ORIGINAL ARTICLE

Assessment of Staff's Knowledge, Attitude, and Practice on Radiation Protection Measures in Mazandaran Province, Iran

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Abstract

Purpose: Ionizing radiation in medical imaging is one of the dominant diagnostic tools, and also correct knowledge of radiation protection affects staff safety behaviors during examinations. This study highlights the radiation protection Knowledge, Attitude, and Practice (KAP) amongst a large number of hospitals and medical centers in Mazandaran province of Iran.

Materials and Methods: In order to assess the level of radiation protection KAP, a validated questionnaire was given to all MAZUMS-affiliated hospitals and clinics. Four hundred fifty-five staff members participated by responding to an original questionnaire. The sample consisted of nurses, radiographers, and medical doctors of various specialties involved daily in surgical procedures where ionizing radiation is required. The survey was conducted from April 2021 to January 2022, and the response rate was 72.3%.

Results: There were statistically significant differences in the level of staff KAP radiation protection with gender ($p < 0.05$), practicing age KAP level and radiation protection ($p < 0.05$), and there is no significant relationship between educational age and staff KAP level of radiation protection ($p > 0.05$).

Conclusion: Our findings revealed that the level of overall radiation protection KAP level of workers regarding radiation protection safety was satisfactory but in some parameters it was insufficient. This could be due to a lack of consistent training and proper protection against ionizing radiation.

Keywords: Knowledge; Attitude; Practice; Radiation Protection.

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1. Introduction

Humans are constantly and naturally exposed to radiation from cosmic rays and decaying radioactive elements in the Earth's crust [1]. In addition to natural sources of radiation, man-made artificial resources, such as industrial and medical sources, have increased the exposure of the community [2]. According to research, 13% of the total quantity of radiation is generated annually by human activities, of which 12% is assigned to medical diagnostic procedures [3]. According to these data, diagnostic procedures are the greatest source of radiation among human-made sources and in recent years, the worldwide application of ionizing radiation for a variety of positive reasons has been steadily expanding. As 30–50% of medical diagnoses are based on X-ray imaging reports, the need for medical radiologic imaging procedures has expanded [4, 5].

Radiation has been a persistent threat in contemporary medicine, and there is no doubt about its harmful effects. Radiation damage may involve deterministic and stochastic effects, like effects on hematopoietic, immune, reproductive, circulatory, respiratory, musculoskeletal, endocrine, nervous, digestive, and urinary systems [6, 7]. Other detrimental consequences of ionizing radiation include cataracts, skin burns, leukemia, and a number of other forms of cancer [8, 9]. At a threshold dosage, deterministic consequences occur, and their intensity rises with increasing radiation exposure. However, the stochastic effects of the radiation have no precise threshold, and there is no safe radiation dose for these consequences, despite the fact that their likelihood increases with increasing exposure [10, 11].

Health-care workers and radiologists specifically were the first and most significant group capable of minimizing the population's absorption dosage during radiological diagnostic procedures. These individuals are directly responsible for radiological exams and play a crucial role in implementing preventive measures [12-14]. It is estimated that roughly 7 million healthcare professionals throughout the world are subjected to radiation doses each year as a direct result of their line of work [15]. Because of this, the application of ionizing radiation is a double-edged blade and has both positive and negative effects. Patients stand to gain an incredible amount by using it. On the other hand, the incorrect or incompetent use of radiation technology might result in potential health risks for the patients as well as the radiation workers [16]. As a consequence of this, greater attention has to be paid to reducing the needless exposure that occupational are subjected to, which necessitates considering Radiation Protection (RP) strategies such as the 'As Low As Reasonably Achievable' (ALARA) principle [17, 18]. According to this concept, three fundamental principles should be adhered to for all medical imaging treatments. These principles include justification, optimization, and dosage limitations [19].

According to the first principle, a radiological technique should only be carried out on a patient if the therapeutic advantages to the patient justify the hazards that are associated with radiation exposure [20]. The second principle states that the radiation dose in radiological procedures should be kept as low as possible, rationally, and taking into consideration economic and social factors [21]. This means that the radiation dose that is administered to the patient should be commensurate with the medical goals that are being pursued. The third premise applies to radiologists, who utilize the Diagnostic Reference Level (DRL) as their standard reference value [22].

Reducing patient and staff exposure to ionizing radiation may be facilitated by assessing the expertise of healthcare employees dealing with radiation and holding Radiation Protection (RP) training [23-26]. In addition to basic training, the World Health Organization (WHO) encourages continual training and regular refresher courses and states that radiology-specific training is essential. According to the International Commission on Radiological Protection (ICRP), interventional techniques are often complicated and operator-dependent [27]. It is crucial that personnel conducting exams have proper training in RP clinical procedures and understanding [28].

Accordingly, the purpose of this study is to assess RP knowledge, attitude, and practice among healthcare personnel at educational hospitals affiliated with the Mazandaran University of Medical Sciences (MAZUMS) regarding self-protection from radiation.

2. Materials and Methods

The Questionnaire-based cross-sectional research was designed to assess the staff's knowledge, attitude, and practices regarding radiation safety in all MAZUMS-affiliated hospitals and clinics in 10 cities in 2021–2022. The questions were divided into four sections: 1) demographic data such as age, gender, occupation, etc., 2) knowledge of personnel, 3) attitude of personnel, and 4) practice of personnel. 10, 26, and 27 questions pertained to knowledge, attitude, and practice, respectively. Six panelists, including four medical physicists, one nuclear medicine specialist, and one epidemiologist advised and assisted with calculating the content validity ratio, the acceptance threshold of which was more than 0.65. The finalized questionnaire was utilized in pilot research, including eight radiology department staff and a four-week retest design to determine its reliability and validity. Pearson's correlation coefficient (r = 0.79, p 0.001) showed that the final version of the questionnaire was very reliable as a whole.

The project's objectives, methods, and protocols were described to the participants, who were healthcare personnel working professionally with radiation as department receptionists, radiology technologists, nurses, and physicians in educational (75.0%), non-educational (5.0%), and private health clinics (20.0%). Staff and technologists who were available and eager to participate completed the questionnaire, so with the recruitment of 455 radiation employees, the response rate was 72.3%. The participants' educational backgrounds varied since working in radiation situations necessitates RP-KAP regardless of the employee's educational level. This research was conducted in 18 educational hospitals and health clinics connected with MAZUMS. Participants were assured of the secrecy and anonymity of the data obtained. The questionnaire that was given out had sections about age, sex, academic degree, job title, educational age (how long it had been since graduation), and general RP topics like wearing lead aprons during exams, film badges, dose limits for occupational exposure, the ALARA principle, and recent RP training courses. Statistical analysis was conducted with the use of the Statistical Package for the Social Sciences (SPSS 20, IBM, Armonk, NY, United States of America).

3. Results

The demographic characteristics of the participants are depicted in Figures 1-5. Table 1 displays the field of work of participants.

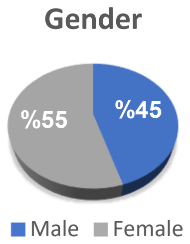

Figure 1. Distribution of gender among participants

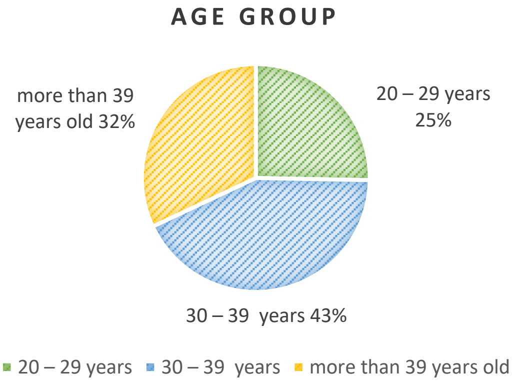

Figure 2. Distribution of age group among participants

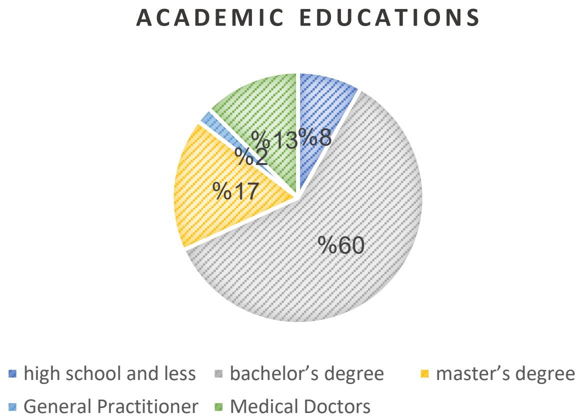

Figure 3. Distribution of academic education among participants

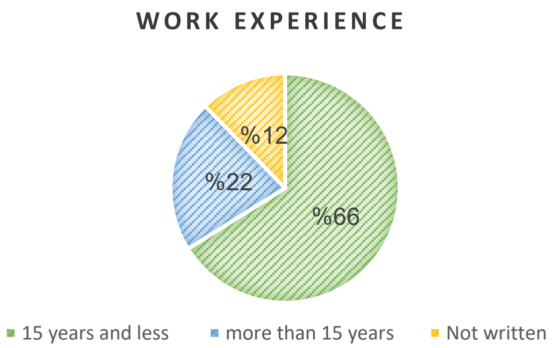

Figure 4. Distribution of work experience among participants

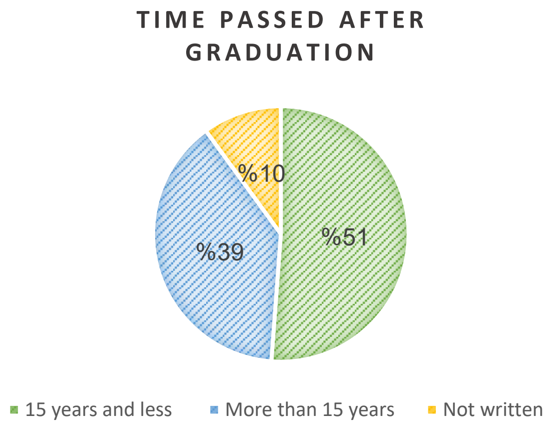

Figure 5. Distribution of time passed after graduation among participants

Table 1. Field of work among participants

Field of work	Number of participants
Nurse	23
Radio department staff	29
Radiology technologists	116
Nuclear medicine technologists	36
CT scan technologists	42
MRI technologists	28
Radiotherapy technologists	15
Medical Physicist	8
Physician	32
Total	**329**

Table 2 presents the staff's level of radiation protection knowledge. This study demonstrated statistically significant gender disparities in the percentage of employees with radiation protection knowledge ($p < 0.05$).

As shown in Table 1, the average knowledge of male and female staff was 65.1 (SD = 10.1) and 52.7 (SD = 8.2), respectively. Regarding the parameter of time since graduation, (it means how many years have passed since graduation), a significant correlation was detected among personnel ($p > 0.05$). According to data analysis, there is a significant correlation between knowledge of radiation protection and years of work experience ($p < 0.05$). The average participant knowledge percentage was 63.3 (SD = 11.05) for those who have less than 15 years of practice age and 69.9 (SD = 12.3) for those more than 15 years of practice age. This difference was statistically significant. So the study shows that staff members with less work experience were less knowledgeable about the hazardous effects of radiation.

According to Table 3, the average level of radiation protection attitudes among male and female staff was 62.05 (SD = 10.09) and 57.50 (SD = 12.1), respectively. Therefore, there was a perception of a significant

Table 2. Radiation protection knowledge among participants

	Characteristic	Mean	SD	P-value
Sex	Male female	65.1 52.7	10.1 8.2	0.018
Time since graduation (yr.)	≤15 >15	59.8 61.0	10.4 11.2	0.25
Work experience (yr.)	≤15 >15	63.3 69.9	11.05 12.3	0.011

Table 3. Radiation protection Attitude among participants

	Characteristic	Mean	SD	P-value
Sex	Male female	62.05 57.5	10.09 12.1	0.024
Time since graduation (yr.)	≤15	58.2	12.0	0.564
Work experience (yr.)	>15 ≤15 >15	60.2 59.6 60.0	14.2 14.5 11.8	0.1

relationship between gender and radiation safety attitudes among personnel ($p < 0.05$). Also, there was a statistically significant difference between clusters in the proportion of radiation protection practice employees with less than 15 years of experience and more than 15 years of experience ($p < 0.05$). In addition, the length of time after graduation had no effect on department staff radiation protection practice, and we found no correlation between the proportion of staff radiation protection practice and the educational age of participants ($p > 0.05$).

According to Table 4, there was a statistically significant difference in the percentage of staff who practice radiation protection based on gender ($p < 0.05$). In addition, we found no correlation between the education level and job experience of participants and their radiation protection views ($p > 0.05$).

In accordance with Table 5, a statistically significant difference was noticed between the proportion of employees with radiation protection knowledge, attitude, and practice based on their gender and experience age ($p < 0.05$). Also, there was no statistically significant difference in the percentage of personnel with radiation safety knowledge, attitudes, and practices based on educational attainment ($p > 0.05$).

4. Discussion

Radiation protection is both subjective and objective, and it is best accomplished when the essential equipment and accessories are available, as well as when the staff have sufficient knowledge and attitude toward employing them in everyday practice [29]. It is worth noting that those who work in radiation departments and are exposed to X-rays should be safeguarded from injury.

This study indicates numerous serious deficiencies in staff's knowledge of critical aspects of radiation safety and might evaluate their practice and attitude, which should be considered when building the radiation protection curriculum to meet future difficulties. Staff in radiation centers should have appropriate knowledge and awareness of radiation threats and its protection in order to adhere to suitable radiation protection measures. In light of this, the objective of radiation protection measures should be to prevent the development of deterministic effects while lowering the likelihood of stochastic outcomes by minimizing exposure to patients and workplace workers. Knowledge and training gained in college are extremely important for a radiologist since knowledge supplied throughout student life affects their attitude [30]. If the technologists do not have an adequate understanding of radiation protection problems, they may be held accountable for an excessively

Table 4. Radiation protection practice among participants

	Characteristic	Mean	SD	P-value
Sex	Male	63.2	13.2	0.04
	female	56.4	14.0	
Time since graduation (yr.)	≤15	61.4	11.5	0.532
	>15	61.5	10.5	
Work experience (yr.)	≤15	57.5	10.5	0.03
	>15	62.7	12.2	

Table 5. Radiation protection Knowledge, Practice and Attitude

	Characteristic	Mean	SD	P-value
Sex	Male	64.1	10.4	0.010
	female	56.7	11.2	
Time since graduation (yr.)	≤15	60.2	12.2	0.315
	>15	61.2	11.0	
Work experience (yr.)	≤15	58.4	14.1	0.014
	>15	63.4	8.4	

accumulative radiation dosage supplied to the patient for a specific imaging exam. Through medical education curriculums, the application of radiation protection courses and training of practical subjects, as well as radiation dosage received by patients and radiation safety might be an operating strategy to reduce the patient's exposure in medical experiences. The collected results show that the majority of the study's participants are aware of radiation protection guidelines and suggestions.

The Mann–Whitney U test was employed based on the study to determine the impact of the "gender" factor on the dimensions; the test was statistically significant for all of these factors. On these parameters, men had a higher mean rank than women. The results of this survey showed that gender affects the level of radiation safety knowledge, attitude, and practice among staff (as shown in Tables 1, 2, 3 and 4). According to the level of staff radiation safety KAP, men employees (Mean = 64.1) had a higher proportion of all these characteristics than females (Mean = 56.7). This could be related to the suitable male staff's capacity to apply practical radiation protective principles. In general, health professionals had accurate conceptions of radiation and the requirement for radiation protection, according to the current study. When gender was involved, the findings revealed that women were typically hostile to radiation protective equipment and that their discomfort was heightened if they had to wear it.

Furthermore, there is not any significant relationship between educational age (time since graduation) and participant radiation protection knowledge, practice, and attitude around the need for periodic examinations and the use of organ shields for patients in this study, but job experience has an effect on the level of staff radiation protection knowledge and practice but does not have an effect on the attitude of staff radiation protection. This result is both remarkable and disturbing. Although they have experience, there is still a lack of awareness regarding the dangers of radiation. It is strongly advised that they regain their grasp of the biological consequences of radiation and update their skills by increasing their knowledge. The level of employee radiation protection attitude, on the other hand, was unaffected by employment experience or educational age. It suggests that employees with less than 15 years of experience have a similar level of radiation protection attitude as employees with more than 15 years of experience. This could be due to a scarcity of radiation safety training and a lack of enthusiasm among senior employees to change their work patterns. In certain circumstances, health professionals' unfavorable behavior is caused by external conditions, such as a negative attitude toward radiation protective equipment. According to the current study, employees dislike wearing radiation protection because it is bulky, dirty, and stinks, and they despise being forced to wear it.

According to Klein *et al.*, lead aprons provide numerous advantages for personal radiation protection. Their weight and size, however, are such that they might cause musculoskeletal harm, particularly to the spine [31]. According to Goldstein *et al.* [32], in interventional cardiologists' studies into the possibility of orthopedic disorders caused by lead aprons, 42% reported problems with the spine and 28% reported problems with other joints (i.e., hip and knee). The issues were substantial in some cases since they were absent from work for days. Furthermore, not all sizes that correspond to all body shapes are frequently available. As a result, when wearing their equipment, overweight employees feel confined, while the equipment is also problematic for thin staff due to its bulk. Although research on style and size is limited, Cremen *et al.*, in their study of surgeons' exposure, concluded that the use of unsuitable radioprotective equipment in terms of its size can have negative effects on its radioprotective effectiveness and can be uncomfortable for staff [33].

Huge lead aprons that are too large for the employee's body type may allow dispersed radiation to reach the chest through huge gaps in the shoulder girdle. Because of their increased weight, they are also more likely to develop musculoskeletal difficulties. Furthermore, radioprotective equipment that is too tiny may not adequately cover all body regions that must not be exposed during X-ray inspection. Personal radiation protection equipment that does not contain lead or that uses sophisticated shielding materials (lead with cadmium, with iodine, or with tin) and is lighter could be a potential solution to the musculoskeletal concerns of workers [34].

In comparison to another study, it was found that education level influenced attitudes, knowledge, and practice of radiation protection [30]. According to

Mojiri *et al.* [35], there is a link between awareness of radiation effects and work experience (years), and individuals with less work experience had less understanding of radiation's detrimental effects. Furthermore, they removed the statistical link between awareness and participant education level. Also, according to LA Swapna *et al.* [36], there is a link between radiation impacts knowledge and work experience. Employees with more than 16 years of experience had a low level of radiation protection knowledge, according to Hundah *et al.* [37]. On the other hand, many aspects were donated to the bad knowledge percentage that would be realized as a result of these consultations; the lack of suitable undergraduate training, insufficient knowledge of basic ethics in postgraduate study, and no systematized uninterrupted radiation protection teaching in hospitals. Furthermore, radiation safety tools such as new radiation dosimeters were difficult to get, which could be one of the main reasons for their non-use. Because there was no systematic annual monitoring of radiation exposure, it is difficult to estimate the routine radiation exposure in medical centers [38]. The negative responses regarding participant awareness of several basic radiation protection values were attributed to a lack of sufficient comprehensive radiation safety training [39, 40]. According to a research by Abdelrahman in Jordan [41], there is little practice among radiologists. According to Nazargi, radiation professionals have a fair amount of knowledge regarding radiation [42]. Additionally, Batista declared that there was a poor level of knowledge and attitude in a Brazilian research study [43]. In two separate studies conducted in Italy, Campanella [44] and Faggioni [45] demonstrated the lack of knowledge among radiation department nurses. Additionally, Hirvonen [46] found that operating room staff members and nurses had limited knowledge.

The training platform for nurses, technologists, and other healthcare department workers would be very beneficial based on the findings of this experiment. However, healthcare workers in more working centers still have acceptable knowledge, attitude, and practice regarding radiation protection. Aside from that, potential plans to extend staff's knowledge, attitude, and practice in the area of radiation safety must be investigated, advanced, implemented, and evaluated. They should be strongly encouraged to learn more about the biological consequences of radiation and to modernize themselves by honing their skills. To reduce unwanted harmful effects of radiation and increase radiation protection KAP, we recommend considering strategies such as ongoing education on radiation protection in hospital practice, embedding radiation protection training for staff in the basic syllabus, and providing information on radiation dangers through online means.

5. Conclusion

The lack of fundamental and specialized understanding of radiation protective safety by health workers has a detrimental effect on the quality of health services supplied. Only ongoing training of employees appears capable of reversing this trend. Seminars devoted to education and training should provide adequate information on all significant aspects of radiation protection, with an emphasis on staff radiation exposure, the associated radiation risk, the significance of radiation safety equipment, and the practical application of theoretical safety knowledge. The training should emphasize how to minimize radiation exposure, thereby preserving their trust and sense of security and significantly enhancing their working environment, while keeping in mind the core radiation protection principles: the principle of justification, the principle of protection optimization, and the principle of dose limit application [47]. All of the following can reverse a health professional's negative attitude, hence enhancing the quality of services offered.

One hundred years after the discovery that ionizing radiation can cause harmful biological effects, researchers have studied and argued over a wide range of issues related to radiation protection, and countless articles have been published on the regulatory aspects of radiation protection. By considering the findings of this study and the importance of continuing professional development for imaging departments such as nuclear medicine centers, it is imperative to hold additional workshops and short-term training courses as well as to educate departments' staff and share posters on radiation protection and safety in order to develop a respectable trend in radiation protection and safety.

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