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Evaluating the Effectiveness of Medical Physics Course Topics in General Medicine on Students' Knowledge Level Regarding Different Medical Imaging Modalities and Radiation Protection

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ABSTRACT

Background and Objective: The ongoing development of various medical imaging methods in hospitals and medical centers doubles the need to increase medical students' knowledge in regard with radiation protection. The present study was conducted to investigate the adequacy of medical physics course topics on medical students' knowledge regarding different medical imaging modalities and radiation protection in these examinations.

Methods: In this interventional study, 80 medical students who met the inclusion criteria were selected by simple random sampling and assigned to test and control groups using permutation blocks. In addition to medical physics sessions, a workshop on different medical imaging modalities and radiation protection was also held for the students in the test group. A researcher-made questionnaire on familiarity with radiation protection concepts was completed by the students before and after the workshop. Then, the level of knowledge and the score obtained from the questionnaire were analyzed.

Findings: After the workshop sessions, the knowledge level and the mean score of the questionnaire regarding familiarity with imaging modalities and radiation protection increased significantly in the test group compared to the control group (21.07±3.37 vs. 13.07±3.97) ($p<0.05$). Furthermore, in the areas of the nature of radiation, radiosensitivity of different body tissues, age-related radiosensitivity of patients, doses received by patients in different imaging tests, effects of ionizing radiation, as well as methods of patient protection against radiation and theoretical and practical foundations of the ultrasound modality, there was a significant difference in the level of knowledge of students between the test and control groups.

Conclusion: The results of this study highlight the valuable role of radiation protection education in reducing the risks of radiation, the most important result of which is reducing patient radiation exposure and reducing the negative effects of radiation.

Keywords: *Radiation Protection, Medical Imaging, Knowledge*.

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Introduction

Different medical imaging modalities play important roles in enhancing the diagnostic process. With technological advances in medical imaging, radiological studies have assisted physicians in many treatment decisions, allowing them to narrow down the differential diagnoses and provide a more appropriate final diagnosis (1, 2). As medical technology advances, the number of radiological examinations is rapidly increasing. Almost all adult hospitalized patients undergo at least one X-ray test, and many of them undergo multiple imaging procedures (3, 4).

The ionizing radiation used in diagnostic imaging is not safe and can cause a range of somatic harms, including an increased risk of cancer; therefore, physicians should be aware of the risks of these procedures (2, 3, 5, 6). In the UK, it is estimated that 100 to 250 deaths from cancer occur each year which are directly related to radiation exposure (7).

The decision whether a patient needs to be exposed to radiation and which method is most appropriate, least expensive, and carries the least potential risks is the responsibility of the physician, and this requires adequate knowledge of the various imaging methods and their potential risks (8). Therefore, most medical students, regardless of their specialty, should be able to interpret and understand radiological studies to some extent and know the indications for each of them (1, 9). In this regard, a review of published studies shows that concerns about the lack of knowledge among physicians about diagnostic radiology procedures are increasing, and various assessments indicate a low to moderate level of knowledge among physicians regarding radiation doses and the health risks associated with them (10).

Today, education is an essential factor in creating an effective radiation protection program. Organizations such as the International Atomic Energy Agency, the World Health Organization, and scientific societies such as the International Radiation Protection Association have increased educational requirements and prepared specific educational guidelines (11, 12).

Few studies have been conducted in Iran regarding education and its outcomes for radiation protection knowledge. A study on medical physics education in Iran was published in 2017 which pointed out the importance of separating the topic of radiation protection and teaching it in a long-term clinical course (13). Another study conducted on 243 nuclear medicine staff showed that knowledge related to radiation protection concepts was insufficient (14). A study was also conducted on 12 participants in a radiation protection knowledge-enhancing course at Qazvin University of Medical Sciences, which showed the effect of education on increasing the knowledge of the participants in this course, and finally, the need to repeat the study in a larger statistical population was emphasized (15). In their study, Ghazanfari et al. stated that the degree of adaptation of clinical training programs to job requirements is not sufficient (16).

Since general practitioners have the possibility to request radiological images, they must have complete information about the effects of ionizing radiation on the patient in order to exercise maximum accuracy in prescribing the most appropriate imaging method. Accordingly, while the correct diagnosis is made, the dose received by the patient is also minimal and radiation protection is properly implemented. The present study was conducted to determine the level of knowledge of medical students regarding familiarity with different medical imaging modalities and radiation protection of patients based on medical physics course topics. In addition, the path to improving and eliminating the weaknesses of the educational curriculum was examined by holding educational workshops for the test group.

Methods

After approval by the Ethics Committee of Gonabad University of Medical Sciences with the code IR.GMU.REC.1401.111, this interventional study was conducted on 80 medical students of Gonabad University of Medical Sciences who were selected by simple random sampling and allocated to two test and control groups using the permuted block technique. The sample size was determined using G.Power 3.1.9.2 software and considering a type I error of 0.05, a test power of 0.9, and a large effect size of 0.8, 34 people were assigned into each group, which increased to 40 people considering sample dropouts. Inclusion criteria included studying in the field of medicine, completing a medical physics course, informed consent to participate in the research, not participating in a similar workshop in the past year, and not being a visiting student for only one semester. Exclusion criteria included unwillingness to continue cooperation, not participating in the workshop, and incomplete completion of the questionnaires.

The tool used to collect data in this study included a two-part questionnaire including demographic information and familiarity with medical imaging modalities and radiation protection concepts. Demographic information included questions such as age and gender. The questionnaire on familiarity with imaging methods and radiation protection concepts was researcher-made and included 31 four-option questions related to radiation protection concepts, which were given a score of 1 for correct answers and a score of 0 for incorrect answers or "I don't know". The students' knowledge level of radiation protection was graded based on the Iranian academic grading system (0 to 20). The scores of the responses were considered as 0-9.99 failure, 10-11.99 acceptable, 12-13.99 good, 14-15.99 very good, and 16-20 excellent. The questionnaire was prepared after studying the relevant sources on the research topic and their content validity was confirmed using the opinions of ten faculty members of medical universities. The reliability of the questionnaire was also confirmed with a Cronbach's alpha of 0.824 in a small sample population.

First, the questionnaire was completed by students who had completed the standard medical physics course (based on the existing curriculum). Then, in addition to the standard training, a workshop session was held for the test group to familiarize them with imaging methods and radiation protection. This workshop was presented in person and in the form of a lecture with slides. At the end of the intervention, in order to comply with ethics, the content of the workshop was provided to the control group in the form of a booklet. After the workshop, the questionnaire was completed again by the students in the test group. Finally, the data were collected and analyzed using SPSS version 21. Chi-square, Fisher's exact, and linear regression tests were used to compare the demographic characteristics of the participants, and $p<0.05$ was considered significant.

Results

The students in both the test and control groups were between 20 and 25 years old. 69.2% of the test group and 52.5% of the control group were female and the rest were male. There was also no statistically significant difference in the knowledge of the two groups in terms of age and gender (Table 1). The results of the students' self-assessment showed that before the workshop, there was no statistically significant difference between the two groups in terms of self-assessment of knowledge and importance of radiation protection. However, after the workshop, the self-assessment of students in the test group increased significantly compared to the control group ($p<0.001$) (Table 2).

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Table 1. Comparison of demographic information in the two groups

Variable / Group	Test group Number(%)	Control group Number(%)	p-value
Age (years)			
20-25	39(97.5)	38(95)	
25-30	1(2.5)	1(2.5)	0.74*
More than 30	0(0)	1(2.5)	
Gender			
Male	12(30.8)	19(47.5)	0.16**
Female	27(69.2)	21(52.5)	

*Fisher's exact test, **Chi-square test result

Table 2. Students' self-assessment of radiation protection knowledge in test and control groups

Variable	Before holding the workshop			After holding the workshop		
	Control Number(%)	Test Number(%)	p-value*	Control Number(%)	Test Number(%)	p-value*
Students' self-assessment of radiation protection knowledge						
Low	21(52.5)	13(30.8)		21(52.5)	4(10.3)	
Average	17(42.5)	20(51.3)	0.11	15(37.5)	22(53.8)	<0.001
Good	2(5)	6(15.4)		4(10)	13(33.3)	
Very Good	0(0)	1(2.6)		0(0)	1(2.6)	

*Fisher's exact test

In other words, receiving sufficient training increased students' self-confidence in this area. This study showed that the students' knowledge regarding the nature of radiation, the radiosensitivity of different body tissues, and the radiosensitivity of patients according to their age increased significantly after participating in the workshop ($p<0.05$) (Figure 1).

In this study, the level of knowledge of medical students regarding the doses received by patients in various imaging tests, the definite and probable effects of ionizing radiation, and methods of protecting patients from radiation was evaluated. The results showed that participation in the workshop sessions significantly increased the level of knowledge of the students in the test group compared to the control group ($p<0.05$) (Figure 2).

The level of knowledge of medical students about the theoretical and practical foundations of different medical imaging modalities was also examined, and the results showed a large standard deviation in the level of students' knowledge. An increase in the level of knowledge of the students in the test group who participated in the workshop sessions was seen compared to the control group, but this increase in knowledge was only significant for the ultrasound modality and was not statistically significant for other modalities (Figure 3).

The mean total score obtained from the questionnaire on familiarity with imaging systems and radiation protection concepts before the workshop was 14.87±3.39 in the test group and 13.52±3.60 in the control group, and after the workshop, the mean score of this questionnaire was 21.07±3.37 in the test group and 13.07±3.97 in the control group (Figure 4). The results of linear regression analysis showed that the difference in the mean score of the questionnaire of radiological concepts familiarity between the test and

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control groups before and after the intervention was statistically significant and was 7.25 points higher in the test group compared to the control group (p<0.001) (Figure 4).

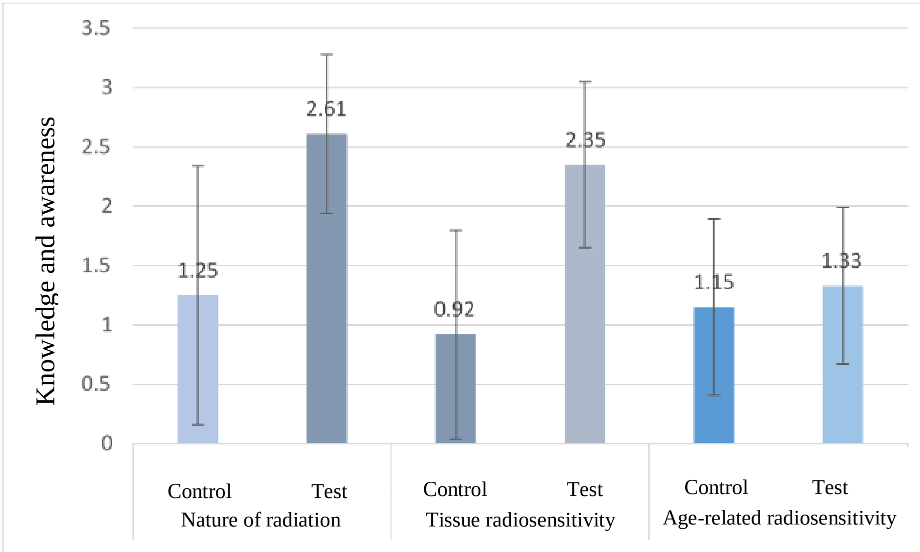

Figure 1. The mean level of knowledge and awareness of students in the control and test groups regarding the nature of radiation, radiosensitivity of tissues, and age-related radiosensitivity of patients (data are in Mean±SD)

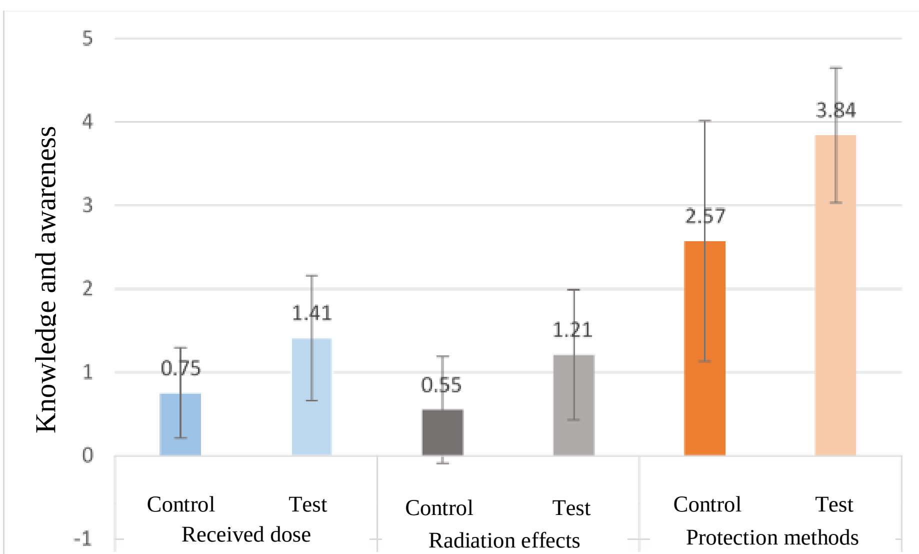

Figure 2. The mean level of knowledge and awareness of students in the control and test groups in the areas of doses received by patients in various imaging procedures, recognition of definite and probable effects of radiation, and methods of patient protection against radiation (data are in Mean±SD)

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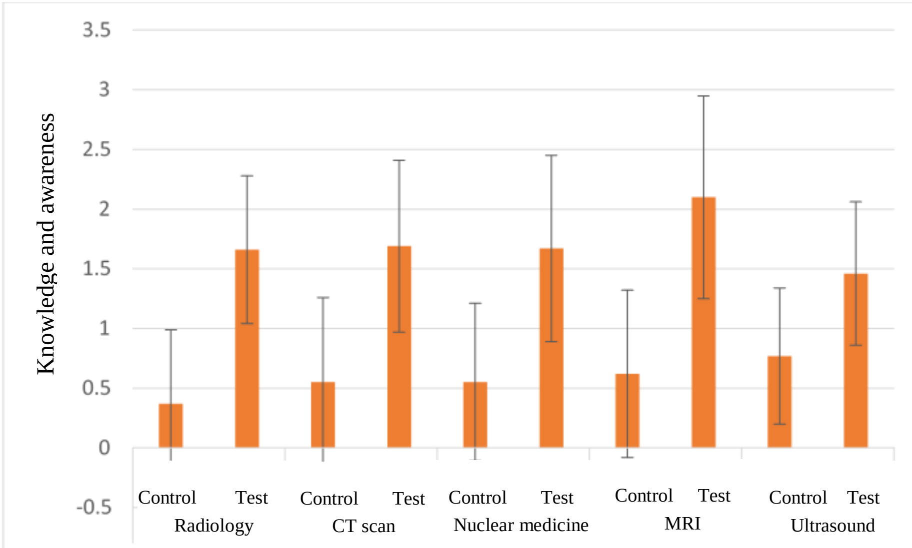

Figure 3. The mean level of knowledge and awareness of students in the control and test groups regarding the theoretical foundations of image production in modalities of radiology, CT scan, nuclear medicine, MRI, and ultrasound (data are in Mean±SD)

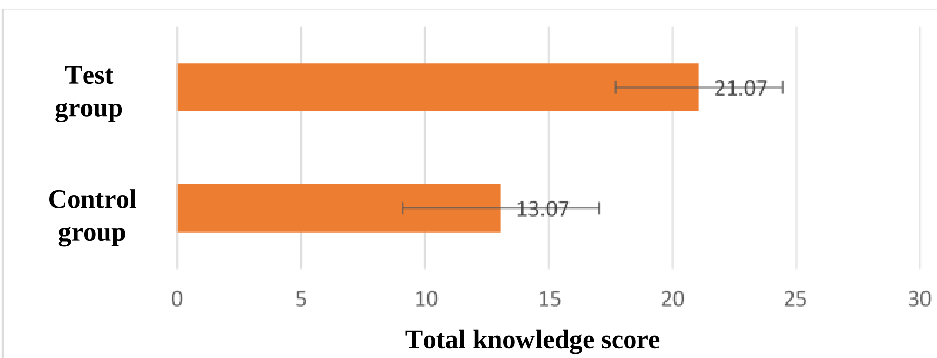

Figure 4. Total knowledge score of students before and after the workshop sessions

On the other hand, the analyses indicated that the knowledge of the test group after the workshop regarding the concepts related to conventional radiology imaging, CT scanning, and nuclear medicine images did not differ significantly from before. Furthermore, the results of the regression analysis showed that the interaction effect of time and group was significant for the concepts of the nature of radiation, patient dose, MRI imaging, ultrasound, tissue radiosensitivity, radiation protection methods, effects of ionizing radiation on living organisms, and the total score. According to the model coefficients, the mean score of these variables after the intervention in the test group was significantly higher than in the control group ($p<0.05$) (Table 3). However, regarding the concepts of nuclear medicine, radiology, and CT scanning, the interaction effect of time and group was not significant, meaning that the changes in the mean score of these variables before and after the intervention between the test and control groups were not statistically significant.

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Table 3. Comparison of the mean total score and subscales of familiarity with radiation protection concepts in the test and control groups

Variable and group	Before the workshop Mean±SD	After the workshop Mean±SD	Result of linear regression analysis Effects	Regression coefficient	Standard deviation	t-statistic	p-value
Nature of radiation			Group	-0.01	0.22	-0.08	0.933
Test	1.25±1.01	2.61±0.67	Time	-1.39	0.49	-2.81	0.005
Control	1.27±1.08	1.25±1.09	Time*group	1.37	0.31	4.38	<0.001
Patient dose			Group	-0.03	0.13	-0.22	0.825
Test	0.59±0.55	1.41±0.75	Time	-0.83	0.30	-2.73	0.007
Control	0.62±0.54	0.61±0.54	Time*group	0.82	0.19	4.25	<0.001
Tissue radiosensitivity			Group	0.49	0.22	2.14	0.034
Test	1.64±1.18	2.35±0.70	Time	-1.15	0.51	-2.28	0.024
Control	1.15±1.21	0.92±0.88	Time*group	0.94	0.32	2.90	0.004
Age-related radiosensitivity			Group	0.49	0.22	2.14	0.034
Test	1.25±0.67	1.33±0.66	Time	-1.15	0.51	-2.28	0.024
Control	1.17±0.84	1.15±0.74	Time*group	0.94	0.32	2.90	0.004
Protection methods			Group	0.62	0.27	2.29	0.023
Test	3.05±1.27	3.84±0.81	Time	-0.49	0.60	-0.81	0.041
Control	2.42±1.21	2.57±1.44	Time*group	0.64	0.36	1.67	0.097
Radiation effects			Group	-0.319	0.15	-2.10	0.037
Test	0.27±0.56	1.21±0.78	Time	-1.02	0.33	-3.01	0.003
Control	0.58±0.63	0.55±0.64	Time*group	0.98	0.21	4.56	<0.001
Total score			Group	0.69	0.79	0.88	0.379
Test	14.87±3.39	21.07±3.37	Time	-7.47	1.76	-4.26	<0.001
Control	13.52±3.60	13.07±3.97	Time*group	7.25	1.12	6.50	<0.001

Discussion

In this study, students reported low to average levels of radiation protection knowledge. In this regard, in a study by Cheki et al., all students believed that the trainings about radiation protection issues and the risks associated with radiations during their academic course and their presence at hospital were insufficient (17). Moreover, according to a study by Kada, despite the fact that medical students had completed radiation-related courses, only 39% of them believed that these courses contained sufficient information about the radiation dose levels of various imaging tests and radiation risks (8). In a study by Janati Esfahani et al., the results also showed that physicians' knowledge of radiation safety was at a low level (15). The sum of these studies shows that medical students' information on most protection issues was insufficient and that changes should be made to their educational curriculum.

In addition to the benefits of using each imaging test, physicians should have sufficient knowledge about the effects of ionizing radiation, because they are the ones who prescribe the tests and should be aware of the harms and benefits of these methods for patients. Proper and correct request for imaging tests and the use of appropriate protective measures can produce high-quality diagnostic images while reducing radiation exposure. Parniani et al. reported that the knowledge, attitude, and performance of radiographers in Bandar

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Abbas, southern Iran, were not satisfactory (18). Furthermore, in a descriptive study by Tohidinia et al., it was stated that only 39.2% of radiographers complied with acceptable radiation protection principles. The highest and lowest rates of compliance with radiation protection principles by radiographers were related to compliance with self-protection principles (60.8%) and compliance with patient-protection principles (6.3%), respectively (19).

The nature of the radiation used in different imaging modalities, the radiosensitivity of different tissues in the patient's body, and age-related radiosensitivity are important subjects that enable the physician to choose the best imaging modality with the least level of damage. Different tissues in the body show different levels of radiosensitivity. Tissues with a higher mitotic index will be more sensitive. In addition, children show more radiosensitivity than adults. The present study showed that the number of teaching hours allocated to these topics is also insufficient.

After the workshop, students' knowledge of imaging concepts (conventional radiology, CT scan, and nuclear medicine imaging) increased, but this increase was not statistically significant, which could be due to the limited time of the workshop and the variety of topics discussed. In the current medical physics course, there is no opportunity to address all common imaging methods, patient dose, and possible complications. Therefore, considering the duration of the workshop and based on priorities, we focused on the nature of radiation and patient dose, radiosensitivity, methods of protection against ionizing radiation, and radiation effects. As a result, students in the test group had a significantly higher mean score in the mentioned concepts than the control group after participating in the workshop.

Moreover, in a study by Georges et al., based on the recommendations of the International Commission on Radiological Protection and the French Society of Cardiology, a radiation protection training program was implemented for cardiologists. The effectiveness of this training program was evaluated and the results demonstrated that this training program was able to reduce the dose received by patients undergoing cardiac surgery and angiography by 50% by teaching simple and low-cost methods of dose reduction without losing diagnostic information (20). All these studies emphasize the valuable role of radiation protection training in reducing the risks caused by radiation, the most important result of which is the reduction of patient radiation exposure and the reduction of the negative effects of radiation.

According to the results of this study, adequate training for medical students on the concepts of radiation protection and imaging modalities seems necessary, and a revision of the medical curriculum can certainly be helpful in this regard. It is also recommended that the necessary training in this regard be provided to general practitioners and specialists, considering the field of expertise of each physician and the extent of their interaction with different radiation departments in accordance with the specialized profession.

Conflict of interest: The authors reported no conflicts of interest.

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