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

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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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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

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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

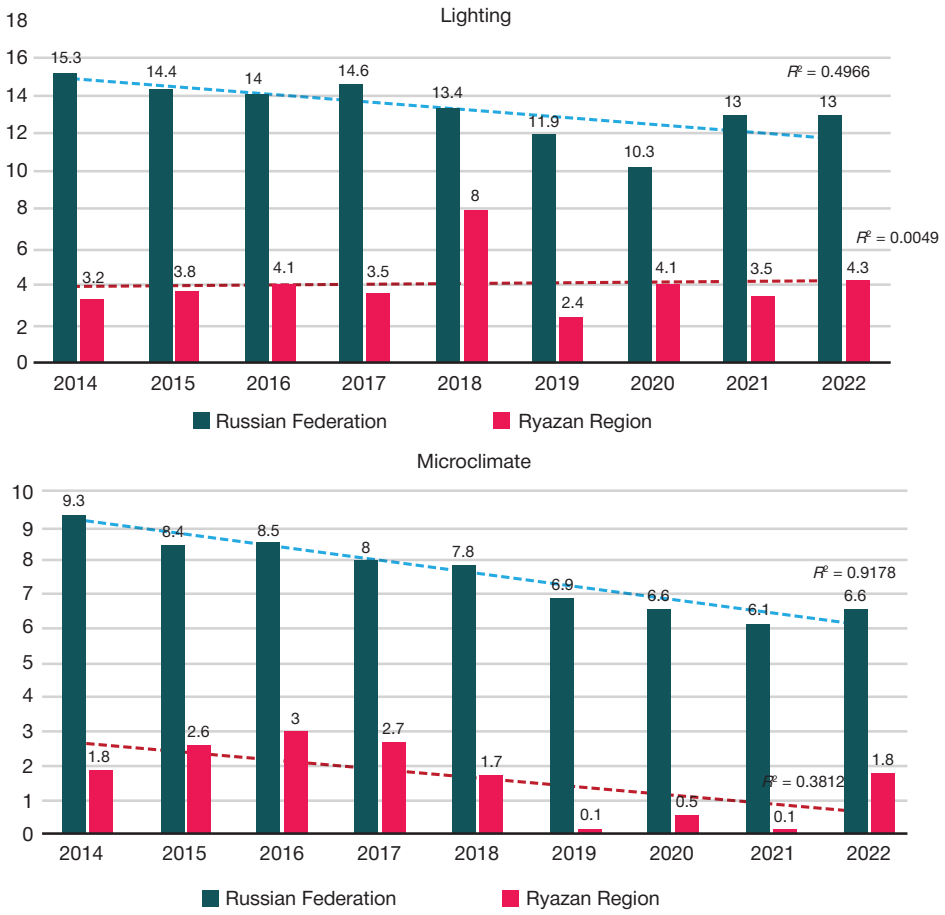

Fig. Share of children's and adolescent institutions noncompliant with the hygienic standards based on physical factors with the growth and decline rates (%)

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 ± 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 ± 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 ± 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	*p*
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	*p*
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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