Journal of Radiology in Medicine

Original Article

Doi: 10.51271/JRM-0026

Knowledge levels of third- and fourth-year medical faculty students about radiation and radiation dose to which patients are exposed during radiologic imaging

Adnan Özdemir[1], Sıla Akalın[2], Atila Gözen[2], Ceyda Kurşun[2], Merve Sude Keçe[2], Sıla Gökdemir[2]

[1]Department of Radiology, Faculty of Medicine, Kırıkkale University, Kırıkkale, Turkiye
[2]Medical Student, Faculty of Medicine, Kırıkkale University, Kırıkkale, Turkiye

Received: 28.03.2025 ◆ **Accepted**: 17.04.2025 ◆ **Published**: 26.04.2025

Cite this article: Özdemir A, Akalın S, Gözen A, Kurşun C, Keçe MS, Gökdemir S. Knowledge levels of third- and fourth-year medical faculty students about radiation and radiation dose to which patients are exposed during radiologic imaging. *J Radiol Med.* 2025;2(2):23-26.

Corresponding Author: Adnan Özdemir, dradnanozdemir@gmail.com

ABSTRACT

Aims: The aim of this survey study was to determine the level of knowledge of 3rd and 4th year medical students about radiation and radiation dose to which patients are exposed.

Methods: This study is a descriptive and cross-sectional study and was conducted using a questionnaire method (Google Form). The study was conducted between January 2025 and February 2025 among 3rd and 4th year students of Kırıkkale University Faculty of Medicine. In the data collection form used in the study, 3 questions were related to age, gender, and medical school year, while the remaining 22 questions were designed to assess the participants' level of knowledge about radiation and radiation dose to which patients are exposed during radiologic imaging.

Results: A total of 170 students participated in the survey, 101 of whom were 3rd year medical students and 69 of whom were 4th year medical students. When the responses of all students regarding the presence of radiation in radiologic imaging methods were examined, the accuracy rates were found to be: ultrasonography 96.5%; X-ray 95.3%; CT 91.2%; MRI 65.9%; mammography 62.9%; and angiography 51.5%. The 3rd and 4th year students stated that ultrasonography contained 2% and 2.9% radiation, and magnetic resonance imaging contained 30.7% and 30.4% radiation, respectively. Among the questions asked about the effect of radiation, the question "Does radiation exposure cause infertility?" was statistically significant between 3rd and 4th year students ($p<0.005$). No significant difference was found in other questions. It was found that the correct dose estimation was significantly less in the responses of the surveyed students to the dose levels to which the patients were exposed in radiological imaging methods involving ionizing radiation. In addition, a statistically significant difference was found between 3rd and 4th year students in the question of the dose exposure in lower extremity arteriography ($p<0.005$). No significant difference was found in other questions.

Conclusion: Our study and similar studies indicate that the level of knowledge of medical faculty students about radiation and radiation-containing imaging methods is not sufficient. Increasing their level of knowledge on this subject is important for patients to receive correct and adequate treatment. We think that increasing the number of courses on this subject and providing reminder trainings after graduation will be beneficial in terms of enhancing physicians' knowledge.

Keywords: Radiation, harmful effects of radiation, patient safety, knowledge level

INTRODUCTION

Radiation causes adverse biological effects on living organisms. These harmful biological effects are related to the amount of radiation and the duration of exposure.[1,2] Today, some of the imaging methods used in the medical diagnosis and treatment of many diseases contain ionizing radiation. Radiation exposure in diagnostic radiology produces stochastic effects. High-dose ionizing radiation used in treatment has deterministic effects. For certain dose levels in humans, the effects that may occur from blood and chromosome damage to sudden death can be clearly demonstrated, but it is not known what the threshold radiation dose is that will cause cancer or genetic damage in humans.[3] Therefore, it is important to use radiation-containing examinations consciously in medical applications.

Studies have reported that physicians' knowledge about radiation and radiation safety is inadequate.[4,5] Increasing educations about radiation safety and radiation for medical school students will make a significant contribution to reducing radiation exposure.[2,6,7]

In this survey study, we aimed to investigate the level of knowledge of 3rd and 4th year medical school students about radiation and radiation dose to which patients are exposed.

METHODS

This study is a descriptive and cross-sectional study and was conducted using a survey method. The study was conducted between January 2025 and February 2025 among 3rd and 4th year students of Kırıkkale University Faculty of Medicine. Participation in the study was voluntary, and data were collected via Google Form. The study was conducted with the permission of Kırıkkale University Non-interventional Researches Ethics Committee (Date: 15.01.2025, Decision No: 2025.01.02). The study was conducted according to the principles of the Declaration of Helsinki.

The data collection form used in the study consisted of a total of 25 questions. Twenty-two of these questions were designed to assess the participants' level of knowledge about radiation and radiation dose to which patients are exposed during radiologic imaging. The other 3 questions were related to age, gender, and medical school year.

The ionizing radiation doses that patients were exposed to in commonly used radiological imaging methods were asked how many chests radiographs they corresponded to (**Table 1**). Responses were evaluated according to the UNSCEAR 2000 Report, and answers with a deviation of 20% were considered correct. In this report, the doses of countries in radiologic examinations are listed in detail. In the last rows of the tables, the average of the countries was taken. Since dose equivalents were not available for the questions in the questionnaire form for our country, the average values of all countries were taken.[8] The data obtained from the study were entered into the SPSS 25.0 statistical package program, and statistical analyses were evaluated at the $p<0.05$ significance level using chi-square tests with the same program.

Table 1. Dose received by patients when radiological imaging methods are applied (mSv), dose exposure according to chest radiography

Imaging method	Dose (mSv)	Number of corresponding chest radiographs
Barium stomach radiography	3.7	26
Abdominal radiography	0.55	3.92
Abdominal CT	13.3	95
Lower extremity arteriography	12.4	88

mSv: Millisievert, CT: Computed tomography

RESULTS

A total of 170 students participated in the survey, including 101 3rd year medical students and 69 4th year medical students. 58 of the 3rd year students were female and 43 were male, and 47 of the 4th-year students were female and 22 were male.

When the responses of all students regarding the presence of radiation in radiologic imaging methods were examined, the accuracy rates were found as follows: ultrasonography 96.5%; X-ray 95.3%; CT 91.2%; MRI 65.9%; mammography 62.9%; and angiography 51.5% (**Table 2**). When the distribution of 3rd and 4th year students' responses to the same question was analyzed, no statistically significant differences were found between the two years (**Table 3**).

Table 2. Distribution of all students' responses to the question about the presence of radiation in radiologic imaging methods

	Radiation presence					
	Yes		None		I don't know	
Imaging method	**n**	**%**	**n**	**%**	**n**	**%**
X-ray	162	95.3	7	4.1	1	0.6
Ultrasonography	4	2.4	164	96.5	2	1.2
Mammography	107	62.9	39	22.9	24	14.1
Computed tomography	155	91.2	8	5.3	6	3.5
Magnetic resonance imaging	52	30.6	112	65.9	6	3.5
Angiography	87	51.5	42	24.7	41	24.1

Table 3. Distribution of responses to the question about the presence of radiation in radiologic imaging methods

		Radiation presence						
		Yes		None		I don't know		p*
Imaging method	**Year**	**n**	**%**	**n**	**%**	**n**	**%**	
X-ray	3	98	97	2	2	1	1	.172
	4	64	92.8	5	7.2	0	0	
Ultrasonography	3	2	2	97	96	2	2	.468
	4	2	2.9	67	97.1	0	0	
Mammography	3	66	65.3	21	20.8	14	13.9	.690
	4	41	59.4	18	26.1	10	14.5	
Computed tomography	3	89	88.1	7	6.9	5	5	.230
	4	66	95.7	2	2.9	1	1.4	
Magnetic resonance imaging	3	31	30.7	65	64.4	5	5	.469
	4	21	30.4	47	68.1	1	1.4	
Angiography	3	50	49.5	27	26.7	24	23.8	.755
	4	37	53.6	15	21.7	17	24.6	

p* value shows the results of Chi-squared test

Among the questions asked about the effect of radiation, the question "Does radiation exposure cause infertility?" was statistically significant between 3rd and 4th year students. No significant difference was found in other questions (**Table 4**).

It was found that the correct dose estimation was significantly less in the responses of the surveyed students to the dose levels to which patients were exposed in radiological imaging methods involving ionizing radiation (**Table 5**). In addition, a statistically significant difference was found between 3rd and 4th year students in the question of dose exposure in lower extremity arteriography. No significant difference was found in other questions (**Table 5**).

DISCUSSION

Although radiation causes various adverse biological effects in living organisms depending on the dose and exposure

Table 4. Problems related to the effects of radiation questions and distribution of answers

	Year	Yes		None		I don't know		p*
		n	%	n	%	n	%	
Is radiation harmful to living things?	3	100	99	0	0	1	1	.785
	4	68	98.6	0	0	1	1	
Does the effect of radiation depend on the duration of exposure?	3	98	97	2	2	1	1	.892
	4	66	95.7	2	2.9	1	1.4	
Does the effect of radiation depend on the dose of exposure?	3	99	98	0	0	2	2	.796
	4	68	98.2	0	0	1	1	
Does exposure to medical radiation (such as X-rays) cause infertility?	3	65	64.4	8	7.9	28	27.7	.035
	4	43	62.3	14	20.3	12	17.4	
Is there an annual equivalent dose for officials?	3	88	87.1	2	2	11	10.9	.073
	4	67	97.1	0	0	2	2.9	
Do you have sufficient knowledge about ionizing radiation used in medicine and its hazards?	3	41	40.6	30	29.7	30	29.7	.505
	4	32	46.4	22	31.9	15	21.7	
Would you like to have lectures about ionizing radiation used in medicine and the harm of radiation?	3	78	77.2	13	12.9	10	9.9	.920
	4	53	76.8	8	11.6	8	11.6	

p* value shows the results of Chi-squared test

Table 5. Distribution of the respondents' responses to the dose levels to which patients are exposed in radiological imaging methods involving ionizing radiation

		Less		Correct		More		p*
Imaging method	**Year**	**n**	**%**	**n**	**%**	**n**	**%**	
Barium stomach radiography	3	77	76.2	7	6.9	17	16.8	.0838
	4	50	72.5	5	7.2	14	20.3	
Abdominal radiography	3	58	57.4	20	19.8	23	22.8	.314
	4	34	49.3	12	17.4	23	33.3	
Abdominal CT	3	74	73.3	4	4	23	22.8	.149
	4	41	59.4	3	4.3	25	36.2	
Lower extremity arteriography	3	85	84.2	5	5	11	10.9	.003
	4	45	65.2	2	2.9	22	31.9	

CT: Computed tomography, p* value shows the results of Chi-squared test

time, it is indispensable in diagnosis and treatment.[2,9,10] In clinics where medical imaging involving radiation is used, the ALARA (as low as reasonably achievable) principle has been adopted, and it is aimed that the patient and healthcare personnel receive the lowest dose possible.[11]

There is a lack of knowledge about radiological examinations, the effects of radiation, and radiation protection in society. As a result of this lack of knowledge, both patients and healthcare professionals are exposed to excessive radiation doses, unnecessary tests are performed, and this process becomes a social health problem.[12]

Physicians should be familiar with imaging techniques with and without ionizing radiation so that patients are not exposed to unnecessary radiation and can benefit from imaging techniques in the most appropriate way. Arslanoğlu et al.[3] reported that 4% and 27.4% of physicians and interns stated that abdominal ultrasonography and abdominal magnetic resonance imaging methods exposed patients to radiation at a rate of 4% and 27.4%, respectively. According to a study by Jacob et al.[13], 10% and 28% of physicians said that US and MRI contained ionizing radiation, respectively. Shiralkar et al.[14] reported that 5% of physicians said that US and 8% of physicians said that MRI contains ionizing radiation. In our study, similar to the literature, 3rd and 4th year students stated that ultrasonography and magnetic resonance imaging contained 2% and 2.9% and 30.7% and 30.4% radiation, respectively. There was no statistically significant difference between 3rd and 4th year students.

When the imaging modalities containing radiation were analyzed, the accuracy rates of the 3rd and 4th year students were significantly higher. When the answers of all students were evaluated, the presence of radiation was correctly answered by 95.3% in X-ray, 91.2% in CT, 62.9% in mammography, and 51.5% in angiography.

While the answers given to the questions "Does radiation harm living things?", "Does the effect of radiation depend on the duration of exposure?", "Does the effect of radiation depend on the dose of exposure?", and "Is there an annual equivalent dose for officials?" were correct at a high rate, a significant decrease was observed in the correct answer rates given to the question "Does exposure to medical radiation (such as X-rays) cause infertility?" Again, a statistically significant difference was found between the 3rd and 4th year answers to this question.

Unnecessary radiological examinations increase radiation exposure for patients and healthcare professionals. Therefore, increasing education about radiation safety and radiation for

medical faculties and healthcare professionals will make a significant contribution to reducing radiation exposure.[2,6,7] In the study by Çakmak et al.[15], 84.3% of medical students answered yes to the question, "I would like to have courses about ionizing radiation used in medicine and the harms of radiation." In our study, 77.2% and 76.8% of 3rd and 4th year students, respectively, answered yes to a similar question.

In the study by Arslanoğlu et al.[3], 93.1% of physicians and interns answered the questions about the dose received in radiological imaging methods using ionizing radiation as much less radiation dose than it should be. In the Cankorkmaz et al.[16] study, the rates of those who could not estimate the radiation doses correctly were 39.8% for anterior-posterior pelvic radiography, 74.3% for voiding cystourethrography, 71.7% for thoracic computed tomography, and 72.6% for abdominopelvic CT. In our study, students significantly misestimated the radiation doses. The rates of those who could not estimate the radiation dose correctly were 93.1% and 92.8% for barium gastroscopy, 80.2% and 82.6% for abdominal radiography, 96% and 95.7% for abdominal CT, and 95% and 97.1% for lower extremity arteriography in 3rd and 4th year students, respectively. In addition, those who guessed incorrectly tended to underestimate radiation.

CONCLUSION

Our study and similar studies indicate that the level of knowledge of medical faculty students about radiation and radiation-containing imaging methods is not sufficient. Increasing their level of knowledge on this subject is important for patients to receive correct and adequate treatment. We think that increasing the number of courses on this subject and providing reminder trainings after graduation will be beneficial in terms of enhancing physicians' knowledge.

ETHICAL DECLARATIONS

Ethics Committee Approval

The study was conducted with the permission of Kırıkkale University Non-interventional Researches Ethics Committee (Date: 15.01.2025, Decision No: 2025.01.02).

Informed Consent

All patients signed and free and informed consent form.

Referee Evaluation Process

Externally peer-reviewed.

Conflict of Interest Statement

The authors have no conflicts of interest to declare.

Financial Disclosure

The authors declared that this study has received no financial support.

Author Contributions

All of the authors declare that they have all participated in the design, execution, and analysis of the paper, and that they have approved the final version.

REFERENCES

1. Bolus NE. Basic review of radiation biology and terminology. *J Nucl Med Technol*. 2001;29(2):67-77.
2. Brenner DJ, Doll R, Goodhead DT, et al. Cancer risks attributable to low doses of ionizing radiation: assessing what we really know. *Proc Natl Acad Sci USA*. 2003;100(24):13761-13766. doi:10.1073/pnas.2235592100
3. Arslanoğlu A, Bilgin S, Kubalı Z, Ceyhan MN, İlhan MN, Maral I. Radyolojik görüntüleme yöntemleri sırasında hastaların maruz kaldıkları iyonizan radyasyon dozu hakkında doktor ve intern doktorların bilgi düzeyi. *Diagn Interv Radiol*. 2007;*13*:53-55.
4. Güzel A, Temzioz O, Aksu B, Süt N, Karasalihoğlu S. A cost analysis of radiologic imaging in pediatric trauma patients. *Ulus Travma Acil Cerrahi Derg*. 2010;16(4):313-318.
5. Vural F, Fil Ş, Çiftçi S, Aydın Dura A, Yıldırım F, Patan R. Ameliyathanelerde radyasyon güvenliği; çalışan personelin bilgi, tutum ve davranışları. *Balıkesir Sağlık Bil Derg*. 2012;1(3):131-136.
6. Amare DE, Dagne H. Knowledge and associated factors of medical students regarding radiation exposure from common diagnostic imaging procedures at the University of Gondar, Ethiopia. *Ethiop J Health Sci*. 2020;30(4):589-598. doi:10.4314/ejhs.v30i4.14
7. Teferi S, Zewdeneh D, Bekele S. Pediatric residents' and medical interns' awareness about pediatric Ionizing radiation dose from computed tomography and Its associated risks in tertiary Hospital in Ethiopia. *Ethiop J Health Sci*. 2018;28(4):383-392. doi:10.4314/ejhs.v28i4.4
8. United Nations Scientific Committee on the effects of atomic radiation. www.unscear.org/reports/2000_1. Annex D: Medical radiation exposures. Table 15, Parts A and B; 375–77.
9. Lee CI, Haims AH, Monico EP, Brink JA, Forman HP. Diagnostic CT scans: assessment of patient, physician, and radiologist awareness of radiation dose and possible risks. *Radiology*. 2004;231(2):393-398. doi:10.1148/radiol.2312030767
10. Hauptmann M, Mohan AK, Doody MM, Linet MS, Mabuchi K. Mortality from diseases of the circulatory system in radiologic technologists in the United States. *Am J Epidemiol*. 2003;157(3):239-248. doi:10.1093/aje/kwf189
11. Lurie AG. Doses, benefits, safety, and risks in oral and maxillofacial diagnostic imaging. *Health Phys*. 2019;116(2):163-169. doi:10.1097/HP.0000000000001030
12. Özdemir A, Atlı VR, Alıcı C, et al. Knowledge level of the community about radiological examinations and harmful effects of radiation:a review. *J Radiol Med*. 2024;1(2):27-30. doi:10.51271/JRM-0008
13. Jacob K, Vivian G, Steel JR. X-ray dose training: are we exposed to enough? *Clin Radiol*. 2004;59(10):928-927. doi:10.1016/j.crad.2004.04.020
14. Shiralkar S, Rennie A, Snow M, Galland RB, Lewis MH, Gower-Thomas K. Doctors' knowledge of radiation exposure: questionnaire study. *BMJ*. 2003;327(7411):371-372. doi:10.1136/bmj.327.7411.371
15. Çakmak V, Akış Ç, Koç M, Güngör B, Tuncel D. Pamukkale Üniversitesi Tıp Fakültesi öğrencilerinin tıbbi radyasyon ve radyasyon güvenliği hakkında bilgi düzeyleri. *Pamukkale Medical Journal*. 2022;*15*(3):461-466. doi:10.31362/patd.997289
16. Cankorkmaz L, Özşahin S, Gümüş C, Arslan M, Köylüoğlu G. Radyolojik görüntüleme yöntemlerinde hastaların maruz kaldığı iyonizan radyasyon dozu hakkında sınıf IV tıp öğrencilerinin bilgi düzeyi. *Cumhuriyet Medical Journal*. 2009;31(3):226-230.