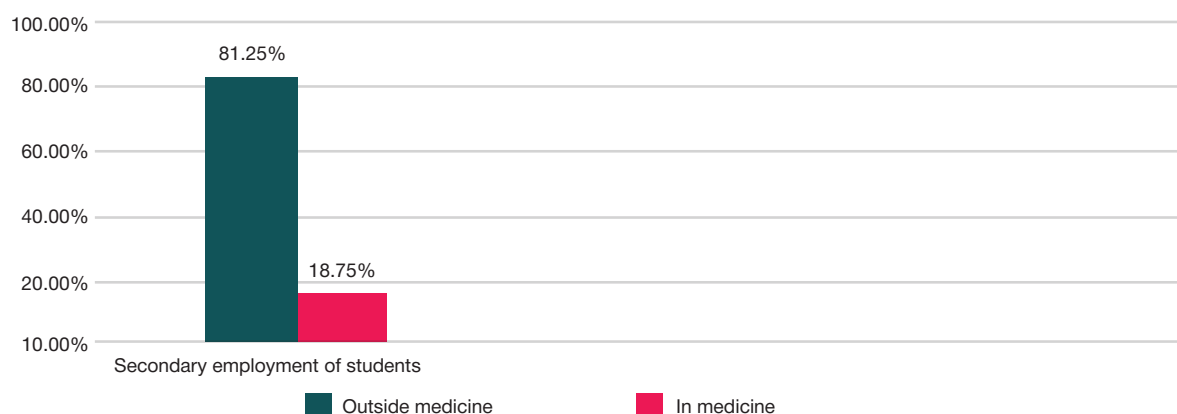


Fig. 4. The choice of the field of activity by working students of a medical university

Sixteen percent of students with burnout syndrome ($n = 10$) [95% CI: 7.02–24.98] had more than two years of experience working in the medical field as secondary employment and were in their 5th or 6th year of education. Eighty percent ($n = 8$) [95% CI: 61.79–98.21] of students with burnout syndrome worked as junior medical staff in departments characterized by high physical, emotional, and psychological stress, such as intensive care, oncology, and emergency surgery. It should be noted that all students experiencing burnout syndrome reported a decline in their motivation to continue working in their specialty after graduating from medical school. Those working in the medical field and not suffering from emotional burnout (81% ($n = 42$) [95% CI: 75.02–92.98]) noted a significant increase in motivation to continue working in their specialty after completing their studies at the medical university.

DISCUSSION

The study of OB among general practitioners and working medical students revealed significant differences in the prevalence and severity of this syndrome between the two groups. Clinical signs of OB, ranging from moderate to severe, were observed in all general practitioners. In contrast, only 16% (10 individuals) [95% CI: 7.02–24.98] of the student cohort exhibited symptoms of the condition. The results of this study confirm that general practitioners are at an increased risk of developing OB, which is consistent with the data from numerous works indicating that medical professionals, especially those who work in primary health care, are subject to high emotional and physical stress [1–8, 22–25]. The main OB risk factors general practitioners are exposed to are as follows [1–10, 22–24]:

- high workload (general practitioners often treat a large number of patients, which leads to chronic overwork);
- emotional strain (constant interaction with patients, the need to make responsible decisions and face negative treatment outcomes create significant emotional stress);

- administrative barriers (increased bureaucratic burden, the need to fill out a large number of documents and limited resources of the healthcare system);

- lack of support (in some cases, lack of psychological and organizational support from management and colleagues also contributes to the development of burnout).

The presence of signs of OB among working students indicates that some of them are already experiencing professional stress, which may be caused by the combination of study and work, high academic and workload, or lack of experience in stress management. Our results show that students working in departments characterized by high physical, emotional, and psychological stress — such as intensive care, oncology, and emergency surgery — face a higher risk of OB (80%, $n = 8$, 95% CI: 61.79–98.21). It should be noted that most medical students (81.25%) chose to work in the medical field while studying, whereas their peers pursuing other fields of education largely preferred employment outside their area of study [17]. General practitioners with many years of work experience suffer from accumulated stress, which leads to severe burnout: for them, the total emotional exhaustion risk score under the Boyko questionnaire (tension, resistance, and exhaustion scales) was 214.4 ± 41.0 points [95% CI: 207.61–221.19]. In addition, general practitioners scored significantly higher than students on the emotional exhaustion, depersonalization, and professional efficacy reduction scales ($H = 156.6$, $p < 0.00001$; $H = 156.7$, $p < 0.00001$; $H = 112.6$, $p < 0.00001$, respectively). Moreover, the severity of clinical signs of OB in them was also significantly than among students ($H = 158.8$, $p < 0.00001$), which is associated with longer work under conditions of increased workload and stress [2]. At the same time, some of the surveyed students who are starting their professional career also exhibit first signs of OB (16% [95% CI: 7.02–24.98] ($n = 10$)), which necessitates a more in-depth study of the problem of OB not only among general practitioners but also among medical students.

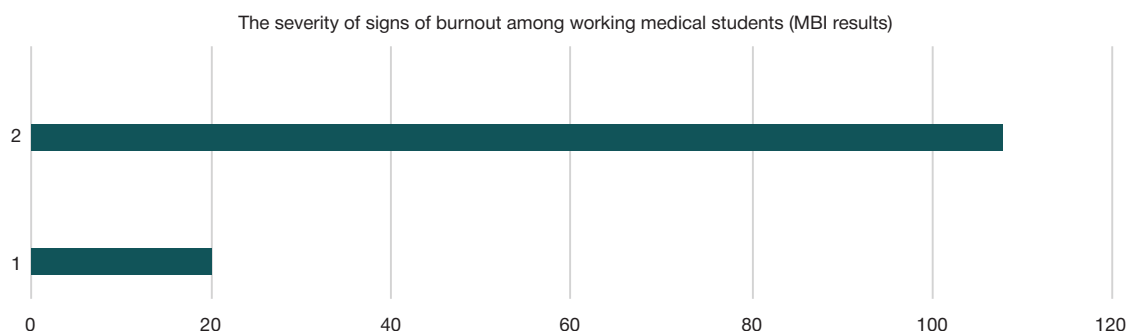


Fig. 5. Indicators of signs of burnout among working medical students (MBI results)

CONCLUSIONS

The results of this study emphasize the need for attention to the problem of occupational burnout among both practicing doctors and working medical students. Early diagnosis

and prevention of burnout can help preserve the health of healthcare professionals, improve the quality of medical care, and enhance the sustainability of the healthcare system as a whole. It will also help students not to give up their profession and maintain their interest in work and health.

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EVALUATING THE OCCUPATION-RELATED HARM TO THE HEALTH OF ORE MINING WORKERS USING TARGET PROTEIN ANALYSIS

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Exposure to harmful and dangerous factors at ore mining facilities poses health risks to workers that are associated with prolonged exposure to airborne chemicals in the work area. Realized, these risks undermine physical condition of people doing key ore mining jobs underground. Relying on the target protein analysis, this study aimed to assess the job-related harm to the health of ore mining workers resulting from exposure to metals airborne in the work zone. The participants were involved in copper-nickel ores mining. To evaluate the impact of metals from the working zone air on their health, we conducted chemical, proteomic, statistical, and bioinformatic analyses on the collected samples and data. With the mean per-shift exposure to metals of up to 0.2 mg/m³ (up to 4 times the MPC), the blood supernatant concentrations of cobalt, chromium, nickel, copper, and manganese increased by 1.4 to 2.6 times in the study group compared to the control group. Comparison of proteomics datasets revealed 33 significantly different protein spots. In 15 of them, the change in intensity was related to the increased concentration of the considered metals in the supernatant. Identification and analysis of proteins from these spots revealed their association with impairments in the functions of the nervous, cardiovascular, and digestive systems. The identified proteins were involved in the development of oxidative stress, metabolic and neurodegenerative disorders. Proteomic analysis improves the prediction and early prevention of occupational adverse outcomes among the ore mining industry workers.

Keywords: mining workers, metals, exposure, proteomic profiling, adverse outcomes, risk prognosis and prevention

Funding: the study was carried out at the expense of the federal budget as part of a state assignment for the Federal Scientific Center for Medical and Preventive Health Risk Management Technologies of the Federal Service for the Oversight of Consumer Protection and Welfare of the Russian Federation.

Acknowledgements: the authors express their gratitude to the staff of the Occupational pathology Department of the Regional Center for Occupational Pathology of the Krasnoyarsk Regional Clinical Hospital for their assistance in organizing and conducting research by the Federal Scientific Center for Medical and Preventive Health Risk Management Technologies (Department of Biochemical and Cytogenetic Research Methods).

Author contribution: Zaitseva NV — editing; Fadeev AG, Goryaev DV, Zemlyanova MA — study concept and design, editing; Peskova EV — study concept and design, literature data acquisition, manuscript writing; Bulatova NI, Galiulina AV, Zakharinskaya ON — data processing; all authors — approval of final version of the article, responsibility for consistency of all parts of the article.

Compliance with ethical standards: the study involved employees of a mining facility (copper-nickel production); it was conducted in accordance with international standards of medical practice (Declaration of Helsinki, revision of 2013, 2024) and approved by the Ethics Committee of the Federal Scientific Center for Medical and Preventive Health Risk Management Technologies (Minutes No. 4 of February 24, 2022).

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Received: 26.05.2025 **Accepted:** 06.06.2025 **Published online:** 25.06.2025

DOI: 10.24075/rbh.2025.132

ОЦЕНКА НЕГАТИВНЫХ ЭФФЕКТОВ У РАБОТНИКОВ ПРЕДПРИЯТИЯ ГОРНОРУДНОЙ ПРОМЫШЛЕННОСТИ ПОСРЕДСТВОМ ИССЛЕДОВАНИЯ БЕЛКОВ-МИШЕНЕЙ

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Воздействие вредных и опасных производственных факторов на предприятиях горнорудной промышленности формирует риски для здоровья работников при длительной производственной экспозиции химическими веществами с воздухом рабочей зоны. Реализация риска может формировать ущерб здоровью работников основных профессий подземной добычи руд. Целью работы было оценить негативные эффекты у работников предприятия горнорудной промышленности, подвергающихся воздействию металлов с воздухом рабочей зоны, путем исследования белков-мишеней. Методы химико-аналитического, протеомного, статистического и биоинформационного анализа применены для оценки воздействия металлов с воздухом рабочей зоны на работников подземной добычи медно-никелевых руд. Среднесменная экспозиция металлами на уровне до 0,2 мг/м³ (до 4 ПДК) обуславливает повышение концентрации кобальта, хрома, никеля, меди и марганца в супернатанте крови работников группы наблюдения в 1,4–2,6 раза относительно аналогичных показателей группы сравнения. Сравнительный анализ протеомных карт выявил 33 значимо различающихся белковых пятна, из которых в 15 имела место связь изменения интенсивности с повышением концентрации изучаемых металлов в супернатанте. Идентификация и анализ белков, обнаруженных в указанных белковых пятнах, показали, что они ассоциированы с нарушением функций нервной и сердечно-сосудистой систем, органов пищеварения. Выявленные белки участвуют в развитии окислительного стресса, метаболических и нейродегенеративных нарушений. Внедрение протеомного исследования повышает эффективность прогнозирования и ранней профилактики производственно-обусловленных неблагоприятных исходов у работников горнорудной промышленности.

Ключевые слова: работники горнорудного производства, металлы, экспозиция, протеомное профилирование, неблагоприятные исходы, прогноз и профилактика риска

Финансирование: исследование выполнено за счет средств федерального бюджета в рамках государственного задания для ФБУН «ФНЦ медико-профилактических технологий управления рисками здоровью населения» Федеральной службы по надзору в сфере защиты прав потребителей и благополучия человека.

Благодарности: авторы выражают благодарность работникам профпатологического отделения краевого центра профессиональной патологии КГБУЗ «Краевая клиническая больница» г. Красноярск за помощь в организации и проведении исследований ФБУН «ФНЦ медико-профилактических технологий управления рисками здоровью населения» (отдел биохимических и цитогенетических методов исследования).

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Соблюдение этических стандартов: исследование с участием работников горнорудного предприятия (на примере медно-никелевого производства) проведено в соответствии с представленными международными нормами медицинской деятельности (Хельсинкская декларация Всемирной медицинской ассоциации 2013, 2024 г.) и одобрено комитетом по этике ФБУН «ФНЦ медико-профилактических технологий управления рисками здоровью населения» (протокол № 4 от 24 февраля 2022 г.).

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Статья получена: 26.05.2025 **Статья принята к печати:** 06.06.2025 **Опубликована онлайн:** 25.06.2025

DOI: 10.24075/rbh.2025.132

Ore mining industry is one of the leading sectors of the economy of the Russian Federation. According to the Federal State Statistics Service, more than 1 million people are employed in this industry. This supports the importance of efforts aimed at preservation of health of workers engaged in the production of metal ores (underground mining in the first place). The said production involves a complex of interrelated process stages, from the extraction of ore, its enrichment, through metallurgical conversion, further processing, to loading and unloading operations and transportation of raw materials and metal products. The key stage, however, is the extraction of raw materials for subsequent processing, and it determines the basic harmful and dangerous factors peculiar to the production environment and the labor process that affect the health of underground miners [1, 2].

There is a number of specific harmful and hazardous dangerous factors associated with underground mining operations, including dust the chemical and fractional composition of which depends on the type of ore being mined [3, 4]. This dust is composed of particles of various sizes, including ultrafine (0.1–10 microns). Such particles can adversely affect critical organs and systems after transition from the lungs into the systemic circulation [5]. They acquire the transition ability once covered with a layer of absorbed proteins and forming a unique crown that allows them to penetrate the aero-hematic barrier [6]. The bloodstream carries the particles to sensitive receptors in critical organs and systems such as the liver, spleen, heart, kidneys, lymph nodes, and brain; there, they initiate metabolic disorders at the cellular and molecular levels [7, 8].

Postgenomic technologies, including proteomics, are widely used to study the toxic effects of chemicals and early detection of the associated negative effects [9, 10]. The study of changes in the expression of proteins and peptides grants insights into physiological processes and disorders of the balance of homeostasis at the cellular and molecular levels [11]. The identified changes in the protein composition of the biological media (plasma, serum, urine, etc.) allow investigating the reactions of the molecular dynamic equilibrium and how the negative effects occur and develop under the influence of harmful and hazardous factors of the industrial environment, including the chemical factor [12, 13].

Relying on the target protein analysis, this study aimed to assess and determine ways for early detection of job-related harm to the health of ore mining workers resulting from exposure to metals airborne in the work zone.

METHODS

The study was conducted from April 14, 2024 to April 15, 2025, and included 113 employees of a mining facility. For both the control group and the study group, the inclusion criteria were: male gender, age 30–65 years, over a year of employment at the facility, satisfactory hygienic conditions and socio-economic standard of living; specific to the study group: professional activities related to underground mining of copper-nickel ores; specific to the control group: professional activities not involving exposure to harmful factors of the production environment and labor process. Exclusion criteria: acute infectious diseases within 4 weeks before the start of the study, intake of medications that have a pronounced effect on the intended target organs less than 30 days before the start of the study. Under these criteria, the study group was comprised of 39 men mining copper-nickel ores underground and representing the key professions: ore face miner, blaster, borer, pitman, fastener, trolley driver, drilling rig driver. Their work experience

at the facility was 18.2 ± 1.0 years, mean age — 47.95 ± 0.87 years. The comparison group included 74 employees of the facility's administrative staff. They were employed by the company for 17.1 ± 1.05 years, and their mean age was 47.1 ± 0.83 years ($p \leq 0.05$ relative to the study group, both figures). Thus, by the above criteria, the groups were comparable, and differed in the fact of exposure to harmful and hazardous factors of the production environment.

The participants' blood was sampled at the Occupational pathology Department of the Regional Center for Occupational Pathology of the Krasnoyarsk Regional Clinical Hospital (head of the department — O.N. Zakharinskaya, occupational therapist — A.V. Galiulina). The samples were analyzed at the on the basis of the Federal Scientific Center for Medical and Preventive Health Risk Management Technologies.

The fact of exposure was confirmed by chemical testing of supernatant isolated from whole blood, conducted to determine the concentration of ions of six metals (cobalt, manganese, copper, nickel, lead, chromium). Fasting blood samples were collected from the ulnar vein using a disposable device. To make supernatant, we destroyed shaped blood elements in a lysing buffer (ratio 3 : 10), put the samples through centrifugation at 14,000 rpm for 10 minutes (twice), and decanted them (separated solid and liquid phases). Metals were quantified by inductively coupled plasma mass spectrometry (ICP-MS) as prescribed in guidelines MUK 4.1.3230-14, MUK 4.1.3161-14. Agilent 7500cx mass spectrometer (Agilent Technologies; USA) was used for this task. The results were compared to those obtained in the control group. The concentration of proteins in the supernatant is higher than in whole blood, which supports the selection of the former as the biosubstrate.

Proteomic testing implied obtaining peptide samples from the blood supernatant, so it was subjected to 2D electrophoresis in polyacrylamide gel and stained with silver using the PROTEAN I12 IEF System and the PROTEAN II XL vertical electrophoresis cell (Bio-Rad; USA). The intensity of protein spots was determined with the help of GeL Doc XR+ gel documentation system (Bio-Rad; USA). To compare the groups' proteomics datasets by intensity, we used PDQuest (Bio-Rad; USA). Significantly different protein spots were excised and sequentially analyzed in an UltiMate 3000 chromatograph (Thermo Fisher Scientific; USA) and a 4000 QTRAP mass spectrometer (AB Sciex; USA), HPLC and tandem mass spectrometry, respectively. The resulting spectra were processed in the ProteinPilot program (AB Sciex; USA); for identification, we used the UniProt database, sampling by the Homo sapiens (Human) taxon. The assessment of metabolic disorders relied on the publicly available bioinformatic resources: UniProt (<http://www.uniprot.org>), Comparative Toxicogenomics Database (<http://ctdbase.org/>) and DisGeNET (<https://www.disgenet.org/dbinfo>).

The results of the data collection and processing stage were analyzed in Statistica 10 (StatSoft; USA), with the differences evaluated for statistical significance using the Mann-Whitney U test, $p \leq 0.05$). To build models illustrating the causal relationship between metal concentration in the supernatant and changes in the intensity of the protein spot, we used regression analysis. The determination factor (R^2) and the Fisher's exact test ($F > 3.96$) allowed assessing the statistical adequacy of the model. The Student's t -test ($p \leq 0.05$) was used to verify the statistical significance of the model.

RESULTS

Long-term mean per-shift exposure to airborne metals (cobalt, manganese, copper, nickel, lead, chromium) at the level

Table 1. Comparative analysis of the blood supernatant metal content, samples from workers in the main professions of underground mining of copper-nickel ores

Substance	Mean ($M \pm m$), mg/dm ³		The share of workers from the study group with indicator values higher than in the control group, %	The order to which the indicator value is greater than in the control group	Significance of differences between groups ($p \leq 0.05$)
	Study group	Control group			
Cobalt	0.0004 \pm 0.00005	0.0002 \pm 0.00006	66.4	2	0.011
Manganese	0.010 \pm 0.001	0.004 \pm 0.001	79.5	2.5	0.0001
Copper	0.834 \pm 0.034	0.446 \pm 0.041	79.1	1.9	0.0001
Nickel	0.0039 \pm 0.001	0.0015 \pm 0.0003	82.2	2.6	0.0001
Lead	0.113 \pm 0.018	0.081 \pm 0.010	28	1.3	0.994
Chromium	0.0038 \pm 0.001	0.0021 \pm 0.0005	95.4	1.8	0.002

of 0.004–0.2 mg/m³ (from 0.1 to 4 times the MPC) raises the concentration of these substances in the blood supernatant by 1.4–2.6 times, study group vs. control group ($p = 0.000$ – 0.011 ; Table 1).

The proportion of workers with elevated blood levels of metals in the study group relative to the comparison group was 66.4–95.4% of the total number of the examined participants.

Quantification of the supernatant proteomics datasets revealed 46 protein spots that exhibited different intensity in the study and control groups. The comparison of intensity of these pots identified significant differences for 33 of them. In 15 protein spots, the synthesis was boosted by 1.1–26.3 times ($p = 0.000$ – 0.021), and in 18 spots, it was decreased by 1.2–38.8 times ($p = 0.000$ – 0.033). Mass spectrometric identification showed that the detected amino acid sequences match 80 proteins from the ProteinPilot library.

For 15 protein spots out of 33 identified, we obtained the intensity change probability dependence models describing a situation in which the content of all elements (cobalt, chromium, nickel, copper, and manganese) grows in the blood supernatant. This allowed labeling the proteins of these spots as indicator proteins (Table 2).

Through bioinformatic analysis, we identified the genes encoding the indicator proteins and their associated diseases. It has been shown that changes in the expression of these genes play a certain role in the pathogenesis of negative effects in workers who had a higher amount of the considered metals in their blood supernatant. Primarily such effects were detected in the nervous (genes *MAP3K9*, *HLA-A*, *LDLR*, *LAMP2*, *AKT2*, *FNDC3B*, *FRRS1L*, *SPTBN4*) cardiovascular (genes *MAP3K9*, *HLA-A*, *LDLR*, *LAMP2*, *HRH1*) systems, and digestive organs (genes *LDLR*, *LAMP2*, *AKT2*). The initiation of these changes determines disorders at the molecular and cellular level, which are signaled by alterations of expression of the identified target proteins (Table 3).

Thus, these results show that the identified target proteins may be involved in the pathogenesis of diseases associated with elevated metal content in the supernatant of blood sampled from workers involved in underground mining of copper-nickel ores. Monitoring the expression of these proteins is necessary to predict the development of negative effects caused by exposure to the considered metals in the air of the working area, as well as to develop measures to prevent such effects.

DISCUSSION

Mining activities have a significant impact on the health of underground miners: the air of the work zone contains metals and their compounds in the form of dust and aerosols [3, 4]. Ultrafine particles can be caught in the alveoli of the lungs, then

enter the bloodstream, and ultimately deposit in various organs and tissues [5]. Proteins and other biomolecules absorbed on the particles enable their transportation and penetration into cellular structures [6]. Through proteomic testing, we identified proteins — *MAP3K9*, *HLA-A*, *LDLR*, *LAMP2*, *AKT2*, *FNDC3B*, *FRRS1L*, *SPTBN4*, and *HRH1* — that contribute to negative effects and related metabolic disorders, which may ultimately increase the incidence of occupational diseases.

Negative effects are associated with the influence of metal ions on protein targets through that translates into increased generation of reactive oxygen species (ROS), which boost or slow down their expression. Damage to proteins impairs activity of the enzymes, which raises the level of endogenous cellular hydrogen peroxides and short-lived ROS, both of which have a significant effect on lipid, protein, and carbohydrate metabolism [14]. The *MAP3K9* protein discovered in this study participates in the cascades of cellular responses caused by changes in the environment. In addition, it is involved in the signaling pathway triggered by mitochondrial death (including the release of cytochrome C) and leading to oxidative stress and apoptosis [15]. The biological functions of another protein, *LAMP2*, are not entirely clear. It is believed to be heavily involved in the work of lysosomes, including maintaining integrity, pH, and catabolism. In addition, one of the functions of *LAMP2* is to protect the lysosomal membrane from proteolytic enzymes and methylating mutagens leading to the development of oxidative stress [16].

Metal exposure also increases the risk of developing metabolic syndrome characterized by hypertension, insulin intolerance, central obesity, and dyslipidemia [17]. his effect is considered to be associated with excessive oxidative stress resulting from the said exposure [18]. As part of the insulin signaling pathway, the identified protein *AKT2* plays an important role in the control of glycogenesis, gluconeogenesis, and glucose transport [19]. The *LDLR* protein mediates endocytosis of cholesterol-rich low-density lipoproteins (LDL) and thus maintains their plasma levels [20]. A change in the expression of this protein significantly correlates with growth of the LDL levels, which leads to the development of atherosclerosis, metabolic syndrome, and steatohepatitis [21]. The *FNDC3B* protein may be a positive regulator of adipogenesis [22]. However, abnormal adipogenesis can trigger pathological conditions such as obesity, insulin resistance, and other metabolic disorders [23].

Diseases of the nervous system are the most common conditions causing temporary disability among ore miners [24]. The discovered *FRRS1L* protein is involved in the glutamate signaling pathway (the main excitatory neurotransmitter) [22]. Increased expression of this protein can lead to excessive excitability of neurons. Another protein, *HRH1*, mediates smooth muscle contraction and increases capillary permeability

Table 2. The parameters of the intensity change probability dependence models, simultaneous increase of the content of all elements (cobalt, chromium, nickel, copper, and manganese) in the blood supernatant

Spot number	Protein name	Direction of change in protein expression compared to the control group	The gene encoding the protein	Parameters of the model illustrating the causal relationship between metal concentration in the supernatant and changes in the intensity of the protein spot		Determination factor	Indicators of adequacy and statistical significance of the obtained models	
				b_0	b_1		$F > 3.96$	$p \leq 0.05$
3	Protein 2 associated with cerebellar degeneration	↓ 38.8 times	<i>CDR2</i>	$8507.3 \leq 12250.4$	$-3072176.2 \leq -67257.0$	0.43–0.96	$5.95 \leq 188.43$	0.001–0.041
	Ceramide synthase 4		<i>CERS4</i>					
	Eukaryotic peptide chain release factor, GTP-binding subunit ERF3B		<i>GSPT2</i>					
10	Peptidyl-prolyl cis-trans isomerase-like 3	↓ 3.2 times	<i>PPIL3</i>	$11449.7 \leq 16213.4$	$-3194317.1 \leq -74074.2$	0.46–0.90	$6.77 \leq 75.54$	0.001–0.031
	Mitogen-activated protein kinase kinase kinase 9		<i>MAP3K9</i>					
	Zinc finger protein 316		<i>ZNF316</i>					
	Transcription factor LBX2		<i>LBX2</i>					
	HLA Class I histocompatibility antigen, alpha A chain		<i>HLA-A</i>					
16	Low-density lipoprotein receptor	↑ 23.3 times	<i>LDLR</i>	$-6354.7 \leq -2828.8$	$57030.1 \leq 2593427.1$	0.47–0.95	$7.16 \leq 145.11$	0.001–0.028
17	DnaJ homologue of subfamily C, member 28	↑ 13.4 times	<i>DNAJC28</i>	$-7376.8 \leq -3195.7$	$68144.0 \leq 3020105.4$	0.47–0.94	$6.96 \leq 129.64$	0.001–0.030
20	Lysosomal-associated membrane glycoprotein 2	↓ 5.9 times	<i>LAMP2</i>	$929.7 \leq 1286.2$	$-307021.0 \leq -6588.4$	0.12–0.96	$5.67 \leq 217.35$	0.001–0.044
	Zinc finger protein 862		<i>ZNF862</i>					
25	RAC-beta-serine/Threonine protein kinase	↓ 7.4 times	<i>AKT2</i>	$1864.8 \leq 2551.4$	$-611457.7 \leq -13530.8$	0.44–0.96	$6.16 \leq 215.24$	0.001–0.038
	Gasdermin A		<i>GSDMA</i>					
28	Cofilin 1	↑ 11.2 times	<i>CFL1</i>	$-2559.6 \leq -1347.7$	$25239.5 \leq 1174851.9$	0.41–0.97	$5.68 \leq 221.62$	0.001–0.011
	Uncharacterized protein C10orf62		<i>C10orf62</i>					
29	Unconventional myosin-Vc	↑ 2.1 times	<i>MYO5C</i>	$-622.7 \leq 135.5$	$10269.5 \leq 451780.1$	0.46–0.73	$6.42 \leq 21.07$	0.002–0.035
	Member of the BCLAF1 and THRAP3 3 family		<i>BCLAF3</i>					
32	Histamine H1 receptor	↑ 2.9 times	<i>HRH1</i>	$-412.3 \leq -69.3$	$4725.8 \leq 197127.0$	0.50–0.87	$8.14 \leq 51.47$	0.001–0.021
33	tRNA (adenine(58)-N(1))-methyltransferase non-catalytic subunit of TRMT6	↑ 1.3 times	<i>TRMT6</i>	$2510.9 \leq 4491.1$	$26816.7 \leq 1362921.1$	0.48–0.93	$7.21 \leq 102.48$	0.001–0.028
	Factor 4 associated with DDB1 and CUL4		<i>DCAF4</i>					
35	Protein 3B containing the fibronectin type III domain	↑ 1.8 times	<i>FNDC3B</i>	$-701.0 \leq 497.14$	$16066.4 \leq 721429.5$	0.54–0.87	$9.48 \leq 54.18$	0.001–0.015
	Peregrine		<i>BRPF1</i>					
	Jupiter microtubules associated with homologue 2		<i>JPT2</i>					
39	Transforming growth factor beta-1-induced transcript 1 protein	↑ 18.7 times	<i>TGFB111</i>	$-2545.3 \leq -1344.2$	$27486.8 \leq 1244407.3$	0.47–0.91	$7.22 \leq 80.58$	0.001–0.028
40	Beta protein phosphatase transferase subunit	↑ 11.9 times	<i>FNTB</i>	$-3789.4 \leq -1756.6$	$307497 \leq 1648931.6$	0.43–0.97	$6.12 \leq 219.41$	0.001–0.038
42	FRRS1L protein containing the DOMON domain	↑ 3.0 times	<i>FRRS1L</i>	$-4495.1 \leq -1212.0$	$62630.9 \leq 2912018.4$	0.41–0.96	$5.48 \leq 214.80$	0.001–0.047
	BRISC and BRCA1-A complex member 2		<i>BABAM2</i>					
45	Spectrin beta chain, non-erythrocyte 4	↓ 19.4 times	<i>SPTBN4</i>	$4036.9 \leq 5811.8$	$-1414900.1 \leq -31150.5$	0.43–0.96	$6.02 \leq 169.26$	0.001–0.040
	Protein 11, containing the domain of disintegrin and metalloproteinase		<i>ADAM11</i>					

by contracting terminal venules. In addition, it promotes neurotransmission in the central nervous system (CNS) and thereby regulates circadian rhythms, emotional and locomotor activity, and cognitive functions [25]. The SPTBN4 protein belongs to spectrins, scaffold proteins that bind the plasma membrane to the actin cytoskeleton. They play a crucial role

in determining the shape of a cell, the location of transmembrane proteins, and the organization of organelles. A change in the synthesis of SPTBN4 disrupts ion channels in the tissues of the nervous system by impairing the cytoskeletal system [26]. The HLA complex, which includes the HLA-A protein, serves as the only link between the immune system and the intracellular

Table 3. Prediction of negative effects (adverse outcomes) associated with changes in the expression of target proteins induced by high content of metals in the supernatant

Gene-associated negative effects (adverse outcomes)	Protein-encoding genes
Diseases of the immune system	<i>HLA-A</i>
Blood diseases	<i>HLA-A, FNDC3B</i>
Diseases of the urinary system	<i>SPTBN4</i>
Diseases of the nervous system	<i>MAP3K9, HLA-A, LDLR, LAMP2, AKT2, FNDC3B, FRRS1L, SPTBN4</i>
Respiratory diseases	<i>HRH1</i>
Diseases of the digestive system	<i>LDLR, LAMP2, AKT2</i>
Skin diseases	<i>AKT2</i>
Diseases of the cardiovascular system	<i>MAP3K9, HLA-A, LDLR, LAMP2, HRH1</i>
Diseases of the endocrine system	<i>SPTBN4</i>
Cognitive impairment	<i>HRH1</i>

state. The expression of this complex causes neuronal effects in the thalamus and hippocampus, which lead to functional disorders in the brain [27, 28].

The results of this study underpin the inclusion of proteomic testing into chemical exposure assessment with the aim to identify the key molecular points and mechanisms leading to adverse outcomes, with the ultimate goal of this inclusion being development of the early prevention measures for occupational diseases.

CONCLUSIONS

1. Long-term, per-shift exposure to metals (cobalt, chromium, nickel, copper, and manganese) dispersed in the air of the working area at concentrations ranging from 0.004 to 0.2 mg/m³ (up to 4 times the MPC) causes up to a 2.6-fold increase in the concentration of these metals in the blood supernatant of workers in the primary occupations involved in underground mining of copper-nickel ores.

2. The revealed transformation of the proteomic profile in the workers' blood supernatant—characterized by up to a 26.3-fold increase in expression in 15 protein spots

and up to a 38.8-fold decrease in 18 spots is the result of increased concentrations of these metals in the body.

3. The expression of the proteins considered is associated with the development of a number of negative effects, primarily from the nervous (*MAP3K9, HLA-A, LDLR, LAMP2, AKT2, FNDC3B, FRRS1L, SPTBN4* genes) and cardiovascular (*MAP3K9, HLA-A, LDLR, LAMP2, HRH1* genes) systems, and digestive organs (*LDLR, LAMP2, and AKT2* genes), which confirms the development of disorders at the molecular and cellular level.

4. The identified target proteins are involved in the pathogenesis of oxidative stress, metabolic, and neurodegenerative disorders, which may increase the prevalence of occupation-related diseases associated with exposure to metals in the workplace air among copper-nickel miners.

5. The results of this study emphasize the importance of integrating proteomic testing into the assessment of the impact of metals on copper-nickel miners for early detection of changes in the key molecular points and assessment of the mechanisms of development of adverse outcomes, with the ultimate goal of this integration being the development of early prevention measures for occupation-related diseases.

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HYGIENIC FACTORS SHAPING POSTURE IN UNIVERSITY STUDENTS

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The basics of student youth health all over the world are ensured by factors of the educational environment and the young adults' lifestyle. Modeling of such conditions is possible with comprehensive assessment of the quality and safety of university internal environment, update of modern educational spaces in response to the students' need for motor activity and physical exercises. Currently, it becomes increasingly necessary to pay attention to the hygienic factors affecting shaping proper posture in university students. The main focus is on such aspects, as learning conditions, workplace organization, physical activity, and other daily habits that contribute to either impairment, or maintenance of healthy posture. There is no need to emphasize the importance of proper workplace organization. The height of the desk and chair, the level of the monitor, the quality of the furniture and lighting play a key role in maintaining a comfortable and safe body position during classes. Incorrect organization can result in developing musculoskeletal disorders and postural alterations. Physical activity and regular breaks while learning are considered important prerequisites for preservation of the students' musculoskeletal system functional disorders. Students leading a sedentary lifestyle face the risk of postural alterations. It is recommended short physical exercises and active breaks in the daily routine in order to improve muscle tone and reduce tension.

Keywords: students, classroom furniture, posture, preventive measures, physical exercises, furniture size, age-related features

Author contribution: Milushkina OYu, Bashmakov OA — data acquisition, manuscript writing.

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

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Received: 11.09.2024 **Accepted:** 22.04.2025 **Published online:** 27.06.2025

DOI: 10.24075/rbh.2025.133

ГИГИЕНИЧЕСКИЕ ФАКТОРЫ, ВЛИЯЮЩИЕ НА ФОРМИРОВАНИЕ ОСАНКИ У СТУДЕНТОВ ВУЗОВ

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Основы здоровья студенческой молодежи во всем мире обеспечивают факторы образовательной среды и образ жизни молодых людей. Моделирование этих условий возможно при полноценной оценке качества и безопасности внутренней среды университетов, актуализации современных учебных пространств с учетом потребности обучающихся в двигательной активности и физических упражнениях. В настоящее время все больше возрастает необходимость уделять внимание гигиеническим факторам, влияющим на формирование правильной осанки студентов высших учебных заведений. Основное внимание уделяют таким аспектам, как условия учебного процесса, организация рабочего пространства, физическая активность и другие ежедневные привычки, которые способствуют либо нарушению, либо поддержанию здоровой осанки. Нет необходимости подчеркивать важность правильной организации рабочего места. Высота стола и стула, уровень расположения монитора, качество мебели и освещение играют ключевую роль в поддержании комфортного и безопасного положения тела во время занятий. Неправильная организация может приводить к развитию заболеваний опорно-двигательного аппарата и изменению осанки. Физическая активность и регулярные перерывы в учебе также рассматривают как важные условия сохранения функциональной работоспособности костно-мышечной системы обучающихся. Студенты, ведущие малоподвижный образ жизни, сталкиваются с риском изменения состояния осанки. Рекомендуется включать в распорядок дня короткие физические упражнения и активные перерывы для улучшения мышечного тонуса и снижения напряжения.

Ключевые слова: студенты, учебная мебель, осанка, профилактические мероприятия, физические упражнения, размер мебели, возрастные особенности

Вклад авторов: О. Ю. Милушкина, О. А. Башмаков — сбор материала, написание статьи.

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

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Статья получена: 11.09.2024 **Статья принята к печати:** 22.04.2025 **Опубликована онлайн:** 27.06.2025

DOI: 10.24075/rbh.2025.133

Even in the distant times of the rise of civilization, humanity began to pay attention to the need for physical activity. Thus, many of the writings of thinkers that have come down to us contain ideas and recommendations aimed at maintaining and improving health. Avicenna wrote: "Those who give up physical exercise often waste away because their body weakens as a result of their refusal to exercise". "Nothing exhausts and destroys a person more than prolonged physical inactivity", Aristotle pointed out [1].

Later Hippocrates wrote: "Gymnastics, physical exercises, walking should become a part of the daily life of everyone, who wants to maintain efficiency, health, a full and joyful life". In the 1st century BC, numerous elements of the Tibetan therapeutic gymnastics theory were shaped [2, 3].

Since the times of the Russian Empire, special attention has been paid to the health of students, as reflected in the works

of contemporaries. Sources for those years indicate that masters forced students to sit correctly so that the apprentices would not develop back pain.

The unique methodological manual "Handbook on Physical Education Issues" was written by a group of authors as early as in the 19th century. It states that physical education can correct hereditary physical disabilities or those acquired under exposure to environmental factors. The authors paid attention to posture and the conditions leading to postural alterations. Even then, the first preventive measures aimed at developing proper posture were defined. The purpose of the exercises proposed was to strengthen muscles of the back, upper and lower extremities, as well as to improve posture [4, 5].

In Soviet times, the attitude towards the issues of developing proper posture in the younger generation was most positive. The necessary requirements for the schoolchildren's positioning

at their desks, requirements for the design and size of classroom furniture and other types of learning conditions aimed at preventing various diseases of the musculoskeletal system, primarily the spine, were developed.

In the mid-20th century, in the heyday of modern hygiene, it was proposed to introduce physical education in kindergartens, secondary and higher educational institutions. Morning exercises, exercises before the start of classes, physical education breaks during theoretical classes were introduced everywhere; groups of therapeutic physical education and "introductory gymnastics" were created to strengthen the back muscles, which contributed to posture improvement. It was proposed to play various outdoor games during breaks.

In the 21st century, during the period of developing the technological options to provide large information flows, it is reported that the planet inhabitants experience severe emotional overload. Numerous "bloggers" appear on the Internet offering "health-improving" technologies, often referring to ancient texts and unconventional types of gymnastics and psychological techniques, some of which are based on "cleansing" the body, etc. Prevention of the use of irrational health preservation methods represents one of the tasks of preventive medicine.

At the current stage of Russia's strategic development, the issue of preserving and improving the health of the younger generation is becoming especially acute. This is mostly due to the persistent trend towards children's health deterioration, changes in their physical development indicators, and the increase in the rate of functional disorders [6, 7]. Given this context, arrangement of physical education in children and adolescents assigned to the preparatory medical group for physical education becomes relevant. The main criteria for inclusion in this group are functional impairment and low physical fitness. These manifestations pose the risk of developing various abnormalities in the future.

Posture is the body's habitual position in space while standing, sitting and walking. Healthy posture is based primarily on the properly shaped spine with all physiological curves (lordosis, kyphosis), tendons and muscles attached to the vertebrae. The axial skeleton becomes fully mature by the age of 20–21 years, i.e. during the period, when the student is senior at the higher educational institution. The current situation (COVID-19 pandemic and other) and lifestyle adversely affect the musculoskeletal system health [6]. The group at risk consists of students attending high school, secondary vocational education institutions, university students, whose childhood and adolescence coincided with the implementation of restrictive measures during the pandemic, i.e. distance learning in unsuitable premises. The core maturation is completed in adolescence and early adulthood, when the students spend most of their time at a desk, not always maintaining proper body position in space. Learning at home has made it impossible to comply with the necessary rules for prevention of various musculoskeletal system abnormalities. In particular, it has been noted that students listen to lectures, write notes, and prepare for seminars while lying down or half-sitting.

Thus, the issues of prevention of the musculoskeletal system abnormalities and the core functional state impairment during undergraduate studies are relevant and timely when organizing training of students. The study aimed to assess the major hygienic factors shaping posture in university students.

METHODS

The study was conducted at the Moscow Pedagogical State University (MPGU) and the Pirogov Russian National Research

Medical University (Pirogov University). It involved 276 first-year medical students and 108 first-year students-teachers. Gender distribution: 82% females and 18% males in the medical university, 59% females and 41% males in the pedagogical university. The research methods were as follows: sociological (questionnaire survey), hygienic (monitoring, natural hygiene experiment), statistical methods, literature review. The standard (GOST) Sutyagin's school stadiometer was used to assess the furniture match to the student sizes (Fig.).

The line is marked with six growth groups in accordance with GOST 22046—2016 "Furniture for Educational Institutions. General Specifications". Assessment was conducted in the morning, afternoon and evening hours; the students' height was measured with their shoes on (in accordance with the measurement procedure). Statistical processing of the data obtained involving calculation of relative values was performed using the StatTech software package (StatTech; Russia).

RESULTS

Distribution of medical students by height showed that three height groups were the most common: 4, 5, and 6 (Table 1).

Distribution of students-teachers by height showed a similar pattern. Sizes 4, 5, and 6 also were the most common (Table 2). Furthermore, the share of students of the 4th size group is higher in the pedagogical university, than in the medical one among both females and males.

The data obtained suggest that classrooms must have furniture of at least three sizes. Furthermore, assessment of classroom furniture in both Pirogov University and MPGU showed that there was only group 5 furniture.

The findings have shown that among MPGU students only 68.7% of the female group have the height corresponding to group 5, while among males only 30.3% correspond to this group. Furthermore, 63.6% of males have the height corresponding to the height group 6, and 6.1% have that corresponding to the height group 4. It is clear that the classroom furniture does not correspond to the height of 2/3 of males and 1/3 females.



Fig. Sutyagin's school stadiometer

Таблица 1. Distribution of medical students by height sizes

Females		Males	
Height group	Share of students (%)	Height group	Share of students (%)
4	5.3	4	3.2
5	77.2	5	30.4
6	17.5	6	76.4

A similar pattern is reported for the Pirogov University, where 77.2% of females correspond to the height group 5 and the majority of surveyed males correspond to group 6. Given the results, the classroom furniture at the Pirogov University is more in line with the students' height. Thus, in 77.2% of females in the medical university and 68.7% of females in the pedagogical university, the classroom furniture will have no negative effect on the posture. However, there are tall girls and short girls studying at the universities (about 30%), in whom the furniture does not correspond to the body length parameters. This will negatively affect the posture, which can result in exacerbation of a number of musculoskeletal system disorders and the development of spinal deformities.

Based on the findings, recommendations for universities on the selection and order of furniture are provided, along with individual recommendations for students.

When organizing the educational process, one should follow the basic recommendations for universities. Classrooms should have furniture that is appropriate for different height groups, so that students can choose the most suitable options. Tables and chairs of the height groups 4, 5, and 6 must be available. A prerequisite should be that educational institutions switch to the maximum use of adjustable furniture ensuring maximum adaptation to the students' individual characteristics.

Temporary solutions for individual selection of furniture include footrests (help maintain the correct angle at the knees and reduce the load on the lower back), using seat cushions (this measure increases the height of the seat and provides a comfortable posture while working), using book or laptop stands (allow one to raise the work surface, reducing the need to slouch).

Each person has individual body type features, legs and arms of different length, different proportions, which also need to be taken into account when choosing furniture. The ideal solution is to use adjustable furniture, which allows one to adjust the height of the table and chair to the student's individual parameters. Furthermore, it is also important to organize the workplace properly: ensure adequate lighting, proper positioning of the computer monitor, and foot support.

One of the individual recommendations may be to conduct an ergonomics consultation. Ergonomics specialists can provide consultations to students, teaching them how to choose the furniture properly and organize their workspace wisely.

DISCUSSION

The properly selected furniture plays a key role in shaping the proper posture and prevention of health problems. Furniture

sizes that are not appropriate for the student's height can lead to muscle tension (incorrect sitting posture causes tension in the muscles of the neck, back, and shoulders), to the emergence of pain (constant tension leads to back pain, neck pain, headache), postural alterations (sitting for a long time on unsuitable furniture can contribute to the development of stoop, scoliosis, and other spinal deformities), to poor concentration (feeling uncomfortable and pain distract students from studying, reducing their performance).

It should be noted that the learning space ergonomics and the students' physical characteristics must be properly matched.

Students with the body length of 160–175 cm and above are the most common, for whom furniture of the height groups 5 and 6 is suitable. Appropriate classroom furniture is available for these height groups.

Medical students, as the majority of young adults, usually fall in the height range that corresponds to the height groups 5 and 6. Female students usually have the height corresponding to the height group 5, although some exceptions are possible. Male students are usually higher; many of them fall into the height group 6. The study has shown that furniture for the height group 5 only is available in the universities.

It is important to take into account individual differences between students [8]. There are tall males among the students. Their body length exceeds 185 cm, so the use of size 5 furniture can cause serious problems. The major abnormalities developed by such students are as follows: increased kyphosis, leading to the rounded back development (stoop); head protraction manifested by pulling the head forward, overloading the neck muscles and causing headache; muscle tension in the back and neck resulting in chronic pain; position of the knees above the pelvis causing blood circulation disturbances and leading to discomfort in the legs (paresthesia, etc.). The general discomfort caused by the low desk and chair often leads to fatigue, decreased concentration and reduced learning performance. Tall young males are the most vulnerable group. During the study, when timing their working posture, they were noted to be in a semi-recumbent position with tilts to different sides.

Shaping proper posture since childhood makes it possible to maintain the core, allowing one to properly hold his/her body throughout the working day, in old age. The time spent at the workplace, and for the student this is primarily classroom furniture, consisting of a desk and a chair, increases from school to the initial years of higher education. The first years of study at the university are probably the most time-consuming in terms of the time spent at a desk and studying textbooks. New learning environment, fundamental disciplines force one

Table 2. Distribution of students-teachers by height sizes

Females		Males	
Height group	Share of students (%)	Height group	Share of students (%)
4	20.3	4	6.1
5	68.7	5	30.3
6	11.0	6	63.6

to spend a lot of time mastering the curriculum. Therefore, the student, being either in the library or in classrooms, overloads his/her musculoskeletal system with static loads, and also strains his visual organ. The data of a number of studies showed that students spent on average 10–11 h learning during the period of distance learning [8, 9]. When conducting the questionnaire survey, it was also noted that 10–13% of students showed higher rate of back pain during learning at home, which they associated with being in a sitting position. The distance learning at home allowed students to move away from the basic rules of hygiene of body positioning at the desk, which immediately affected the condition of the skeletal and muscular systems [9, 10]. The surveyed individuals admitted that they often watched lectures and seminars while lying down or reclining, which resulted in exacerbation of some chronic conditions. Adynamia, prolonged time spent at the computer, incorrect posture — all this led to poor posture, and subsequently to deterioration of health. Furthermore, some students complained of sleep alteration and deterioration due to the problems emerging.

According to the research data obtained by E.N. Vavilova, physical exercises that force active work of the back extensor muscles and abdominal flexor muscles represent the main means to prevent postural abnormalities in primary-school-age children [11]. Professor S.N. Popova points out that physical exercises should be selected in accordance with the postural disorder type [11, 12]. It is important to proceed from the fact that disease prevention is a complex of medical and non-medical measures of preventive and health-improving nature. Hippocrates also said that "...the patient, those around him, and all external circumstances should assist the doctor in his work" [6]. In medicine, prevention is a set of measures aimed at preventing various diseases and injuries, as well as eliminating risk factors [13]. Preventive measures represent an important part of the healthcare system, which is aimed at developing medical and social activity and motivation for a healthy lifestyle in the population.

The main objectives of prevention are as follows:

- prevention of various postural disorders;
- minimization of the effect of various risk factors;
- reduction of the risk of various postural disorder complications;
- slowing down the postural disorder progression;
- prevention of chronicity and secondary disorders;
- reduction of various negative effects associated with postural disorders;
- general posture improvement [1, 5].

Implementation of preventive measures and following recommendations will help students maintain proper posture and high mental performance at all stages of training.

CONCLUSIONS

The properly selected furniture that suits the height and individual characteristics of students plays an important role in maintaining their health and performance. Educational institutions must pay attention to ergonomic issues, providing students with the opportunity to study in comfortable and safe environment. The use of furniture corresponding to the height groups 5 and 6, as well as adjustable furniture, is an important step in this direction.

The use of size 5 furniture by tall students (over 185 cm) is unacceptable; it can result in serious postural and health problems. Educational institutions must consider this and apply measures to provide students with furniture that is appropriate for their height. Using adjustable furniture is the most effective solution to ensure comfortable and healthy learning for all students.

Comprehensive and well-organized physical activity can reduce the likelihood of developing the disease, as well as reduce the disease duration and accelerate restoration of performance. However, both in educational institutions and at home, an effective way to prevent postural disorders is properly selected furniture. It is necessary to comply with the requirements and recommendations aimed at shaping proper posture. Short breaks for performing a set of physical exercises should be used during long-term loads and prolonged sessions.

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