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Research Article

Awareness of Radiation Protection and Common Radiation Dose Levels Among Healthcare Workers

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ABSTRACT

Introduction: Access to ionizing radiation has become widely available for diagnosis and treatment. The increased use of ionizing radiation has been associated with radiation exposure hazards for patients and radiation workers. Raising the level of radiation protection awareness is important to maintain the safety of healthcare settings. **Methods:** Online questionnaires were distributed to 755 healthcare workers and students at King Abdulaziz Medical City and King Saud bin Abdulaziz University for Health Sciences, Riyadh, Saudi Arabia. The questionnaire consisted of 14 multiple-choice questions divided into two sections (questions related to radiation protection and common radiologic examination doses). **Results:** In total, 443 participants completed the questionnaire, including 142 (32%) medical students, 107 (24%) radiology technologists, 105 (24%) radiography students, and 89 (20%) physicians. Of the participants, 245 (55%) were men. A total of 74 (84%) physicians and 51 (47%) radiology technologists had more than 5 years of experience. Eleven (12%) physicians and 44 (41%) radiology technologists had 1–4 years of experience, whereas the rest had less than 1 year of experience. Only 16% of participants attended training courses on a regular basis. However, 15% of the participants thought that they had excellent knowledge of radiation protection, whereas 18% admitted that they did not have sufficient knowledge. Sixty-two percent of the questions related to radiation protection awareness were answered correctly. Forty-five percent of the participants correctly answered questions related to doses from common radiologic examinations. Only 23% and 16% of participants were aware of the noncontrast chest CT and lumbar x-ray doses, respectively. Moreover, 35% and 24% of participants did not know that pelvic MRI and abdominal ultrasound do not contribute any radiation dose, respectively. **Conclusion:** The results showed a knowledge gap regarding radiation protection and dose levels; therefore, periodic refresher courses are recommended for healthcare workers in order to increase the level of awareness.

Keywords: ionizing radiation, radiation workers, radiation protection, radiation dose

INTRODUCTION

Access to ionizing radiation for diagnosis and treatment purposes has become widely available.[1] Increased use of ionizing radiation has been associated with radiation exposure hazard for patients as well as radiation workers.[1–3] The average radiation dose to the public is 2.5 mSv per year, 15% of which is related to medical exposure.[4,5] Excessive exposure to ionizing radiation can cause biological harm.[6] Imaging procedures involving the use of ionizing radiation should be carried out by expert professionals to minimize risks.[7] Justification, optimization, and As Low As Reasonably Achievable (ALARA) principles are considered the main principles that support radiation dose reduction.[8] Applying these principles is associated with acquiring an accurate and diagnosable image with the lowest possible dose.[8] This cannot be achieved unless there is sufficient knowledge of radiation protection and dose levels.[8] The evidence indicates a low level of awareness among radiation workers, including a study done in this region.[9–14] There are few studies that have examined the local community's knowledge about radiation risks. Raising the level of radiation protection awareness is important to maintain the safety of the healthcare setting.[15] This study investigated the level of radiation protection awareness and knowledge about common radiologic examination doses among physicians, radiog-

Table 1. Distribution of demographic and general data

Parameter	*n* (*N* = 443)	Percentage
Sex		
Male	245	55
Female	198	45
Participants		
Medical student	142	32
Radiology technologist	107	24
Radiography student	105	24
Physician	89	20
Level of experience		
Less than 1 year	263	59
1–4 years	55	13
5–10 years	44	10
More than 10 years	81	18
Perceived knowledge of radiation protection		
Excellent	66	15
Good	170	38
Satisfactory	127	29
Insufficient	80	18
Attended training courses		
Never	180	41
Seldom	115	26
Regularly	73	16
Irregularly	75	17

raphy students, radiology technologists, and medical students in a large tertiary care hospital.

METHODS

This descriptive cross-sectional study was conducted among healthcare workers and students from King Abdulaziz Medical City and King Saud bin Abdulaziz University for Health Sciences, Riyadh, Saudi Arabia. Institutional Review Board approval was obtained from the King Abdullah International Medical Research Center.

With an estimated population size of 579 (medical students, physicians, radiology students, and radiology technologists) and a margin of error of 5% at a 95% confidence level, the optimal required sample size was calculated to be 232 with the help of the Raosoft online sample size calculator. The sample size from each section was calculated as 80 medical students, 32 radiology students, 40 technologists, and 80 physicians.

In total, 755 online questionnaires were distributed among healthcare workers and students from King Abdulaziz Medical City and King Saud bin Abdulaziz University for Health Sciences. Physicians from all specialties, radiology technologists, radiography students, and senior medical students were included in the study. Trainees, residents, and junior medical students were excluded from this study. The participants were invited to participate in an online questionnaire. The questionnaire was optional; each participant consented to participate in the study, and the data were kept anonymous. The questionnaire consisted of 14 multiple-choice questions divided into two sections: radiation protection and common radiologic examination doses[14] (see the Supplemental Material, available online). The first section consisted of seven questions regarding the following: (1) the need to inform patients about risks related to the use of ionizing radiation; (2) sensitivity to ionizing radiation; (3) responsibility for unnecessary exposure to ionizing radiation; (4) which professionals are exposed to higher levels of ionizing radiation; (5) which organ has more susceptibility to radiation damage; (6) long-term risks from high-level exposure of ionizing radiation; and (7) dose optimization. The second section consisted of two questions regarding average dose from one-view chest radiograph, and equivalent doses from common radiologic procedures including noncontrast chest computed tomography (CT), lumbar x-ray, pelvic magnetic resonance imaging (MRI), and abdominal ultrasound (US).

Table 2. Level of experience

	Physicians, *n* (%)	Radiology Technologists, *n* (%)
Less than 1 year	4 (4)	12 (11)
1–4 years	11 (12)	44 (41)
5–10 years	21 (24)	23 (21)
More than 10 years	53 (60)	28 (26)

RESULTS

A total of 443 participants completed the questionnaire for a response rate of 59%. Participants included 142 (32%) medical students, 107 (24%) radiology technologists, 105 (24%) radiography students, and 89 (20%) physicians. Of the participants, 245 (55%) were men. Only 16% of participants attended training courses on a regular basis. Fifteen percent of the participants thought they had excellent knowledge of radiation protection. Only 18% of the participants admitted that they did not have sufficient knowledge (Table 1). A total of 74 (84%) physicians and 51 (47%) radiology technologists had more than 5 years of experience. Eleven (12%) physicians and 44 (41%) radiology technologists had 1–4 years of experience, whereas the rest had less than 1 year of experience (Table 2). Sixty-two percent of the questions related to radiation protection awareness were answered correctly (Fig. 1). Eighty-five percent of the participants knew that it was necessary to inform the patients about risks related to the use of ionizing radiation. Only 38% of participants knew that a 1-year-old girl was the patient most sensitive to ionizing radiation. Sixty-eight percent of the participants knew that referring physicians, radiologists, and radiographers were all responsible for unnecessary exposure to ionizing radiation. Only 46% of participants identified that interventional cardiologists and radiologists were more likely to be exposed to higher levels of ionizing radiation because of their job. Seventy-one percent of participants knew that the breast was the organ most radiosensitive to radiation damage. Sixty percent of the participants

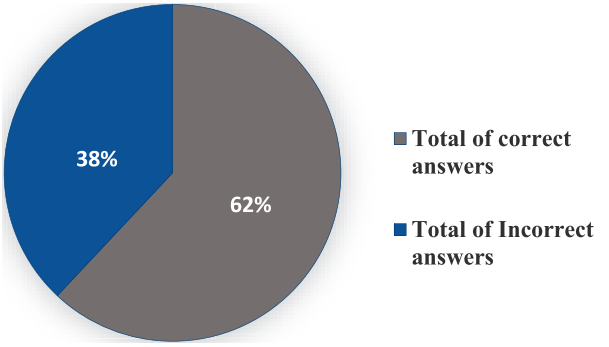

Figure 1. Responses to questions related to radiation protection awareness.

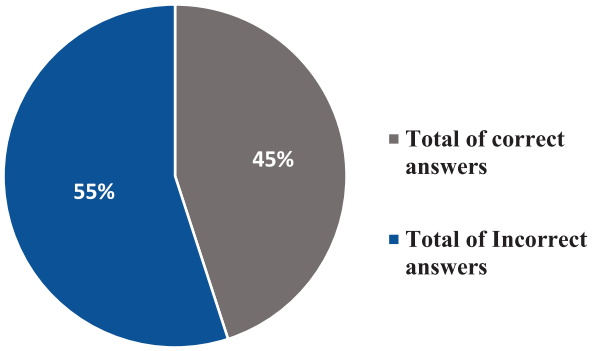

Figure 2. Responses to questions related to common radiologic dose levels.

identified leukemia as a long-term risk that occurs owing to high-level exposure to ionizing radiation. Only 66% of the participants were aware that the ALARA principle is the best for describing the concept of dose optimization in radiology examinations (Table 3). Only 45% of the participants correctly answered questions related to doses from common radiologic examinations (Fig. 2). Dose values were expressed in terms of the equivalent dose of one-view chest radiograph and were based on estimates from available published data.[16–18] Forty-five percent of participants knew that the average dose from one-view chest radiograph was between 0.01 and 0.1 mSv. Only 23% and 16% of the participants were aware of the noncontrast chest CT and lumbar x-ray doses, respectively. Moreover, 35% and 24% of participants did not know that pelvic MRI and abdominal US did not contribute any radiation dose (Table 4).

DISCUSSION

This is the first study to investigate awareness of radiation protection and dose levels among physicians, medical students, radiography students, and radiology technologists in Riyadh. The chosen participants were those who dealt with radiologic modalities or played a major role in referring patients to imaging. In King Abdulaziz Medical City, a 10% annual increase in diagnostic imaging procedures was recorded. Only 16% of participants attended radiation protection courses on a regular basis. This is despite the fact that local regulations mandate that all radiation workers attend radiation protection courses annually. The mandate is governed by King Abdullah City for Atomic and Renewable Energy, the regulatory authority in Saudi Arabia. According to the hospital radiation safety officer, adherence of radiation workers to regulations is suboptimal. Reinforcement of radiation workers' compliance with the regulations needs to be addressed at the national level. When the participants were asked about the necessity of informing the patients about the risks related to the use of ionizing radiation, it was obvious that people working in the field had less chance of choosing the correct answer in comparison with others. This can be explained by the fact that people working in the field are reluctant to provide too much information to patients. This is thought to be because they associate giving patients too much information with procedural rejection. Awareness of the importance of informed consent is an area that requires improvement. More than half of the participants did not know that a 1-year-old girl was the patient most sensitive to ionizing radiation. This can affect the choice of appropriate modality for a specific group of patients. Decision support software can help in choosing the best modality and minimizing the knowledge gap. Half of the radiography students thought that the radiographer was the only one responsible for reporting and preventing unnecessary exposure to ionizing radiation and/or

Table 3. Percentage (*n*) of correct answers regarding radiation protection with respect to category

Question	Medical Students	Physicians	Radiography Students	Radiology Technologists	Total
Necessity of informing the patients about risks related to the use of ionizing radiation	94 (133)	84 (75)	83 (88)	77 (82)	85 (378)
Patients' sensitivity to ionizing radiation	34 (48)	43 (38)	36 (38)	41 (44)	38 (168)
Who is responsible for unnecessary exposure to ionizing radiation	63 (90)	89 (79)	55 (58)	73 (78)	68 (305)
Professionals who are at risk of higher level of ionizing radiation	36 (51)	47 (42)	43 (45)	61 (65)	46 (203)
Organ that has more susceptibility to radiation damage	58 (82)	72 (64)	72 (76)	87 (93)	71 (315)
Long-term risk that occurs owing to high-level exposure of ionizing radiation	70 (100)	74 (66)	40 (42)	52 (56)	60 (264)
Concept of dose optimization	68 (96)	45 (40)	70 (74)	79 (84)	66 (294)

Table 4. Percentage (*n*) of correct answers regarding dose levels with respect to category

Questions	Medical Students	Physicians	Radiography Students	Radiology Technologists	Total
Average dose from one-view chest radiograph	47 (67)	43 (38)	48 (50)	43 (46)	45 (201)
Chest x-ray equivalent of noncontrast chest CT dose	25 (35)	36 (23)	18 (19)	23 (25)	23 (102)
Chest x-ray equivalent of lumbar x-ray dose	11 (15)	18 (16)	23 (24)	13 (14)	16 (69)
Chest x-ray equivalent of pelvic MRI dose	61 (87)	74 (66)	52 (55)	74 (79)	65 (287)
Chest x-ray equivalent of abdominal US dose	78 (111)	82 (73)	64 (67)	80 (86)	76 (337)

CT: computed tomography; MRI: magnetic resonance imaging; US, ultrasound.

improperly performed radiologic examinations. According to the legal authority, all workers from ordering physicians to radiographers are responsible for reporting and preventing unnecessary exposure to ionizing radiation; however, the participants singled out physicians, radiologists, or radiographers. Medical students and physicians should be aware of the sensitivity of organs to radiation so that they can consider the choice of imaging modality. However, 70% of medical students and physicians do not know which organs are more susceptible to radiation damage. Physicians and medical students identified leukemia as a long-term risk that occurs owing to a higher level of exposure to ionizing radiation in comparison to other participants. This is because physicians and medical students have a stronger biological background. More than half of the physicians could not correctly identify the concept of dose optimization, and this finding was consistent with data reported in the literature.[9] A similar observation by emergency physicians was reported in another study.[10] Half of the participants did not know that 0.01–0.1 mSv is the average dose from one-view chest radiograph. This was expected because knowledge of the dose levels is insufficient, even among radiation workers. The introduction of electronic dose-reporting systems could help improve the awareness of dose levels. Most of the participants could not identify how many chest x-rays were equivalent to noncontrast chest CT and lumbar x-rays, which was was consistent with another published study.[14] Although MRI and US are nonionizing modalities, some participants believed that they contribute to the radiation dose. The results obtained in this study are very important. However, they are based on a single center, and multicenter data need to be collected to increase their reliability.

CONCLUSION

The results showed a knowledge gap regarding radiation protection and dose levels, so in order to increase the level of awareness, the frequency of refresher courses needs to be increased. However, measures must be taken to ensure the participation of all radiation workers in the refresher courses. Conducting radiation safety conferences and seminars on a regular basis and inviting all radiation workers in the community to attend are of paramount importance. Awareness of radiation protection and dose levels may vary by the year of experience, area of specialty, and area in which the study is conducted. Therefore, it is recommended in future research to include multicenter studies, correlate the results with the year of experience and area of specialty, introduce an intervention, and then compare the results before and after intervention.

Supplemental Material

Supplemental material is available online with the article.

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