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Comparison of University Students' Awareness of Radiation Protection before and after Hospital Internship

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ABSTRACT

Background: This study aims to compare the pre- and post-application results of university students' knowledge regarding radiation protection.

Materials and Methods: The study was conducted on 116 students enrolled in the medical imaging and radiotherapy program. These students were administered a two-stage, 33-item radiation protection knowledge scale via Google Forms before and after the application course. The application results were analyzed as pre-test and post-test.

Results and Discussion: A total of 116 students participated in the study. According to the study results, there was a difference in the students' awareness of the radiation protection subfactor before and after the application. The primary reason for this is that observing the use of protective equipment during the application has increased their awareness. The importance of protective equipment for both worker health and patient safety has been understood.

Conclusion: This study demonstrated the necessity of recording and monitoring radiation exposure during diagnosis and treatment procedures. The need to implement safety protocols to minimize the potential consequences of radiation hazards has also been recognized.

Keywords: Ionizing Radiation, Radiation Safety, Radiation Protection

Original Article

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Introduction

Radiation refers to the emission and transfer of energy from atoms and can originate from both natural and artificial sources [1]. The primary source of natural radiation exposure is radon gas, which is released during the decay of radium (Ra-226) present in the Earth's crust [2]. In contrast, over 95% of artificial radiation exposure is attributed to medical applications [3]. Therefore, radiation-related practices in healthcare settings must be rigorously monitored to ensure safety.

Radiation is classified into ionizing and non-ionizing types based on its energy levels. Ionizing radiation, which has the capability to ionize atoms in the substances it interacts with, constitutes the predominant type of artificial radiation [4]. X-rays, widely employed in diagnostic imaging, fall under this category and can induce biological effects in living organisms through direct or indirect interactions [5]. Medical imaging technologists utilize advanced imaging technologies, including computed tomography (CT), mammography, conventional radiography, and dental radiology, to perform diagnostic procedures. Given the increasing scope and frequency of these applications, healthcare professionals face heightened radiation exposure [6]. Therefore, knowledge and expertise in radiation protection are fundamental in medical imaging to safeguard both patients and healthcare workers [7].

To standardize radiation protection training, the European Union has established guidelines that outline curricula and course content for university education in this field [8]. Technicians involved in diagnostic and therapeutic radiation applications must possess comprehensive knowledge of both the benefits and risks of radiation, as well as the principles of radiation protection [9]. Professional radiation safety measures encompass protocols designed to protect healthcare personnel involved in imaging and treatment procedures [10]. Without adequate protective measures, healthcare professionals—especially those working with radiation-intensive modalities such as CT, interventional radiology, nuclear medicine, and radiotherapy—are at risk of adverse health effects, including skin burns, hair loss, acute radiation syndrome, and, with prolonged exposure, an increased likelihood of cancer [11, 12].

Radiation is a natural component of everyday life and occurs inherently, making constant protection unnecessary, particularly at low exposure levels. However, the adverse effects of radiation are documented, and acquiring sufficient knowledge is essential for effectively mitigating the risks associated with high levels of exposure [13]. As a result, monitoring the level of radiation protection knowledge among future healthcare professionals is crucial [14]. This study aims to evaluate the awareness of radiation protection education among medical technology students before and after their hospital internships. Students specializing in medical imaging technology and radiation therapy undertake clinical training in radiology, nuclear medicine, and radiation oncology departments, where they apply theoretical knowledge in practical settings. Given that these students will actively work with radiation, it is essential that they are well-versed in radiation safety protocols to protect both themselves and their patients. Enhancing their understanding of radiation protection not only ensures their safety but also promotes a culture of responsibility in radiation-based healthcare practices.

Materials and Methods

1. Overview of Research Methods

This study encompasses all students (n = 116) enrolled in the Medical Imaging and Radiation Therapy Techniques programs at İstinye University who underwent practical training. Prior to their internships, all students received education on radiation safety and protection. Data collection was conducted through an online Google Form, administered to all participants before the commencement of their internships. Upon completion of the internship, the same survey was administered again in person through a face-to-face questionnaire, with participation remaining voluntary. The data collection form consisted of 33 questions categorized as follows: questions 1–12 focused on radiation physics, biology, and principles of radiation usage; questions 13–25 addressed radiation protection; and questions 26–33 assessed knowledge on safe ionizing radiation usage. Responses were scored on a 10-point Likert scale ranging from 1 ('no knowledge') to 10 ('full knowledge'). The data collection form utilized in this study underwent validity and reliability analyses based on previous research, specifically the "Adaptation of the Healthcare workers radiation protection knowledge scale to Turkish" by Mahmut Ay on December 28, 2021 [6].

2. Study Design

Data were analyzed using SPSS version 22.0 software (IBM Co.), employing statistical techniques including frequency analysis, reliability analysis (Cronbach's alpha), *t*-tests, and analysis of variance (ANOVA), with a significance level set at $p < 0.005$.

3. Participants

The number of participants, their gender, and the distribution across departments are presented as percentages in Table 1.

A total of 116 individuals participated in the study, with 79.3% of the participants being female students and 20.7% male students, as indicated in Table 1. It is noted that 65.5% of the students studied in the medical imaging program, while 34.5% were enrolled in the radiation therapy program.

Table 1. Descriptive Information about the Students

Variable	No. (%)
Gender	
Female	92 (79.3)
Male	24 (20.7)
Department	
Medical imaging	76 (65.5)
Radiation therapy	40 (34.5)

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4. Data Analysis

In Table 2, the Cronbach's alpha values for the subscales of the scale were determined separately for pre- and post-tests. In the pre-test results, it was found that factor 1 had a reliability value of 0.962, factor 2 had 0.947, and factor 3 had 0.943. In the post-test results, factor 1 had a reliability value of 0.868, factor 2 had 0.859, and factor 3 had 0.904. The reliability value for the factor 2 sub-dimension was found to be 0.947 in the pre-test and 0.859 in the post-test. The Cronbach's alpha coefficient for the overall scale was determined to be 0.981 for the pre-test and 0.929 for the post-test, indicating internal consistency.

As shown in Table 3, the study focuses on the pre- and post-application outcomes of radiation protection knowledge among students preparing to work in radiation fields. According to the research findings, the majority of the participants (79.3%) were female, and over half of them (65.5%) were enrolled in the medical imaging program. It was found that the pre- and post-test results for the three factors of the radiation protection knowledge scale were highly reliable (Cronbach's alpha > 0.80).

No significant differences were found in the pre-test and post-test analyses based on gender and departments. However, significant differences were observed in the comparison of the pre-test and post-test for the subfactors of radiation protection and safe ionizing radiation usage guidelines, as shown in Table 4.

Results and Discussion

According to the study's findings, students demonstrated a statistically significant improvement in their awareness regarding the radiation protection sub-dimension following the completion of their internship. This change is attributed to the correct behaviors they observed among healthcare professionals during their training. Observing the use of personal protective equipment by healthcare workers heightened their awareness of the necessity of utilizing such equipment themselves. Additionally, the importance of protective measures was better understood in terms of both occupational health and patient safety. Other key findings include

Table 2. Reliability Statistics of the Radiation Protection Knowledge Scale

Factors	Cronbach's alpha	
	Pre-test	Post-test
Factor 1. Radiation physics, biology, and usage principles	0.962	0.868
Factor 2. Radiation protection	0.947	0.859
Factor 3. Safe ionizing radiation usage guidelines	0.943	0.904
Total	0.981	0.929

Table 4. Pre- and Post-test Results of the Radiation Protection Knowledge Scale

	No.	Mean	Test statistics	p-value
Factor 1				
Pre-test	116	6.93	–0.814	0.417
Post-test	116	7.14		
Factor 2				
Pre-test	116	7.46	–3.625	0.000[a]
Post-test	116	8.26		
Factor 3				
Pre-test	116	7.51	–2.646	0.009[a]
Post-test	116	8.19		

[a] $p < 0.005$, indicates statistical significance.

Table 3. Analysis of Descriptive Information with *t*-Test for Subfactors of the Scale

		Pre-test				Post-test			
		No.	Mean	Test statistics	p-value	No.	Mean	Test statistics	p-value
Factor 1	Female	92	6.93	0.026	0.980	92	7.19	0.816	0.416
	Male	24	6.92			24	6.90		
Factor 2	Female	92	7.41	–0.512	0.610	92	8.30	0.754	0.452
	Male	24	7.64			24	8.07		
Factor 3	Female	92	7.39	–1.138	0.257	92	8.25	0.827	0.410
	Male	24	7.94			24	7.92		
Factor 1	Medical imaging	76	6,47	–1.624	0.107	76	7.35	1.071	0.286
	Radiation therapy	40	7,17			40	7.02		
Factor 2	Medical imaging	76	7.09	–1.451	0.150	76	8.20	–0.322	0.748
	Radiation therapy	40	7.65			40	8.28		
Factor 3	Medical imaging	76	7.16	–1.290	0.200	76	8.19	0.028	0.978
	Radiation therapy	40	7.69			40	8.18		

students' recognition of the necessity of recording and monitoring radiation exposure during diagnostic and therapeutic procedures. A significant increase in awareness was observed regarding the potential risks of radiation exposure to the fetus during pregnancy and the implementation of safety protocols to mitigate radiation hazards. The role of radiation warning signs within safety protocols, as outlined in safe radiation use guidelines, was comprehended. Furthermore, students gained insight into the unique working conditions in radiation-exposed areas compared to other environments, along with the specific responsibilities of personnel working in these settings. Students also understood the purpose of dosimeters for monitoring radiation exposure among workers in radiation areas and the necessity of regular dose assessments. The content of the radiation protection training emphasized the biological effects of radiation on healthcare professionals and reinforced the principle of dose limitation as a fundamental aspect of radiation safety.

As a result of this study, it was determined that radiation exposure should be recorded and monitored during diagnostic and treatment procedures. Additionally, the necessity of implementing safety protocols to minimize the potential consequences of radiation hazards was acknowledged. A review of studies on similar topics in the literature revealed that while 9.6% of students reported having knowledge about radiation, approximately 84.3% lacked sufficient understanding of radiation safety and required further education [15]. These findings emphasize the importance of providing students with more comprehensive education on radiation safety, as well as practical training through internships, to enhance their awareness and preparedness in this field.

A study conducted on radiology technicians working in a hospital revealed that they were largely unaware of radiation protection measures and the permissible annual dose limits [16]. This finding underscores the need to reinforce theoretical training with practical application. Similarly, in the context of protective clothing use for radiation safety, another study supports this conclusion, reporting that the utilization rate of lead aprons was 51%, while the use of protective glasses was only 14%. In a separate study, the prevalence of protective glasses usage was found to be as low as 4.5% [17]. Additionally, only 31% of radiology technicians reported regularly wearing protective aprons [18], and another study further supported this finding by indicating that just 22.5% of radiology technicians consistently used lead aprons [19]. Furthermore, the compliance of interventional radiology practitioners (radiology technicians) with recommended behavioral attitudes toward radiation protection, including the use of lead aprons and protective glasses, was scored at 65 out of 100. These findings from the literature highlight the necessity of maintaining a consistently high level of awareness regarding radiation safety to ensure both occupational protection and patient safety.

There are significant studies in the literature highlighting the consequences of neglecting radiation protection measures. Long-term exposure to radiation has been reported to result in health issues such as cataracts and certain types of cancer [20]. Research has also shown that healthcare workers are unnecessarily exposed to radiation due to insufficient protective equipment and the inadequate implementation of safety measure [21]. Studies assessing the awareness and practices of healthcare professionals exposed to ionizing radiation have indicated that many do not fully adhere to radiation protection protocols and often work without implementing appropriate protective measures [22]. Given these findings, raising awareness of radiation protection among students during their education is critically important.

Conclusion

If a healthcare worker is exposed to unnecessary, erroneous, or excessive radiation, this situation is considered a preventable medical error. The failure of healthcare workers to use radiation protection measures (such as lead aprons and dosimeters) and the lack of proper supervision further contribute to this preventable medical error. Therefore, ensuring effective radiation protection depends on increasing awareness among individuals working in radiation-exposed environments. This study has demonstrated that students' awareness of radiation protection improves through education and practical training. A healthcare professional who is conscious of radiation protection will not only safeguard themselves from radiation exposure but also contribute to patient safety by minimizing unnecessary radiation exposure.

To enhance awareness of radiation safety, practical training sessions can be organized to demonstrate the implementation of radiation safety protocols in the hospital environment. These training sessions can be delivered using virtual reality or augmented reality technologies. Additionally, newly recruited personnel should be supervised by experienced staff to ensure that they do not make errors in radiation safety practices. Furthermore, employees can be provided with

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regular individual and general reports on their radiation exposure levels. In this way, medical technicians will become significantly more aware of maintaining their radiation safety.

To enhance students' awareness, informative visual materials on radiation safety can be displayed within the university. A designated radiation safety week can be established, during which various events, seminars, and workshops are organized to increase students' knowledge and awareness. Additionally, online educational platforms can be developed, incorporating interactive e-learning modules and assessments related to radiation safety. Through these initiatives, students will develop a heightened awareness of radiation safety throughout their educational process.

This study, which focuses on awareness of radiation safety, will serve as a guide for future research on this subject. Although conducted with students, the findings can provide valuable insights for future studies examining radiation safety awareness among healthcare professionals or patients. Additionally, future research could explore alternative recommendations from healthcare professionals or patients regarding radiation protection, with efforts directed toward developing and improving these protective measures.

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Conflict of Interest

This article does not contain any studies with human participants or animals performed by any of the authors.

Ethical Statement

This study was conducted in accordance with the principles of the Declaration of Helsinki. It was approved by the Istinye University Social and Human Sciences Ethics Committee (IRB approval no. 3023/3-36). Written informed consent was obtained from all participants.

Data Availability

Data generated or analyzed during this study are included in this published article.

Author Contribution

Conceptualization: all authors. Methodology: all authors. Formal analysis: Kolca D. Project administration: Kolca D. Visualization: all authors. Writing - original draft: all authors. Writing - review & editing: Kolca D. Approval of final manuscript: all authors.

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