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ORIGINAL ARTICLE

Knowledge Levels of Medical Faculty Students and Residents about Ionizing Radiation

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ABSTRAK

Kajian ini bertujuan untuk menilai tahap pengetahuan pelajar sekolah perubatan dan doktor pelatih mengenai radiasi mengion. Penyelidikan ini direka bentuk sebagai kajian deskriptif dan ia telah dijalankan di kalngan 369 pelajar sekolah perubatan dan doktor pelatih. Borang kaji-selidik telah digunakan dalam penyelidikan. Ujian khi-kuasa dua digunakan untuk membandingkan pembolehubah kategorikal. Dalam kajian ini, 369 orang telah dicapai dalam skop penyelidikan. Sebanyak 60.7% peserta kajian ialah pelajar perubatan klinikal (gred 4, 5, 6) dan 39.3% merupakan doktor pelatih. Didapati bahawa 17.9% pelajar perubatan klinikal dan 18.6% doktor pelatih mempunyai pengetahuan yang mencukupi mengenai radiasi mengion (p=0.002). Sebanyak 87.0% peserta kajian menjawab dengan betul bahawa pengimejan resonans magnetik (MRI) tidak mengandungi radiasi dan 93.5% menjawab dengan betul bahawa ultrasonografi (USG) tidak mengandungi radiasi. Sebanyak 74.8% peserta menyatakan bahawa pengetahuan tentang radiasi mengion akan menyumbang kepada "melindungi kumpulan sensitif daripada radiasi mengion" dalam amalan perubatan. Nisbah ini ialah 77.2% pelajar perubatan klinikal dan 71.0% doktor pelatih. Kajian mendapati bahawa tahap pengetahuan pelajar fakulti perubatan dan doktor pelatih mengenai radiasi mengion adalah tidak mencukupi. Pelajar perubatan dan doktor pelatih disyorkan untuk dilatih mengenai radiasi dan doktor pelatih radiologi disaran untuk dinilai.

Kata kunci: pelajar perubatan, pendidikan perubatan, radiasi mengion

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ABSTRACT

This study aimed to evaluate the knowledge levels of medical school students and residents about ionising radiation. The study is designed as descriptive research, and it was conducted with 369 medical school students and residents. A survey form was used in the research. A Chi-square test was used to compare categorical variables. In the study, 369 people were reached within the scope of the research. A total of 60.7% of the research participants were clinical medicine students (4th, 5th, 6th grade) and 39.3% were residents. A total of 42.0% of the participants of the study were male, 58.0% were women. It was found that 17.9% of the clinical medical students and 18.6% of the residents had sufficient knowledge of ionising radiation (p=0.002). A total of 87.0% of the participants in the study answered correctly that magnetic resonance imaging (MRI) does not contain radiation and 93.5% answered correctly that ultrasonography (USG) does not contain radiation. 74.8% of the participants stated that having knowledge about ionising radiation would contribute to "protecting sensitive groups from ionising radiation" in medical practice. This ratio is 77.2% in clinical medicine students and 71.0% in residents. The study found that knowledge levels of medical faculty students and residents about ionising radiation were insufficient. Medical students and residents are recommended to be trained on radiation and the radiological requests of residents to be evaluated.

Keywords: ionising radiation, medical student, medical education

INTRODUCTION

Ionising radiation plays an effective role in the developed world. X-rays revolutionised diagnosis. The use of high-dose ionising radiation can cause the death of humans and other living organisms (Grant et al. 2017). In daily practice, physicians request numerous diagnostic tests that use ionising radiation and write prescriptions (European Commission 2001). The average radiation dose taken annually by the community is 2.5 mSv, and 15% of them are associated with medical exposures (Quinn et al. 1997; Rahman et al. 2008). A total of 97% of all artificial radiation sources affecting humans are caused by medical procedures (Turkish Atomic Energy Institution 2009). The use of radiation in medical applications has increased continuously, and 30% to 50% of medical decisions are based on radiological examinations (Tavakoli et al. 2003). The presence of advanced imaging methods in the last 25 years has led to a 6-fold increase in patients' ionising radiation exposure (Schauer & Linton 2009; Mettler et al. 2009).

The strong relationship of ionising radiation exposure with medical procedures reveals the importance of physicians to have clear information regarding the harm of radiation.

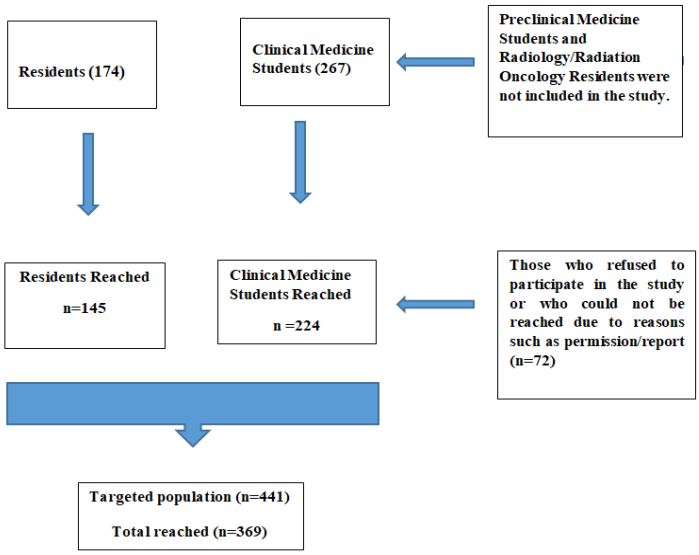

Figure 1: Flow chart of the study sampling

The physician must have general information about ionising radiation and its harms and doses administered to the patient by radiological examinations in order to determine the balance of necessity and harm in the examination request. Studies have revealed that physicians' general knowledge regarding radiation is insufficient (Abuelhia 2017; Arslanoğlu et al. 2007).

This study is different in that the efficiency of ionising radiation theoretical training in medical education includes subjective evaluations of residents and clinical medical students and may benefit the self-evaluation of the institution where the study was conducted. Based on this regard, it is aimed to determine the knowledge level and awareness of the students and residents of a medical faculty in Istanbul about ionising radiation.

MATERIALS AND METHODS

This study is a cross-sectional descriptive type of research. The population of the research consists of 441 people, including 4th, 5th, 6th-grade students of İstanbul Medeniyet University, Faculty of Medicine, and the residents in the first two years of IMU Goztepe Training and Research Hospital. Students in the first three years of medical faculty were not included in the study, as they had not yet received any training on ionising radiation. The residents in their first two years were mostly preferred due to their recent graduation from the medical school, allowing them to evaluate the theoretical knowledge provided by the faculty. Radiology and radiation oncology residents were not included in the study, as their knowledge of radiation might be higher than other physicians due to their specialty (Figure 1).

The entire population was tried to be reached. Two hundred and twenty-four (83.8%) of 267 students and 145 (83.3%) of 174 residents, in sum, a total of 369 people (83.6%) were contacted. The questionnaire could not be administered to 72 people from the target population because they were on leave or did not agree to participate in the study. From the participants, the Faculty of Medicine 4th, 5th, 6th-grade students were defined as "clinical medicine students," and two groups were established together with the residents. Radiology and radiation oncology residents were not included in the study.

The study was conducted in April 2019. In the research, a questionnaire form was prepared by the researchers through scanning the literature and benefiting from the theoretical information included in the medical school education curriculum. Information was given to the volunteers about the research by the researchers, and the volunteers were asked to fill the questionnaires under observation after obtaining consent.

The survey consists of three sections. In the first section, demographic questions (age, gender, status, department) and self-evaluation questions (their level of knowledge, the necessity of the knowledge for themselves, and the medical education) related to ionising radiation information and whether they received training on this subject or not were present.

In the second section, information questions about ionising radiation were included. Difficult information questions were created according to the largest radiation source (radon) in nature, the dose-independent effect of ionising radiation (stochastic effect), the definition of the As Low As Reasonably Achievable (ALARA) principle (the use of tests containing the least and the most effective dose of radiation as possible) and false facts. In the options given in the question of sources emitting ionising radiation, sources that emit ionising radiation were not included, but sources thought to emit ionising radiation in the community were included.

In the third part, assuming that a single radiograph is equal to one unit of radiation, the doses for radiological imaging such as Computed tomography (CT), İntravenöz Pyelografi (IVP), Pozitron Emisyon Tomografisi (PET), barium enema, angiography, and imaging without ionising radiation such as ultrasonography (USG) and magnetic resonance imaging (MRI) were given in a tabular form (1-5U, 6-10U, 11-50U, 51- 300U and >300U) and participants were asked to estimate the doses. In addition, they were asked to rank the four organs (gonad, stomach, bladder, kidney) according to their radiosensitivities (between 1=the least radiosensitive and 4=the most radiosensitive). "Sources and Effects of Ionising Radiation Report" was used for the answers (UNSCEAR 2000). Fourteen ionising radiation knowledge questions in the third and second sections were scored as 1 point for the correct answer, and the total knowledge points of the participants were calculated (min. 0 and max. 14).

Table 1: Distribution of the participants according to gender, ionizing radiation knowledge self-assessment, and education status

Variables		Clinical Medicine Students		Residents		Total	
		n	%	n	%	n	%
Gender	Female	133	62.1	81	37.9	214	58.0
	Male	91	58.7	64	41.3	155	42.0
Self-Assessment of Ionizing Radiation Knowledge Level	Good	51	61.4	32	38.6	83	22.5
	Moderate	68	48.9	71	51.1	139	37.7
	Bad	105	71.4	42	28.6	147	39.8
Ionizing Radiation Training Status	Yes	125	65.4	66	34.6	191	51.8
	No	99	55.6	79	44.4	178	48.2
Total		224	60.7	145	39.3	369	100.0

Statistical Analysis

The research data were evaluated with the SPSS v.22.0 program. Descriptive statistics are presented as mean(±)standard deviation, frequency distribution, and percentage. A Chi-square test was used to compare categorical variables. The Kruskal Wallis test was applied according to the level of knowledge that the participants thought they had (no, very little, moderate, good, very good) in analysing the scores they received since the total scores did not match the normal distribution. The statistical significance level was taken as $p < 0.05$ in the analysis.

Approval was obtained from the Clinical Practices Ethics Committee of Istanbul Medeniyet University (No: 2019/0192) for the research.

RESULTS

Three hundred sixty-nine people were reached within the scope of the research. A total of 60.7% (n=224) of the participants were clinical medicine students (4th, 5th,6th grade) and 39.3% (n=145) were residents. A total of 42.0% of the participants of the study were male (n=155), 58.0% (n=214) were women, with a mean age of 25.2 ± 3.1 and a median of 24 (min: 21; max: 41) (Table 1).

In the study, it was found that 17.9% (n=40) of the clinical medical students and 18.6% (n=27) of the residents thought to have a good degree of knowledge about ionising radiation (p=0.002). It has been determined that 35.7% (n=80) of clinical medical students and 51.0% (n=74) of residents think that knowing ionising radiation is important in medical practice (p <0.001). A statistically significant relationship was found between the radiation education they received and the level of thinking that ionising radiation knowledge was important in medical practice (p=0.005) (Table 1).

A total of 74.8% of the participants (n=276) stated that having knowledge about ionising radiation would contribute to "protecting sensitive

Table 2: Distribution of the radiosensitivity rankings of the participants in the research according to correct knowing conditions

	Clinical St.	Residents	Total
	n (%)	n (%)	n (%)
Correct	9 (4,0)	15 (10,3)	24 (6,5)
Incorrect	215 (96,0)	130 (89,7)	345 (93,5)
		χ^2=5,794 p=0,016	

groups from ionising radiation" in medical practice. This ratio is 77.2% (n=173) in clinical medicine students and 71.0% (n=103) in residents.

A total of 4.0% of the clinical medical students (n=9) and 10.3% (n=15) of the residents participating in the study successfully knew the radiosensitivity ranking of the organs. The frequency of knowing correctly by the residents was statistically significantly higher (p=0.016) (Table 2).

A total of 72.4% (n = 267) of the participants of the study correctly knew that gonads were very radiosensitive, 14.6% (n=54) knew stomach was moderately radiosensitive, 35.2% (n=130) knew bladder was less radiosensitive, and 13.6% (n=50) knew that the kidneys were too few radiosensitive (Figure 2).

It was determined that 29.9% (n=67) of clinical medical students and 10.3% (n=15) of residents answered the dose-independent effect question correctly (stochastic effect). It was found that 70.1% (n=157) of clinical medical students and 35.2% (n=51) of residents answered the definition of the ALARA principle correctly. It was found that 19.6% of clinical medical students (n=44) and 26.2% (n=38) of residents knew the answer of the largest source of radiation in nature (radon) question correctly (Figure 3).

Of the participants, 34.4% (n=127) answered laser beams, 29.8% (n=110) answered microwave, 6.5% (n=24) answered telephone, 2.7% (n=10) answered television, 1.9% (n=7) answered radio and 19.0% (n=70) answered as no idea to the question of

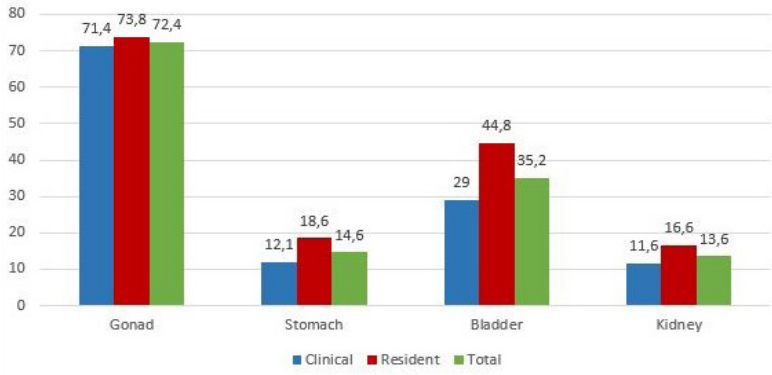

Figure 2: Distribution of the correct answers given by the participants to the radiosensitivity of the organs

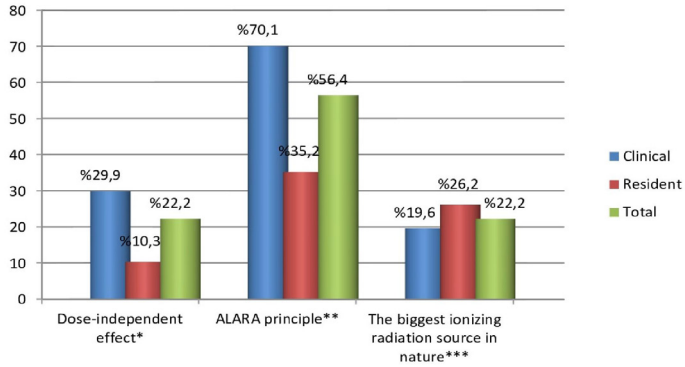

Figure 3: Distribution of the participants according to the correct knowledge level about ionizing radiation

the sources that emit ionising radiation.

In the question, we asked how many lung radiograph doses the imaging methods containing ionising radiation equal to, it was found that 36.9% (n=136) of the participants correctly knew CT, 14.9% (n=55) correctly knew IVP, 26.3% (n=97) correctly knew PET, 35.8% (n=132) correctly knew angiography and 6.8% (n=25) correctly knew the barium enema dose. When compared by groups, frequency of knowing the correct dose in IVP and PET was found to be statistically significantly higher in residents (p <0.001, p=0.001, respectively), while knowing the correct dose of barium enema was higher in clinical medicine students (p=0.043). No intergroup difference was found on CT and Angiography (p=0.917, p=0.828, respectively) (Figure 4). In addition, it was found that 58.8% (n=217) of the participants did not correctly know the ionising radiation dose of CT, 64.8% (n=239) of IVP, 55.3% (n=204) of PET, 58.3% (n=215) of Angiography and 77.5% (n=286) of Barium Enema.

A total of 87.0% (n=321) of the participants in the study answered

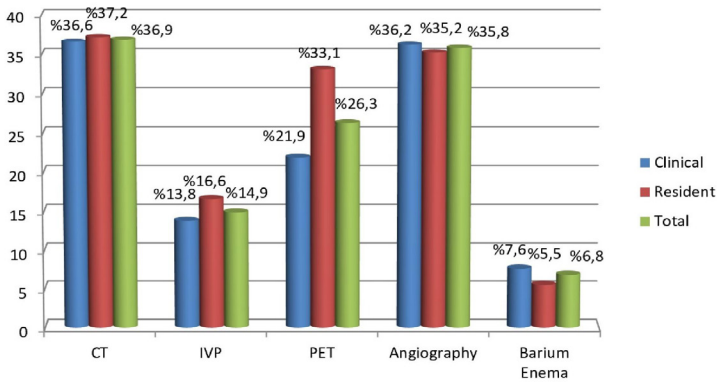

Figure 4: Distribution of the participants according to their knowing status of correct doses of radiological diagnostic modalities

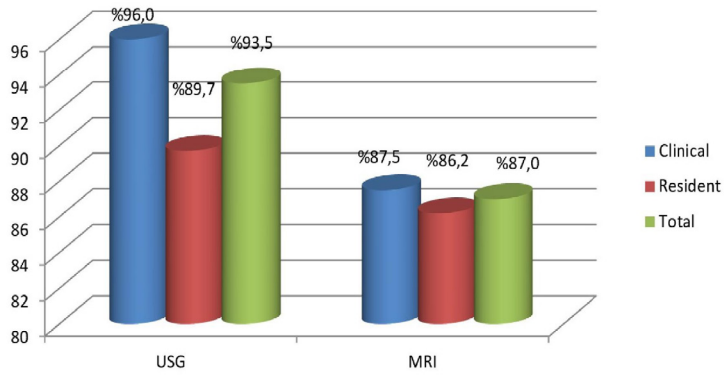

Figure 5: Distribution of the study participants according to their knowing status there is no radiation in USG and MR

correctly that MRI does not contain radiation, and 93.5% (n=345) answered correctly that USG does not contain radiation. In terms of knowing correctly, that MRI and USG do not contain radiation, no difference was found between clinical medical students and residents (Figure 5).

When the level of knowledge that the research participants think they have about ionising radiation and their answers to 14 knowledge questions were evaluated, the median score of those who think they have no knowledge was found as 3 (25%:2; 75%:5), the median score of those who think they have little knowledge was 5 (25%:4; 75%:6), the median score of those who think they have moderate knowledge was 5 (25%:4; 75%:7), the median score of those who think they have good knowledge was 6 (25%:5; 75%:8), and median score of those who think they have very good knowledge was 7 (25%:5; 75%:9). A statistically significant difference was found between the scores they received according to the level of knowledge they thought ($p<0.001$).

DISCUSSION

In our age, ionising radiation is important and necessary in diagnosing and treating many diseases in medicine, but the dangers it poses to health cannot be denied. In this study evaluating ionising radiation awareness, it was found that 17% of the clinical medical students and 18% of the residents thought to have good knowledge about ionising radiation. Also, the median score was 5 for those who thought they had very little knowledge and 7 for those who thought they had very good knowledge, with the total knowledge score ranging from 0 to 14. This analysis of the level of knowledge that participants have declared and the knowledge they actually have is worrying about their awareness of ionising radiation. In the study conducted by Campanella et al. (2017) with physicians, the average frequency of correct answers to the questions regarding ionising radiation knowledge is 62%. Doctors who have more than ten years of experience were found to have a higher percentage

of correct answers than those with less experience in ionising radiation knowledge questions (Campanella et al. 2017). In the study conducted by Ditkofsky et al. (2016), 26% of physicians answered correctly to general radiation knowledge questions (Ditkofsky et al. 2016). Studies show that physicians' radiation knowledge levels are low.

The fact that the study population consists of clinical medicine students whose education is still in progress and the residents who successfully accomplished the national medical specialty exam and have been continuing their specialisation education for two years arouses the expectation that the participants have updated information. This data leads us to think about the effective use of the guidelines on radiation safety for protection, the knowledge about ionising radiation in diagnosis and treatment practices, and the quantitative and qualitative existence of ionising radiation in medical education. It is known that the subject of ionising radiation is not included in the 6-year education programs of medical faculties in our country, it is included in the clinical education in the radiology internship more heavily, and in the public health internship, it is limited in environmental health, patient health, and safety issues. Medical faculties are required to structure their educational content in line with the professional competencies of physicians and to organise these contents in an integrated manner for all educational periods, including specialist training.

In the study, it was seen that 35% of clinical medical students and 51% of residents think that knowing ionising radiation is important in medical practice. A statistically significant relationship was found between the radiation education they received and the level of thinking that ionising radiation knowledge was important in medical practice. In the study conducted by Campanella et al. (2017), 48% of the participants participated in the radiation safety course in the academic period or during their professional careers. In a study conducted by Thomas et al. (2006) in pediatricians, 35% of the participants stated that they received training on radiation doses in medical imaging. Similar to our study, other studies also support that clinicians think that radiation knowledge is important, and they need training. Coordination and communication between the physician who makes the request and applies for radiological imaging are also important for the in-depth analysis of the parameters such as the benefit, necessity, and suitability of the procedure before patient treatment or request. This process ensures that the right decision is made for the patient. Besides, physicians should inform patients and their relatives about the ionising radiation dose and its risks and benefits. In therapeutic applications, the basic principle of applying the lowest possible dose should be acted upon by considering the economic and social factors. This process of competence, knowledge, and skill development, which includes all of these and we expect to be present in

physicians, extends mainly to specialist education starting from pre-specialist medical education. Physicians who think that knowledge is important can be supported with sample case discussions and scenarios that will be prepared specifically for the development of skills for application decisions and competencies.

It was found that 70% of clinical medical students and 35% of residents, and 37.4% of all participants answered the definition of the ALARA principle correctly. In the study conducted by Sharma et al. (2019), 91% of the participants stated that they knew what the ALARA principle means. In the study conducted by Thomas et al. (2006), it was found that 15% of the participants in the study knew the ALARA principle regarding radiation doses in medical imaging.

It was determined in the study that almost one-third of clinical medicine students (29%) and 10% of residents answered the dose-independent effect question correctly (stochastic effect). In the study conducted by Özel et al. (2015), 13.8% of the participants answered correctly to the dose-independent effect of ionising radiation (stochastic effect). The insufficiency of knowledge on this subject is remarkable.

A total of 72% of the participants of the study correctly knew that gonads are very radiosensitive, 14% knew stomach was moderately radiosensitive, 35% knew bladder was less radiosensitive, and 13% knew that the kidneys were too few radiosensitive. In the study conducted by Özel et al. (2015), 89.5% of the participants gave the correct answer (gonad) to the question of the organ sensitive to ionising radiation. In the researches, it is seen that most of the physicians have knowledge of the most radiosensitive organ.

In the questionnaire, we asked how many lung radiograph doses the imaging methods containing ionising radiation have. It was found that 36% of the participants correctly knew CT, 14% correctly knew IVP, 26% correctly knew PET, 35% correctly knew angiography, and 6% correctly knew the barium enema dose. When compared by groups, the frequency of knowing the correct dose inIVP and PET was found to be statistically significantly higher in residents and barium enema in clinical medical students. In the study conducted by Sani et al. (2009), 16.7% of the general physicians correctly knew the dose of IVP, 13.1% of a barium enema, 25% of the chest and head CT, 19% of cerebral angiography, 16.7% of the specialist physicians correctly knew the dose of IVP, 8% of a barium enema, 33.3% of the chest and head CT, 16.7% of cerebral angiography. In the study carried out by Gökçe et al. (2012) in the Faculty of Medicine Hospital, it was determined that 15.9% of physicians correctly know the dose of abdominal CT, 15.7%chest CT, and 9.3% IVP. In the study conducted by Arslanoğlu et al. (2007), 8.2% of the participants correctly answered the dose of abdominal CT, 1.7% of the barium stomach radiography, 2.4% of the lower extremity arteriography. In a study conducted by Cankorkmaz et al. (2009) on sixth-grade medical students, it was found that 28% of the participants

correctly knew the dose of thorax CT, and 27.4% of the participants correctly knew the dose of abdomen and pelvis CT. In the study conducted by Koçyiğit et al. (2014) on health personnel, none of the participants could know the radiation amount of abdominal CT and barium gastric radiography. In the study carried out by Ramanathan and Ryan (2015) on radiology employees, 72% of the participants correctly knew the effective radiation dose of the abdominal CT and 36% of the head CT. In the study carried out by Campanella et al. (2017), 25.7% of the physicians knew the correct dose of abdominal CT, 13.6% of coronary angiography, and 83.5% of mammography. In the study conducted by Abuelhia (2017), 29.6% of the participants correctly knew the effective dose of head CT, and 27% of the PET dose. Research findings show that one of both physicians did not know the ionising radiation doses of CT, PET, Angiography, Barium Enema, IVP correctly. Studies show that physicians have insufficient knowledge of the doses of radiological examinations with high radiation doses. Requesting these tests without knowledge of radiation dose can cause important problems in terms of patient health and safety. Three basic principles in radiation protection are taking into account the damages for not allowing any application that will not provide a clear benefit, the number of people for application optimisation, the size of personal doses, as well as the application of the at the lowest possible dose considering economic and social factors, and the equivalent dose and effective dose limits for the organ or related organs to be applied should not be exceeded (Official Gazette 2012 and 2010). Physicians should make decisions by assessing risk and return on treatment for patient health safety. The aim is not only to stay within the dose limits set by the decision-making authorities but also to provide the lowest dose that can be taken and to protect the physicians, staff, and patients.

A total of 87% of the participants in the study answered correctly that MRI does not contain radiation, and 93% answered correctly that USG does not contain radiation. No difference was found between clinical medical students and residents. In the study conducted by Sani et al., it was determined that 88.1% of general physicians were aware of MR dose, 89.3% of them were aware of the USG dose, and 100% of specialist physicians were aware of MR and USG (Sani et al. 2009). In the study conducted by Gökçe et al. (2012), 82.4% of the participants stated that USG does not contain radiation, and 71.4% of the participants stated that MR does not contain radiation. In the study conducted by Arslanoğlu et al., 96% of the participants stated that abdominal USG does not contain radiation, and 72.6% of the participants stated that abdominal MR does not contain radiation (Arslanoğlu et al. 2007). In the study conducted by Koçyiğit et al. (2014) on health personnel, 80.9% of medical students stated that USG does not contain radiation and 64% stated that MR does not contain radiation, 100% of researcher physician stated that there was no radiation in USG, and

95.7% in MR. In the study conducted by Soye and Paterson on healthcare providers, 10% of the participants incorrectly stated that there is ionised radiation in USG, and 22% of the participants incorrectly stated that there is ionised radiation in MR (Soye & Paterson 2008). In the study conducted by Mubeen et al. (2008) on medical students, 18.7% of the participants stated that MR emits ionising radiation. In the study conducted by Campanella et al. (2017) on physicians, 96.9% of physicians stated that there was no ionising radiation in abdominal USG, and 80.9% stated that there was no ionising radiation in MR (Campanella et al. 2017). It is seen in the studies that a significant number of physicians know that there is no radiation in MRI and USG.

According to the results of the study, it was observed that the awareness of the importance of ionising radiation knowledge in medical practice was better in residents who had just started medicine, had more patient interaction, and had more use related to ionising radiation than clinical medicine students. While the evaluation of ionising radiation knowledge level, which was mostly determined with theoretical knowledge questions, was higher in clinical medicine students who had recently received radiation training, no significant difference was found between the two groups in questions about the doses of imaging methods. However, we expected that the residents would have higher knowledge about the radiological examinations they used and referred to more frequently in their daily medical practices. Our data revealed that the theoretical knowledge of ionising radiation should be supported in practice in medical school education, and the importance given to in-service training should be increased during specialty training.

The inclusion of physicians in different professional years in the research population would have helped to see the differences compared to the years spent in the profession. Due to its cross-sectional characteristic, the target population has been reached within a single time frame and evaluated only according to person, place, time characteristics. Due to the nature of the research results, the study can be generalised to the university hospital where the study is conducted, the research assistants, and clinical students. To increase the external validity of the research, studies to be conducted in a larger sample are needed. In the future, studies in which the attitudes and behaviors that can be questioned in primary, secondary, and tertiary health services, physicians of different occupational years, according to the frequency of use of ionising radiation in practice and with standardised questionnaires that would also evaluate their different knowledge about ionising radiation will contribute to the literature. Educational interventions that will include medical and specialty training in this field will also be beneficial.

CONCLUSION

Study results support the need to raise awareness about ionising radiation

knowledge. As a result, our findings indicate that there should be reference sources that include ionising radiation knowledge, which includes information such as ionising radiation doses, sources in nature, ALARA principle, and dose-independent effects, for use in organs for radiosensitivity, diagnosis and examination. Besides, web-based programs can be considered where risk assessments can be made easily to protect the patient from the health risks of ionising radiation and warn physicians during their applications. In faculties of medicine and education for a specialty in medicine, the subject of ionising radiation should be re-evaluated, and the content and duration of education should be restructured. To prevent health risks that may occur in both physicians and patients, to reduce radiation exposures, and protect the patients and physicians, studies to be conducted on awareness are valuable.

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