UDC 316.334.52+378+623.454.862+621.039+539.1
DOI: 10.56871/MHCO.2024.42.24.008

Awareness of radiation safety issues among medical students

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For citation: Biblin AM, Vodovatov AV, Kapyrina YuN, Imamov AA, Puzyrev VG, Vishnyakova NM, Guseva RA, Mironova NR. Awareness of radiation safety issues among medical students. Medicine and Health Care Organization. 2024;9(4):85–96. (In Russian). DOI: https://doi.org/10.56871/MHCO.2024.42.24.008

Received: 28.10.2024 ***Revised: 28.11.2024*** ***Accepted: 27.12.2024***

ABSTRACT. Sources of ionizing radiation are widely used in all spheres of human activity, including health care. In case of non-accordance with the requirements of sanitary legislation and low safety culture they can be dangerous for the society and the stuff. Competencies in the field of radiation impact on humans and the environment, ensuring radiation safety, as well as timely diagnosis of pathology associated with sources of ionizing radiation, prescription of relevant therapy are laid in the process of education in higher educational institutions. The study of students' awareness of radiation safety issues allows to develop measures to improve the efficiency of the educational process and, as a result, to increase the competence of students as future specialists, including those involved in informing the population and increasing their level of environmental literacy. The aim of this work was to assess the level of knowledge about ionizing radiation and perception of radiation risk. The study was carried out on the basis of St. Petersburg State Pediatric Medical University. A total of 301 people were interviewed. The study revealed a high level of students' interest in radiation topics. Students demonstrated an average level of knowledge about radiation safety and a relatively low level of knowledge on the profile issue of ionizing radiation application in health care. Ionizing radiation is not perceived by students as a risk factor dangerous for health, while the respondents tend to exaggerate the negative consequences of major radiation accidents. Students have ambiguous attitudes towards nuclear power and are not ready to unequivocally support it or insist on its reduction. The obtained research results indicate the necessity to make adjustments in the programs of students' education at profile cycles.

KEYWORDS: students, sociological survey, radiation protection, information work, ionizing radiation, radiation accident, nuclear energy

DOI: 10.56871/MHCO.2024.42.24.008

Осведомленность студентов медицинского вуза о вопросах радиационной безопасности

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Для цитирования: Библин А.М., Водоватов А.В., Капырина Ю.Н., Имамов А.А., Пузырев В.Г., Вишнякова Н.М., Гусева Р.А., Миронова Н.Р. Осведомленность студентов медицинского вуза о вопросах радиационной безопасности. Медицина и организация здравоохранения. 2024;9(4):85–96. DOI: https://doi.org/10.56871/MHCO.2024.42.24.008

Поступила: 28.10.2024 ***Одобрена: 28.11.2024*** ***Принята к печати: 27.12.2024***

РЕЗЮМЕ. Источники ионизирующего излучения находят широкое применение во всех сферах деятельности человека, в том числе в здравоохранении. При несоблюдении требований санитарного законодательства и низкой культуре безопасности они могут представлять опасность для населения и персонала. Компетенции в области радиационного воздействия на человека и окружающую среду, обеспечения радиационной безопасности, а также своевременной диагностики патологии, связанной с источниками ионизирующего излучения, назначения релевантной терапии закладываются в процессе обучения в высших учебных заведениях. Исследование информированности студентов по вопросам радиационной безопасности позволяет разработать меры по повышению эффективности образовательного процесса и в итоге повысить компетенции обучающихся как будущих специалистов, в том числе занимающихся информированием населения и повышающих его уровень гигиенической грамотности. Цель данной работы заключалась в оценке уровня знаний об ионизирующем излучении и восприятии радиационного риска студентами медицинского вуза. Всего был опрошен 301 студент Санкт-Петербургского государственного педиатрического медицинского университета. Исследование выявило высокий уровень интереса студентов к радиационной тематике. Для студентов характерен средний уровень знаний о радиационной безопасности и относительно невысокий уровень знаний по профильному вопросу о применении ионизирующего излучения в здравоохранении. Ионизирующее излучение не воспринимается студентами как опасный для здоровья фактор риска, при этом респонденты склонны значительно преувеличивать негативные последствия крупных радиационных аварий. Студенты неоднозначно относятся к атомной энергетике и не готовы однозначно поддерживать ее или настаивать на ее сокращении. Полученные результаты исследований свидетельствуют о необходимости внесения корректив в программы обучения студентов на профильных циклах.

КЛЮЧЕВЫЕ СЛОВА: студенты, социологическое исследование, радиационная безопасность, информационная работа, ионизирующее излучение, радиационная авария, ядерная энергетика

INTRODUCTION

For more than a hundred years since its discovery, ionizing radiation has become an integral part of healthcare practice. New diagnostic and treatment technologies are being continuously introduced, and the number of X-ray examinations performed per year is growing. Medical exposure due to diagnostic procedures accounts for up to 22% of the annual radiation dose of population in the Russian Federation [1].

Obtaining basic ideas about ionizing radiation (IR), its use in healthcare, and possible negative health consequences is important for students of all faculties of medical universities [2, 3]. This is due to fact that medical students are highly likely to either prescribe X-ray examinations to their patients or directly conduct them. After graduating from the Preventive medicine faculty, young specialists may be assigned responsibilities for overseeing compliance with sanitary legislation in the field of radiation hygiene.

Studies assessing the level of basic knowledge about various aspects of radiation safety among medical university students are presented in national and foreign publications [4–8]. As a rule, studies demonstrate students' low knowledge levels and confirm the mythologized idea of IR among the population. Conducting such research allows for the adjustment of curricula and improvement of the effectiveness of educational activities.

Foundation training of specialists and creation of safety culture in them occurs during the course of study at universities in the departments of medical physics, radiation diagnostics, and hygiene. Competencies in the field of the effect of IR on the human body and environment, ensuring radiation safety in graduates of medical universities are formed during all years of study [9]. The quality of young professional training will largely determine the level of radiation safety of patients. It is especially important for students of Pediatrics universities as they will work with children, whose radiation protection requires special attention. [10, 11]. Studies have shown that parents and legal guardians of hospitalized children demonstrate high levels of trust in attending physicians and medicine in general [12]. Those who were informed of the risks tend to rate the degree of danger of medical X-ray examinations lower than uninformed individuals.

AIM

The aim of the study is to assess the level of knowledge about ionizing radiation and perception of radiation risk among medical university students.

MATERIALS AND METHODS

The study was conducted from September 2023 to March 2024. A total of 301 students of the St. Petersburg State Pediatric Medical University was surveyed. Questionnaires were

Table 1

Characteristics of the sample

Таблица 1

Характеристика выборки

Пол, % / Sex, %					
Мужской / Male			Женский / Female		
13			87		
Возраст, лет / Age, years					
Минимум / Minimum		Среднее / Average		Максимум / Maximum	
17		20,4±2.2		44	
Курс, % / Year of study, %					
1	2	3	4	5	6
15	14	26	20	16	9

Специальность, % / Specialty, %				
Педиатрия / Pediatrics	Лечебное дело / Medicine	Медико-профилактическое дело / Preventive medicine	Стоматология / Stomatology	Прочее / Other
45,7	18,0	19,3	8,3	8,7

filled out in Google.Forms[1]. Characteristics of the sample are shown in Table 1.

In addition, the total sample of students was divided into two groups based on their year of study: a group of 1st–3rd year students and a group of 4th-6th year students.

The questionnaire consisted of 27 questions. Separate blocks of questions were devoted to the perception of radiation risk, attitudes towards the nuclear industry and included a test of knowledge in the field of radiation safety.

As part of the test to assess the level of knowledge in the field of radiation safety, respondents were asked to answer 4 questions.

1. Which of the following can be sources of ionizing radiation? (Multiple answers are possible.)
2. How can a person receive a dose of radiation? (Multiple answers are possible.)
3. In what areas of activity is radiation used? (Multiple answers are possible.)
4. How can elevated radiation compared to natural background be detected? (Multiple answers are possible.)

The maximum possible test score was 22 points. For the purposes of analysis, respondents were divided into three groups: those with good knowledge (20–22 points), average (15–19 points), and poor (0–14 points).

The knowledge assessment block also included a profile question about what types of diagnostic procedures are associated with the use of IR.

The block of questions about the perception of radiation and other risks included questions about risk factors that pose the greatest danger to respondents (road traffic accidents (RTA), drug addiction, IR exposure, etc.), with a request to rate them on a scale from 1 (least dangerous) to 5 (most dangerous).

Respondents were asked questions about the number of victims of the largest radiation accidents at the Fukushima Daiichi and Chernobyl nuclear power plants to assess the perception of radiation hazards. In addition, an evaluation of the acceptability of nuclear and other types of energy was conducted.

Research data underwent comprehensive statistical analysis using parametric and nonparametric methods. Accumulation, adjustment, systematization of source data and visualization of results were carried out in Microsoft Office Excel 2016 spreadsheets. Statistical analysis was carried out using the STATISTICA 6.0 program.

A normality test of quantitative data distributions was performed using the Kolmogorov-Smirnov test. The normality test refuted the hypothesis of distribution of answers to all questions considered in the article. Nominal data were described with absolute values and percentages. The results of measuring different subgroups in samples on ordinal scales were compared using the Mann–Whitney test. Differences between samples were considered statistically significant at $p < 0.05$.

RESULTS AND DISCUSSION

Two thirds of those who took part in the study indicated that they had limited knowledge of radiation safety issues (Fig. 1). Statistically significant differences in answers of 1st–3rd and 4th-6th year students were not observed ($p > 0.05$).

Figure 2 shows the distribution of respondents' answers to questions assessing the level of knowledge in the field of radiation safety. Statistically significant differences in answers of 1st-3rd and 4th-6th year students were not identified ($p > 0.05$).

The highest percentage of correct answers was received to the questions on how IR can be detected (63.5% of respondents chose the statement "Only with the special devices"), and how one can receive a radiation dose (60.4% of respondents chose all options except "Hard to say"). When asked about health effects associated with ionizing radiation, 36.8% of respondents chose all options except "Hard to say". The greatest difficulty was caused by the option "Cardiovascular disease". When answering the question about possible sources of IR, 31.5% of respondents chose all options except "Hard to say". The smallest number of correct answers was received to the question about where IR is used. Only 23.4% of respondents chose all the correct answers — all options except "Hard to say".

Overall, respondents demonstrated an average level of knowledge in the field of radiation safety: 22.9% scored from 20 to 22 points and 52.8% scored from 15 to 19 points (Table 2). Statistically significant differences in answers

[1] URL: https://docs.google.com/forms/d/12Trgyo6BHkYTkoBULC-esTGyo0nGhbIKK-i884m3tb4.

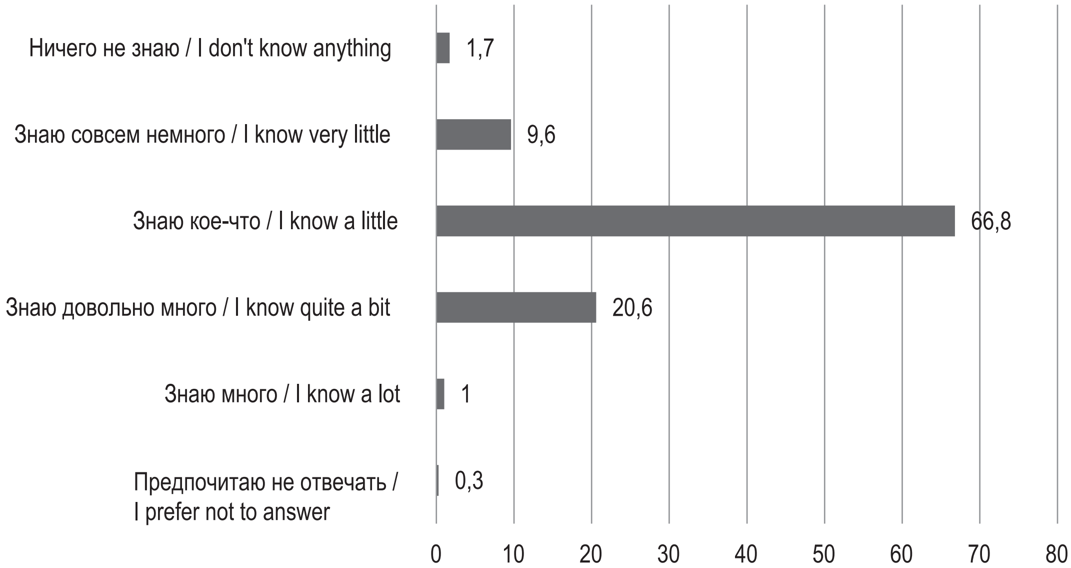


Fig. 1. Self-assessment of radiation safety knowledge level (%)

Рис. 1. Самооценка уровня знаний о радиационной безопасности (%)

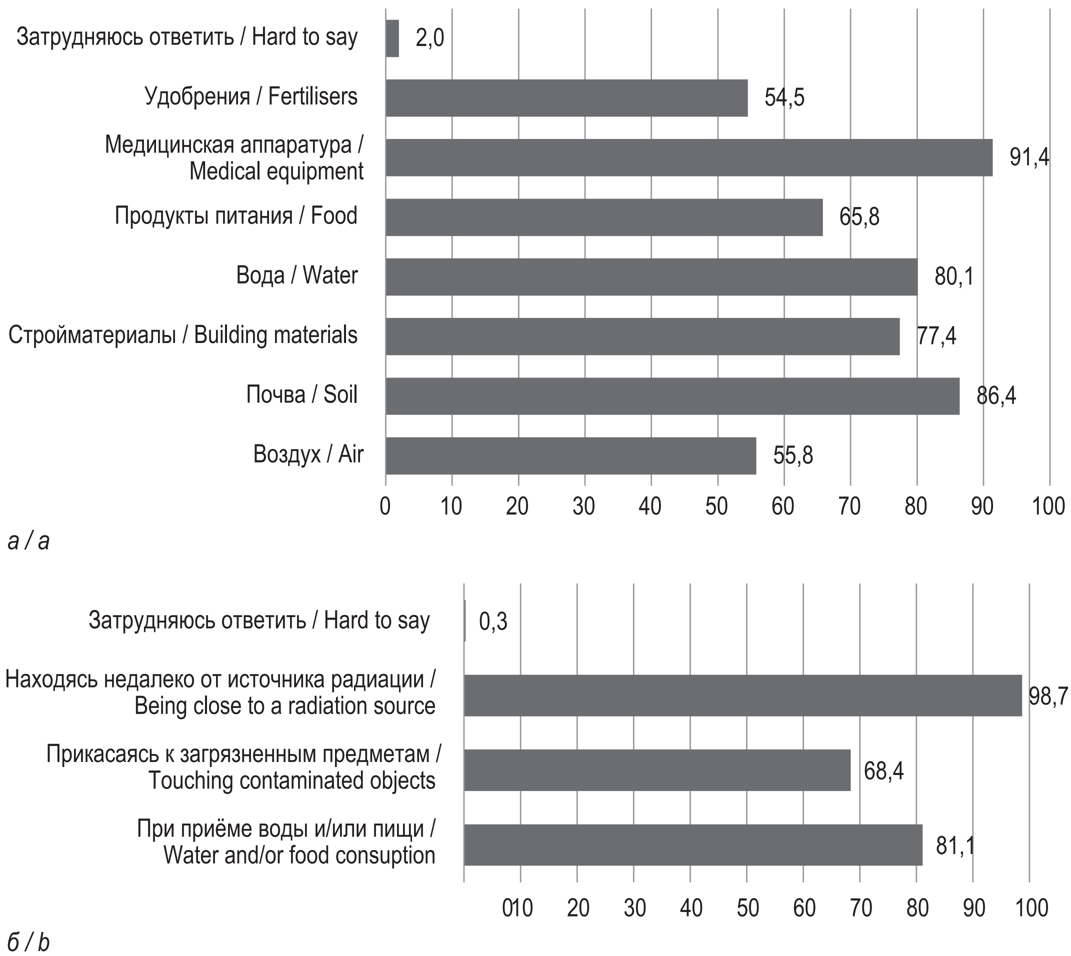
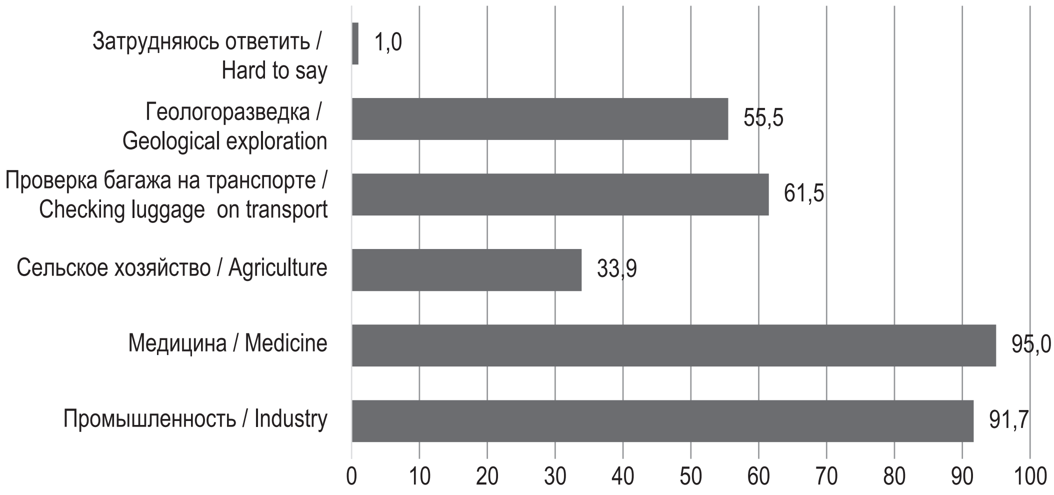


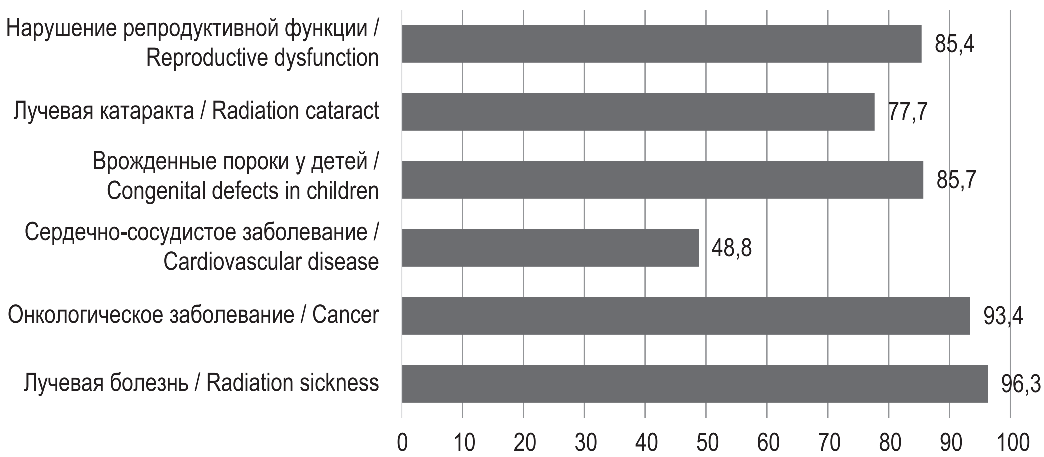
Fig. 2. Distribution of answers to the questions: *a* — about possible sources of ionizing radiation; *b* — about how one can receive additional radiation dose

Рис. 2. Распределение ответов на вопросы: *а* — о возможных источниках ионизирующего излучения; *б* — о том, как можно получить дополнительную дозу облучения



в / c

г / d



д / e

Fig. 2. *Ending.* Distribution of answers to the questions: *c* — about where ionizing radiation is used; *d* — about methods of ionizing radiation detection; *e* — about possible medical effects of ionizing radiation exposure

Рис. 2. *Окончание.* Распределение ответов на вопросы: *в* — о том, где находит применение ионизирующее излучение; *г* — о способах обнаружения ионизирующего излучения; *д* — о возможных медицинских эффектах воздействия ионизирующего излучения of 1st–3rd and 4th–6th year students were not found (p >0.05).

The surveyed students demonstrated generally satisfactory knowledge about sources of IR used in diagnostics. However, only 18.9% of students chose three correct answers simultaneously: fluorography, CT, and PET. At the same time, more than half of all respondents (56%) classified MRI as a diagnostic research method associated with IR. Figure 3 shows the distribution of answers of 1st–3rd and 4th–6th year students to the question about which diagnostic methods are associated with IR.

Statistically significant differences were found in the answers of 1st–3rd and 4th–6th year students for such diagnostic studies as MRI (p <0.01), ultrasound (p=0.02), ECG (p=0.02), PET (p <0.01). This indicates that as students progress through studies at specialized departments, their competencies in the field of radiation diagnostics increase.

The study showed that students tend to exaggerate the health consequences of major radiation accidents (Fig. 4). This is also typical of the general population of the Russian Federation [13]. Statistically significant differences

Table 2

Distribution of respondents by level of knowledge in the field of radiation safety according to test results

Таблица 2

Распределение респондентов по уровню знаний в сфере радиационной безопасности по результатам теста

Уровень знаний / Level of knowledge	**Критерий отнесения / Attribution criteria**	**1–3-й курс, N / 1st–3rd year students, N**	**%**	**4–6 курс, N / 4th–6th year students, N**	**%**	**Всего, N / Total, N**	**Всего, % / Total, %**
Плохой / Poor	0–14 баллов / 0–14 points	58	28,6	15	15,3	73	24,3
Средний / Average	15–19 баллов / 15–19 points	104	51,2	55	56,1	159	52,8
Хороший / Good	20–22 баллов / 20–22 points	41	20,2	28	28,6	69	22,9

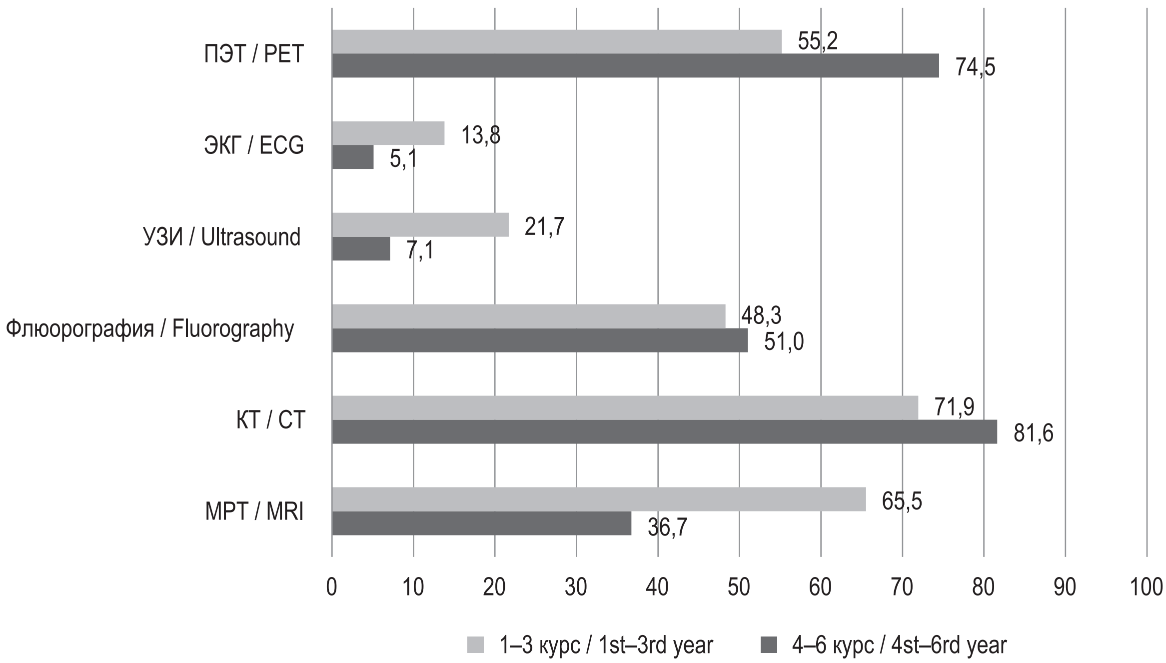


Fig. 3. Distribution of answers to the question about diagnostic methods associated with ionizing radiation (%): CT — computed tomography; MRI — magnetic resonance imaging; PET — positron emission tomography; ECG — electrocardiography

Рис. 3. Распределение ответов на вопрос о том, какие методы диагностики ассоциированы с ионизирующим излучением (%): КТ — компьютерная томография; МРТ — магнитно-резонансная томография; ПЭТ — позитронно-эмиссионная томография; УЗИ — ультразвуковое исследование; ЭКГ — электрокардиография

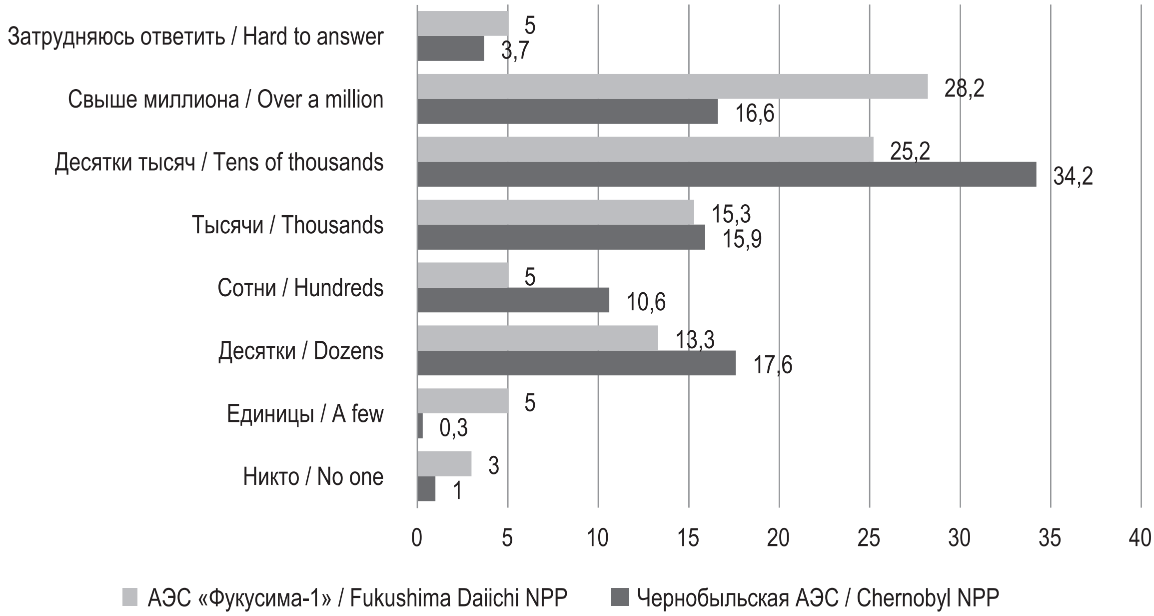


Fig. 4. Distribution of respondents' answers to the question about the number of deaths from radiation exposure as a result of accidents at Fukushima-1 and Chernobyl NPPs, %

Рис. 4. Распределение ответов респондентов на вопрос о количестве погибших от радиационного воздействия в результате аварий на АЭС «Фукусима-1» и **Чернобыльской АЭС**, %

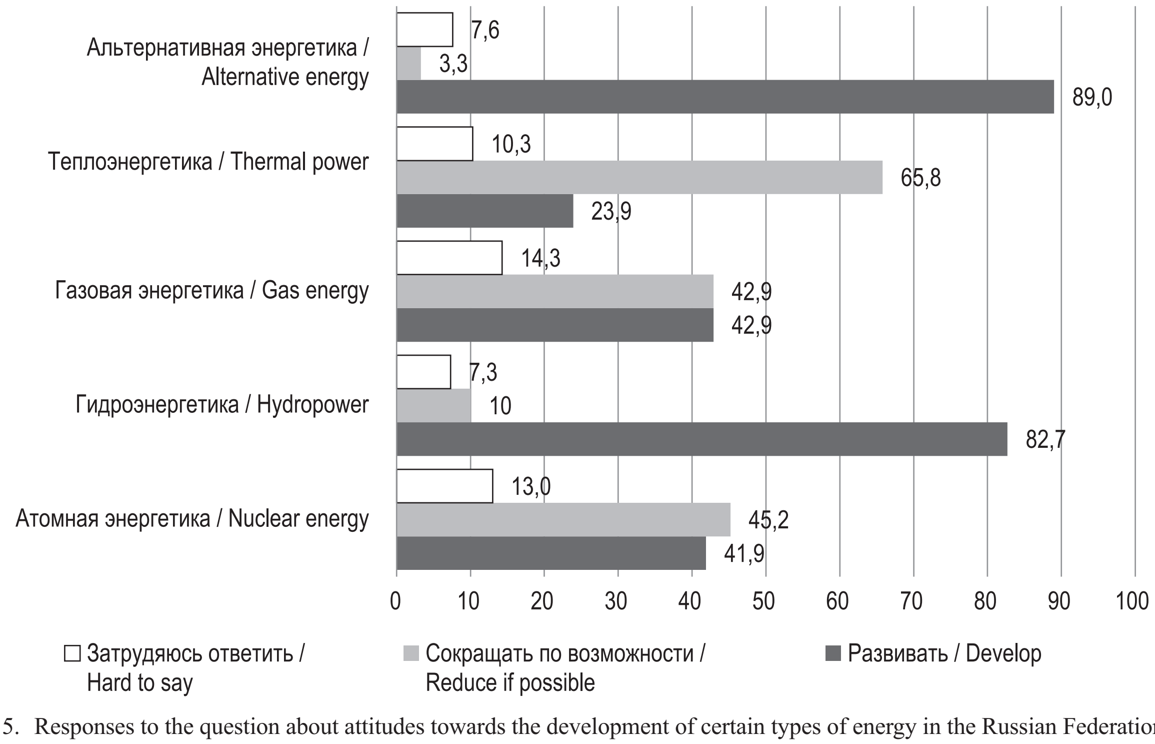


Fig. 5. Responses to the question about attitudes towards the development of certain types of energy in the Russian Federation, %

Рис. 5. Ответы на вопрос об отношении к развитию отдельных видов энергетики в Российской Федерации, %

in answers of 1st–3rd and 4th-6th year students were not identified (p >0.05). Lacking knowledge about the actual number of victims, respondents tended to select answer options that aligned with their subjective perceptions, i.e., with a large number of casualties. The Chernobyl nuclear power plant accident resulted in 28 direct deaths from acute radiation syndrome [14]. According to the World Health Organization (WHO), the Chernobyl accident may

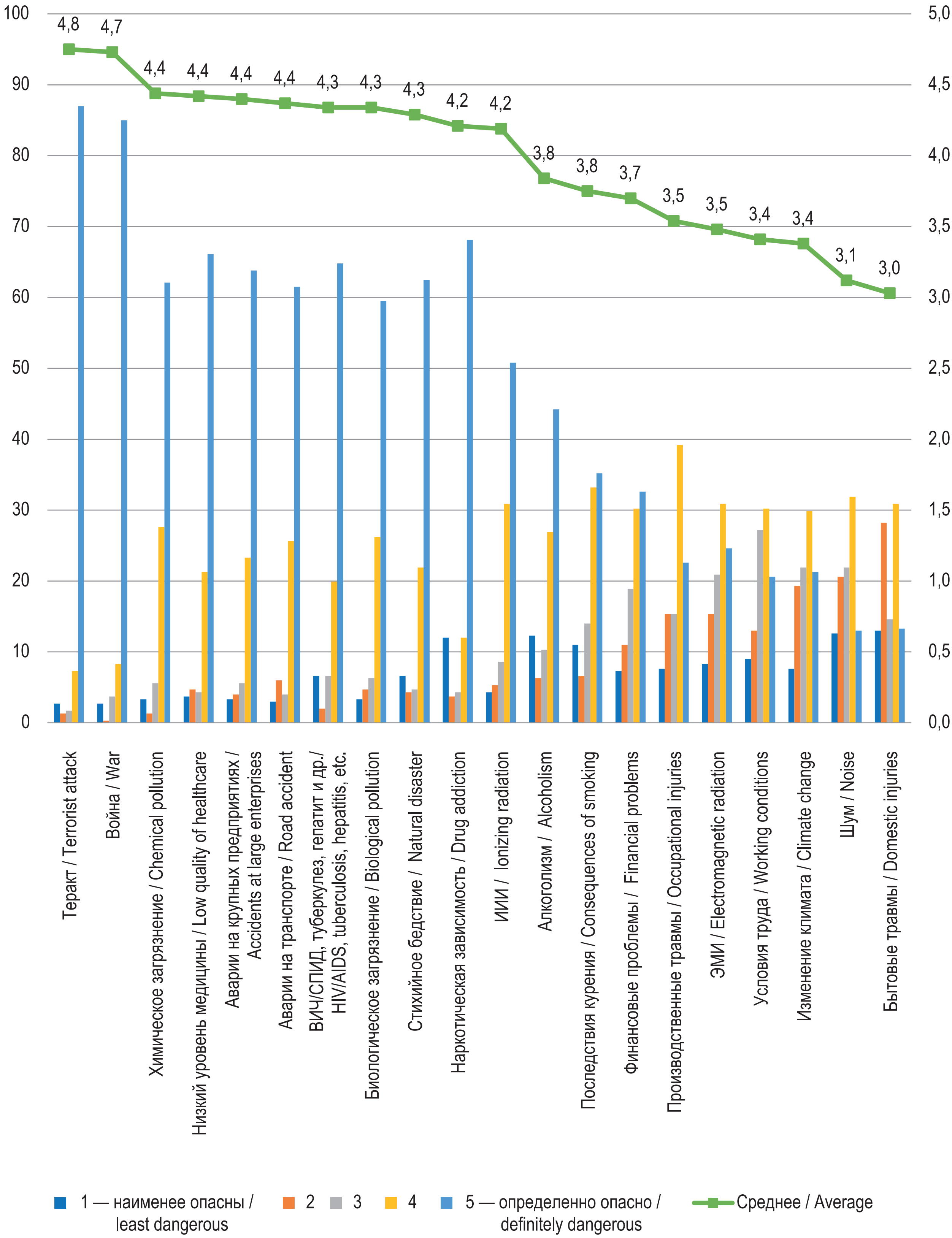


Fig. 6. Distribution of answers to the question about risk factors most dangerous for respondents, calculated average scores of hazards

Рис. 6. Распределение ответов на вопрос о факторах риска, наиболее опасных для респондентов, рассчитанные средние баллы опасностей ultimately have caused up to 4,000 total deaths [15]. The Fukushima Daiichi nuclear power plant accident resulted in no deaths from acute radiation syndrome [16]. WHO studies have shown no significant increase in cancer mortality is expected [17]. This discrepancy between objective data about actual consequences and student perceptions indicates an established societal view of radiation accidents as posing significant hazard to public health.

The study found that two types of energy sources are supported by students: alternative energy and hydropower (Fig. 5). Nuclear energy, along with gas energy, elicited mixed responses, with supporters and opponents being almost equally divided. Such a cautious attitude towards nuclear energy is caused, among other things, by an exaggerated idea of the danger of radiation accidents. Thermal power was the only energy source where a majority of students supported reduction. Statistically significant differences in answers of 1st–3rd and 4th–6th year students were not observed ($p > 0.05$).

The analysis of perception of risks of various nature showed that the effect of IR is perceived at a moderate level (Fig. 6). The average score of 4.2 corresponds to the median value of perception of all risks. The danger of IR exposure is perceived at a similar level to a wide range of risks of various natures, from drug addiction to chemical pollution of the environment. Statistically significant differences in answers of 1st–3rd and 4th-6th year students were not identified ($p > 0.05$).

The results of the data analysis indicate satisfactory radiation safety training levels among medical university students. The students' baseline attitudes are rather conservative (i.e., with an exaggerating the effect of ionizing radiation on the body), which is subject to correction during the course of training. It is advisable to increase the level of awareness of students on issues of medical and emergency exposure, since they will most often encounter these situations in practice.

CONCLUSION

1. In general, students have an average level of knowledge about radiation safety, which corresponds to their self-assessment. It is noteworthy that they have a relatively low level of knowledge on specialized subject of using ionizing radiation in healthcare.
2. Statistically significant differences in answers of 1st-3rd and 4th-6th year students to questions assessing radiation safety knowledge levels were not found ($p > 0.05$).
3. There were statistically significant differences in answers of 1st–3rd and 4th–6th year students to the question about which diagnostic methods are associated with ionizing radiation. This allows us to conclude that as they progress through studies at specialized departments, students' competencies in the field of radiation diagnostics increase.
4. Although ionizing radiation is not perceived as a health risk factor, students tend to significantly exaggerate the negative consequences of major radiation accidents.
5. Students have ambivalent attitudes towards nuclear energy and are not ready to support it or insist on its reduction.

The results of the studies show that there is a need to adjust the programs for students in specialized training modules. The knowledge obtained during the studies will be necessary in the process of risk communication with patients or their legal guardians. Insufficient knowledge can negatively affect the process of prescribing and conducting studies. This may also lead to neglect of radiation safety standards for patients and personnel.

ADDITIONAL INFORMATION

Author contribution. Thereby, all authors made a substantial contribution to the conception of the study, acquisition, analysis, interpretation of data for the work, drafting and revising the article, final approval of the version to be published and agree to be accountable for all aspects of the study.

Competing interests. The authors declare that they have no competing interests.

Funding source. This study was not supported by any external sources of funding.

Consent for publication. The authors received written consent from the respondents to publish the data.

ДОПОЛНИТЕЛЬНАЯ ИНФОРМАЦИЯ

Вклад авторов. Все авторы внесли существенный вклад в разработку концепции, проведение исследования и подготовку статьи, прочли и одобрили финальную версию перед публикацией.

Конфликт интересов. Авторы декларируют отсутствие явных и потенциальных конфликтов интересов, связанных с публикацией настоящей статьи.

Источник финансирования. Авторы заявляют об отсутствии внешнего финансирования при проведении исследования.

Информированное согласие на публикацию. Авторы получили письменное согласие анкетируемых на публикацию данных.

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