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Original Article

Assessing the awareness of the Madinah Munawarah medical staff and students about the risk of radiation: are we safe?

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Abstract: The exposure of patients to radiation has been discussed for a long time in medical studies. The exposures are due to multiple factors and can result in the development of cancer. This study aims to assess and determine the level of knowledge and awareness of the risk of radiation among the medical staff and students in Madinah, Saudi Arabia. Medical staff and students (n = 405) from different colleges affiliated with Taibah University, completed a questionnaire. The participants responded to the radiation risks related to the different radiation doses and imaging modalities. The medical staff was aware of the risks of ionizing radiation. The average natural background radiation in mSv according to both the medical staff and students was 20-30 mSv. An insignificant difference exists between the information and the awareness levels of both the male and female participants (P = 0.061). An insignificant difference exists between the risks of radiation and the population at risk (P = 0.188). The participants were of the view that the parents of pediatric patients should be given appropriate education about radiation risks (P = 0.035). The medical students at Taibah University had insufficient and poor knowledge about the risks associated with radiation doses, risks which need urgent attention for pediatric and pregnant patients. The findings can be included as a preamble for designing awareness campaigns and a curriculum for the medical staff.

Keywords: Awareness, doses, education, knowledge, medical staff, students, radiation, risks

Introduction

The rapid surge in patients' exposure to the risks of radiation is one of the hot debates in the medical imaging and radiology field. The increase is due to several reasons [1]: the long-term risk of radiation increases one's lifetime risk of cancer, and [2] the risk of radiation that induced an injury caused by the complications found in the interventional fluoroscopy procedures. It is reported that a 7.5% increase in mortality from cancer is expected among 16% of the patients who have received a collective dose greater than 75 mSV [1]. The alarming issue for medical students in society is to protect themselves from the genetic waste and the risks of medical radiation, which has been proposed by national and international institutions [2]. In diagnostic radiography, the objective is to draw inferences with the assistance of imaging, which is notable for protecting the medical students beyond the radiation risk. Among medical students, radiation produced by X-rays are harmful for pregnant females [3].

Approximately 95% of the ionizing radiation exposure to the medical students is because of the medical radiation used in diagnostic procedures, and merely 15% of this exposure emerges from artificial and natural sources [4]. This increase in demand is alarming for radiological procedures taking place in health care settings over the past two decades, to assist in medical decision-making [5]. It is estimated that almost 30-50% of medical decisions rely on X-ray imaging outcomes [6]. Physicians' advice and care are sought by patients for diseases for which physical and clinical examinations are needed. Generally, the medical imaging process is not required for all patients, so they are protected

from any irrelevant ionizing radiation [5]. Self-presentation emerges as a psychological assurance for patients and are associated to a dominant culture in particular communities when they consider a radiology service effective. Medical students consider that physicians usually ignore them for a medical diagnostic procedure due to a lack of non-referrals [7]. Medical imaging procedures are effective for some patients despite the fact that these procedures are not considered a treatment [8]. This viewpoint is uncertain as medical students are not aware of the referral system, the risks of ionizing radiation, or the financial stress based on their excessive use [9].

Studies have indicated that medical students are unaware of their exposure to ionizing radiation from medical procedures due to a widespread belief that medical staff have received extensive training in radiation principles and are likely to reduce the risk [10-13]. On the contrary, the medical staff may not be as concerned as the medical students believe. The beliefs of the medical staff towards medical sources is not firm in terms of ionizing radiation doses as they are even dubious of the medical tests utilized as ionizing radiation sources [14]. Therefore, it is essential to educate medical students with fundamental information about ionizing radiation risks and exposure [15]. The medical staff becomes an important information source for the medical students who offer accurate information to their patients [16].

The objective of this study is to assess and evaluate the levels of knowledge and awareness about radiation hazards among the medical staff and students in Madinah. Previously, Salih and colleagues [1] conducted similar research in Madinah Al-Munawarah in 2014. They surveyed medical students, interns, and residents to assess their awareness and knowledge of the risks related to ionizing radiation. However, the study revealed that knowledge about radiation hazards and protection was inadequate among the interns, students, and residents. Based on this inadequacy, it is hypothesized that Madinah's medical students lack the requisite awareness of and the inherent risks related to the use of ionizing radiation compared to the medical staff who prescribe radiological procedures for diagnostic objectives.

Material and methods

Study design and setting

A cross-sectional study design was applied to evaluate the awareness of the medical staff and students at Taibah University, Madinah Al-Munawarah. The study participants were adults >18 years, final year students, and medical staff of Taibah University, Madinah Al-Munawarrah.

Sampling

A single population proportion formula was used to calculate the sample size based on the number of the Madinah population (1,000,000), and estimated the proportion of medical staff and students who have an awareness of radiation at 40%, (14;15) with a 95% confidence level, and a 5% margin of error. A total of 258 adults >18 years were recruited based on the aforementioned criteria and a 10% non-response rate. Participants were excluded if they were less than 18 years, not a final year student, or and a resident of other cities/hospitals of Saudi Arabia.

Instrument

A self-reported questionnaire was used as a measurement tool, prepared from 3 previous studies (3, 8, 20). The instrument comprised two sections: Section 1 covered socio-demographic information including age, gender, occupation, college, university, and class. Section 2 covered 14 items related to the awareness of the risks of ionizing radiation.

Validity and reliability

The validity of the questionnaire was ensured by a committee of 8 physicians in the radiology department who assessed the content, appropriateness, and the readability of the items. The instrument was created in both the English and Arabic languages in response to the committee's request for the participants' easy comprehension. The instrument was pre-tested on a sample of 25 participants to ensure its reliability. The reliability of the questionnaire was evaluated and the coefficient Alpha was 0.89.

Data collection and analysis

The management of Taibah University were contacted, and we got the approval to conduct

Table 1. Subject Characteristics

Variables	Medical Staff	Medical Students	Total
Age			
18-30	30 (28.3%)	76 (71.7%)	106
31-40	68 (90.7%)	7 (9.3%)	75
>41	63 (98.4%)	1 (1.6%)	64
Gender			
Male	102 (73.4%)	37 (26.6%)	139
Female	58 (55.2%)	47 (44.8%)	105
Specialization			
Medical doctor	24 (88.9%)	3 (11.1%)	27
Nurses	4 (100%)	0 (0%)	4
Technician	11 (91.7%)	1 (8.3%)	12
Faculty member (Dentistry)	22 (100%)	0 (0%)	22
Faculty member (Nursing)	1 (100%)	0 (0%)	1
Faculty member (Medical sciences)	14 (100%)	0 (0%)	14
Faculty member (Rehabilitation)	1 (100%)	0 (0%)	1
Faculty member (Pharmacy)	1 (100%)	0 (0%)	1

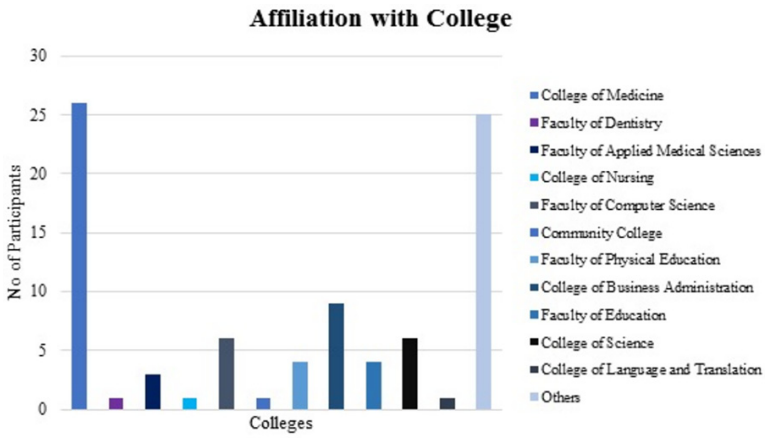

Figure 1. Colleges affiliated with Taibah University.

the study. The questionnaires were distributed using the Media Center and the social media channels of Taibah University to both the medical staff and students. The questionnaires were accompanied by an information sheet explaining the objective of the study. The information related to the participants' consent was presented in detail. The data were collected from May to July 2018. A few questionnaires were sent back earlier by the participants, but the rest of them, who were busy or at semester break, filled out the questionnaire after they returned to university.

Statistical Package for Social Sciences (SPSS) version 21 was used to carry-out the statistical analysis (SPSS Inc.). A descriptive analysis, including the frequencies and percentages, was used to evaluate the respondents' knowledge of ionizing radiation protective measures, ionizing radiation-related risks, socio-demographic variables, outliers, inconsistencies, and radiation imaging history.

Results

Overall, 106 of the participants were ≥18-30 years old while 75 participants were 31-40 years old (**Table 1**). The majority of the participants were male (n = 139) and were medical doctors (n = 27). Among these participants, most were affiliated with Taibah University (28.7%) and the college of medicine (10.1%) (**Figure 1**).

Table 2 presents the awareness of the use of radiation doses. The medical staff (70.1%) was aware of the risks of ionizing radiation, but the awareness of medical students was inadequate (29.9%). A majority of the participants gained an awareness of the permissible radiation doses during their university days. Furthermore, 67.2% of the medical staff was aware of the natural background to undergo ionizing

Table 2. Awareness about the use of Radiation Doses

Variables	Medical Staff	Medical Students	*p*-value
Are you aware of the risks of ionizing radiation? (n = 243)*			
Yes	54 (70.1%)	23 (29.9%)	0.165
No	105 (63.3%)	61 (36.7%)	
Total	159 (65.4%)	84 (33.3%)	
Have you undertaken awareness about the radiation doses permissible? (n = 96)*			
During University	27 (57.4%)	20 (42.6%)	0.014
Training Year	1 (50.0%)	1 (50.0%)	
During Residency	22 (100.0%)	0 (0%)	
Others	20 (80.0%)	5 (20%)	
Total	70 (72.9%)	26 (27.1)	
Are you aware of the natural background to undergo ionizing radiation procedure? (n = 238)*			
Yes	80 (67.2%)	39 (32.8%)	0.622
No, I don't know	76 (63.9%)	43 (36.1%)	
Total	156 (65.6%)	82 (34.4%)	

*Missing numbers.

radiation procedures, but the awareness of the medical students was inadequate (36.1%).

The information and awareness about the right amount of radiation doses are presented in **Table 3**. From the findings, it was reported that the medical staff (75.0%) was aware of the average radiation doses permissible in mSv, which was 20-30 mSv. From the findings, it was clear that the effective dose of radiation was low among the medical students with respect to PA chest X-rays and plain abdominal X-rays. This lack of information shows an insignificant difference between the information and awareness levels of both genders (P = 0.061). Both the medical staff and students were of the view that 100-500 CXR is the effective dose from a CT-scan abdomen as compared to a chest X-ray. The difference is also significant (P = 0.008).

The participants were asked about the effect of the risks of radiation, and they were of the view that children were mostly affected by the risks of radiation (medical staff = 67.8%, medical students = 32.1%). However, there was an insignificant difference between the risks of radiation and the population at risk (P = 0.188). The awareness level of the participants toward the fatal cancer risk was not significant for brain computed tomography (P = 0.823). Most participants were of the view that ultrasound has no radiation risks (Medical Staff = 71.0%, medical students = 29.0%). This level of awareness was significant with respect to the imaging modalities effect (P = 0.029) (**Table 4**).

The participants were asked about the appropriateness of radiation education offered to the patients' parents before going for radiation. The majority of the participants strongly agreed that the parents of the pediatric patients should be given appropriate education about radiation risks (P = 0.035). Similarly, the majority of the participants were of the view that pregnant patients should be given adequate information about the radiation risks in emergency departments. A total of 69.6% of the medical staff and 30.2% of the medical students were of the view that education should be provided for a minimum of three months on the use of diagnostic imaging techniques in the ED (P = 0.024) (**Table 5**).

Discussion

This study evaluated the knowledge and awareness levels about radiation risks among the medical staff and students in Madinah. The results revealed an inadequate knowledge and awareness of radiation doses and their effects among medical students. Likewise, 70.1% of the medical staff was aware of natural background radiation. Likewise, Salih et al. [1] who conducted a similar study in Madinah, reported an inadequate knowledge and awareness of radiation doses and their effects among medical students, interns, and residents. The inadequate knowledge and awareness among the medical students, as found in present study, was due to the lack of professionalism and the inappropriate education and training offered. The findings of Asl et al. [2] differed from the

Table 3. Awareness about the Right Amount of Radiation Doses

	Medical staff	Medical students	*p*-value
Are you aware of the average radiation doses permissible in milliSieverts? (n = 244)*			
20-30 mSv	9 (75.0%)	3 (25.0%)	0.749
2-3 mSv	13 (76.5%)	4 (23.5%)	
0.2-0.3 mSv	5 (71.4%)	2 (28.6%)	
200-300 mSv	3 (60.0%)	2 (40.0%)	
I don't know	130 (64.0%)	73 (35.9%)	
Total	160 (65.6%)	84 (34.4%)	
Are you aware of the radiation doses a patient should be exposed during a PA Chest X-ray? (n = 244)*			
0.02 mSv	5 (71.4%)	2 (28.6%)	0.313
0.2 mSv	20 (87.0%)	3 (13.0%)	
2 mSv	6 (85.7%)	1 (14.3%)	
20 mSv	3 (60.0%)	2 (40.0%)	
I do not know	126 (62.4%)	76 (37.6%)	
Total	160 (65.6%)	84 (34.4%)	
Are you aware of the effective dose permissible for a plain abdominal X-ray (AXR)? (n = 243)*			
0-1 CXR	5 (2.9%)	2 (28.6%)	0.061
1-10 CXR	10 (12.9%)	1 (9.1%)	
10-50 CXR	21 (3.6%)	6 (22.2%)	
100-500 CXR	123 (2.9%)	75 (37.8%)	
I do not know	0 (0%)	0 (0%)	
Total	159 (65.4%)	84 (34.6%)	
Are you aware of the effective dose permissible for a CT-scan abdomen? (n = 243)*			
0-1 CXR	32 (82.1%)	7 (17.9%)	0.008
1-10 CXR	3 (60.0%)	2 (40.0%)	
10-50 CXR	2 (100.0%)	0 (0.0%)	
100-500 CXR	122 (62.2%)	74 (37.8%)	
I don't know	0 (0%)	0 (0%)	
Total	159 (65.7%)	83 (34.3%)	
Are you aware about the effective dose permissible for an ultrasound abdomen? (n = 241)*			
0-1 CXR	28 (23.7%)	7 (20.0%)	0.000
1-10 CXR	3 (0.7%)	2 (40.0%)	
10-50 CXR	3 (0.7%)	2 (40.0%)	
100-500 CXR	1 (74.8%)	0 (0.0%)	
I don't know	122 (62.6%)	73 (37.4%)	
Total	157 (65.1%)	84 (34.9%)	

*Missing numbers.

findings of present study and revealed a high-level of knowledge and an awareness among the medical residents and interns towards radiation protection in pediatrics diagnostic imaging. However, Asl et al. [2] recommended improving the knowledge and awareness of both groups to reduce their exposure to radiation, specifically among the pediatric group as they are more likely to be harmed.

Regarding the awareness of radiation doses, this study found a low-level of knowledge and awareness among medical students. Similar findings were reported by Zakeri et al. [17], specifically, that the knowledge of physicians was not sufficient regarding radiation doses and the risks of the existing diagnostic tests in Iran. Another study supported the present findings, namely that the knowledge regarding radiation doses and risks among residents, technologists, radiology fellows, and staff radiologists was poor [8]. However, a study conducted in Italy found a high-level of awareness among physicians of the non-ionized radiation

Table 4. Awareness of the Impact of Risks of Radiation

	Medical Staff	Medical Students	*P*-value
Who are the most vulnerable to the radiation risks? (n = 240)*			
Children	135 (67.8%)	64 (32.1%)	0.188
Teenager	2 (66.7%)	1 (33.3%)	
Adult	4 (80.0%)	1 (20.0%)	
Older	17 (51.5%)	16 (48.5%)	
Total	158 (65.8%)	82 (34.1%)	
Are you aware of the risk of fatal cancer exposed from brain computed tomography? (n = 241)*			
<1/1000	24 (66.7%)	12 (33.3%)	0.823
1/1,000-1/10,000	9 (64.3%)	5 (35.7%)	
1/10,000-1/100,000	6 (66.7%)	3 (33.3%)	
1/500,000-1/1,000,000	10 (76.9%)	3 (23.1%)	
I do not know	108 (63.9%)	61 (36.1%)	
Total	157 (65.1%)	84 (34.9%)	
Which one of these imaging modalities has no radiation risks? (n = 222)*			
Abdominal X-Ray	27 (57.4%)	20 (42.5%)	0.029
Magnetic Resonance Imaging	9 (60.0%)	6 (40.0%)	
CT-scan	10 (52.6%)	9 (47.41%)	
Nuclear Imaging	6 (66.7%)	3 (33.3%)	
Ultrasound	103 (71.0%)	42 (29.0%)	
Total	155 (66.0%)	67 (34.0)	

*Missing numbers.

detected through MRI and therefore emphasized that physicians should adopt protective training courses to increase their knowledge and awareness [18]. This supports the outcomes of other previous studies and indicates a continued lack of understanding among the non-medical residents [11, 19].

The present study also found a significant difference between the lack of information and the awareness levels among both medical staff and students. A similar finding was reported by Gunalp et al. [20], specifically that the knowledge levels of residents, radiologists, and interns in Turkey was unsatisfactory. Furthermore, Thomas et al. [21] indicated that the radiation awareness of diagnostic imaging is poor among physicians. Another study found that physicians should be trained in diagnostic imaging radiation [22]. The knowledge and awareness levels of emergency department physicians was poor regarding diagnostic imaging as examined by Keijzers and Britton [23].

The findings have revealed that there was a poor understanding and awareness of the effective doses of radiation among both medical staff and students. These participants were also unaware of the effective dose of radiation during a chest X-ray and plain abdominal X-ray. A majority of the participants were not aware of the risk of fatal cancer caused by brain computed tomography. Astonishingly, there is a lack of evidence of radiation knowledge among medical students as the radiation doses and their risks are part of their learning curriculum and the presumption that they would be professionals in different elements of radiation. It is essential for the physicians to provide an adequate knowledge of radiation risks to their students, as they will be requesting a radiology assessment during their training phase. On the contrary, both the medical staff and students should have a deeper and wider understanding of the different elements of medical radiation exposure and must be available to guide their colleagues to select an adequate imaging modality.

Both the students and medical staff were of the view that the parents of pediatric patients and pregnant patients should be given adequate education about radiation risks. Overall, the participants agreed with the assumption that the education on potential radiation risks should be disseminated to the parents and patients. This finding is in-line with the findings of Barnawi et al. [14] who reported that 63.1%

Table 5. Appropriateness of Radiation Education

	Medical Staff	Medical Students	*p*-value
Regarding X-ray in pediatric patients, do you agree that we have to explain the radiation risk adequately for their parents? (n = 242)*			
Strongly yes	103	53	0.035
	66.0%	34.0%	
Yes	36	19	
	65.5%	34.5%	
Possible	12	10	
	54.5%	45.5%	
Not to explain	7	2	
	77.8%	22.2%	
Total	158 (65.3%)	84 (34.7%)	
Regarding X-ray in pregnant patients, do you agree that we explain the radiation risk adequately in the emergency department? (n = 242)*			
Strongly yes	129	60	0.003
	68.3%	31.7%	
Yes	22	9	
	71.0%	29.0%	
Possible	6	9	
	40.0%	60.0%	
Not to explain	3	4	
	42.9%	57.1%	
Total	160 (66.1%)	82 (33.9%)	
What is your thinking about the optimal period of education about radiation doses and risks while using diagnostic imaging techniques in the emergency department? (n = 240)*			
Less than 3 months	103	45	0.024
	69.6%	30.2%	
3 Months	24	20	
	54.5%	45.5%	
6 Months	14	9	
	60.9%	39.1%	
One year	7	5	
	58.3%	41.7%	
No need	8	5	
	61.5%	38.5%	
Total	156 (65.0%)	84 (35.0%)	

*Missing numbers.

of the participants agreed with the dissemination of information on radiation risks. However, based on the findings of both studies, it was assumed that this extent should be higher compared to previous studies [20, 22]. Physicians and doctors should empower patients to make informed choices about their healthcare needs. Furthermore, the parental perception of radiation-ionized risks can be improved by sharing information with the parents, a practice that consequently lowers the parental refusal of examinations requested by their doctors. In an emergency setting, the doctors who do not share the risks with their patients can claim that the requirement for radiological examinations is most apparent, and they only share the risks when there is a questionable or borderline need of an examination.

Several measures should be taken in order to bridge the knowledge gap. First, curricula on the effects and risks of radiation should be mandatorily adopted in medical colleges and universities. Second, graduates should be instructed to take these courses to be synced with the existing risks of radiation. Third, developing an interaction between radiology departments and emergency departments can raise the awareness among the medical staff and the students for creating local protocols to select adequate radiological modalities. Offering radiation doses and risks on the imaging examination form will allow the ordering doctor to focus on the associated risks with patients. Instructing the medical staff and students to sign off on having informed the patients about the effects and risks of an imaging modality and that the patients provided consent before

the ordering. The findings of the present study indicate that there is a need to promote health in the fundamental concepts of ionizing radiation exposure and risk in patients, the general population, and the caregivers. The public awareness and knowledge should be increased through organizational efforts by involving healthcare experts in diagnostic radiological procedures.

The main limitation is that majority of the participants were medical doctors and faculty members of medicine. This study has quantitatively assessed the knowledge about doses from participants while specific case scenarios can be used in future studies to collect information about radiation doses. The awareness and knowledge of the risks related to radiation ionization are insufficient and poor. The study also found knowledge differences based on gender. This issue needs attention given the increasing use of radiological examinations. Several measures have been proposed in order to increase the levels of knowledge and awareness among the medical staff and students. These measures include creating protocols for selecting examinations, including accumulated doses of radiation for patients, adopting radiation protection curricula in colleges and universities, and instruction on regular radiation protection for physicians.

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Disclosure of conflict of interest

None.

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