ORIGINAL ARTICLE

Knowledge about imaging modalities, risks, and protection in radiology among medical students at the University of Hail

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ABSTRACT

Aim: The aim of this study was to evaluate awareness and knowledge about radiation risks and safety principles among medical students at the College of Medicine, University of Hail, Hail, Saudi Arabia, in their clinical years. **Materials and Methods:** In this cross-sectional study, an anonymous electronic questionnaire was sent to 174 randomly selected students in clinical years 4–6. The questionnaire contained 38 questions. The respondents' answers to these questions were used to classify them according to their demographic characteristics and to evaluate their knowledge about common imaging modalities, radiation risks, and safety measures. The data were analyzed using the Statistical Package for the Social Sciences (SPSS) software, version 22. **Results:** Seventy-five (51.7%) of 145 respondents were female and 70 (48.3%) were male. Fifty-five respondents (37.9%) were in year 4, 38 (26.2%) were in year 5, and 52 (35.9%) were in year 6. The mean score for knowledge about common imaging modalities was 4.10 ± 2.030 of 10, that for knowledge about the risks of radiation was 3.17 ± 1.954 (range, 0–8) of 13, and that for knowledge about radiation protection measures was low at 0.79 ± 0.922 (range, 0–4) of 8. Overall, there was an improvement in knowledge about the imaging modalities and the risks of radiation as the number of clinical years increased (*P* = 0.000), but it was still unsatisfactory. **Conclusion:** The results of this study indicate that the medical students at the University of Hail have very limited knowledge about radiation risks and safety measures. These findings highlight the need for urgent action to improve students' knowledge of these topics.

Key words: Awareness, medical students, patient safety, radiation risk, radiation protection

INTRODUCTION

Medical imaging has become an important diagnostic tool in the medical field. However, the radiation dose received from some imaging modalities increases the lifetime risk of cancer.[1] Moreover, as mentioned in the Biological Effects of Ionizing Radiation Report, the exposure to a radiation dose of 100 mSv has an estimated lifetime risk of radiation-induced cancer of one per 100,[2] as well as tissue reactions, including hair loss, skin rashes, and ulceration as a result of accidental exposure to high doses.[3] Furthermore, *in utero* exposure to radiation can lead to generalized growth retardation, mental disability, and seizures, as well as decreased school performance.[4] Fortunately, these risks can be minimized by a principle called optimization and by understanding and implementing radiation protection principles.[5]

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Many studies conducted worldwide, but only three in Saudi Arabia, have concluded that medical students and even radiology residents lack adequate knowledge about the principles of radiation protection.[6-11] However, no studies on this subject have been performed in the Hail region, Saudi Arabia. The aim of this study was to evaluate awareness and knowledge of the radiation risks and safety principles among medical students at the University of Hail in their clinical years.

MATERIALS AND METHODS

This study was performed at the University of Hail in 2018, at which time, 244 medical students in their clinical years of study (years 4–6) were enrolled. Hail is a city in Saudi Arabia that has a population of 699,774.[12] Seventy-nine students (39 female and 40 male) were in year 4, 83 (39 female and 44 male) were in year 5, and 82 (38 female and 44 male) were in year 6. We estimated the study sample size that needed to be enrolled from the total student population of 244 by Raosoft sample size calculator, Raosoft inc, Seattle, USA. It was determined that 150 students would be an appropriate sample size with a confidence interval of 95%. We added 16% ($n = 24$) to this figure to allow for nonresponders.[13] We used random numbers generated online by a research randomizer website.[14] One hundred and seventy-four students were selected at random and approached to participate in this prospective cross-sectional study, which involved completing a one-time, self-administered anonymous online questionnaire between August 2 and August 5, 2018.

Ethical approval to conduct this study was obtained from the ethics committee at the College of Medicine, University of Hail (approval number EC-00025/CM/UOH.11/18). Agreement to complete the anonymized online questionnaire was accepted as willingness to participate in the study.

Data collection

The questionnaire contained 38 multiple-choice and true or false questions and was divided into four sections. The first section contained items on demographic characteristics (i.e., gender, clinical year, nationality, and marital status) and three questions regarding the respondent's opinion of their knowledge of this topic. The second section contained items that tested the respondent's knowledge about the various imaging modalities and the differences between them, with additional questions regarding effective radiation doses. The third section contained items that tested knowledge about radiation risks and the contraindications of some imaging modalities. The fourth section tested knowledge about radiation safety principles. The validity of the questionnaire was confirmed by a radiologist and a medical physicist [Appendix 1].

We calculated the score for each respondent by awarding one mark for each correctly answered question, for a total possible score of 31. The second section was scored of 10, the third section of 13, and the fourth section of 8.

Statistical analysis

The data were shown as frequency and percentage. The categorical data were compared between subgroups using the chi-square test. The mean scores were compared between the students in the three clinical years using analysis of variance (ANOVA). All statistical analyses were performed using the Statistical Package for the Social Sciences (SPSS) software, for Windows (version 22; IBM, Armonk, New York). P values <0.05 were considered statistically significant.

RESULTS

One hundred and forty-five students (75 [51.7%] female and 70 [48.3%] male) returned completed questionnaires. One hundred and forty students (96.6%) were single, four (2.8%) were married, one (0.7%) was divorced, and all were Saudi nationals. The sample distribution according to clinical year and gender is shown in Table 1.

Fifteen respondents (10.3%) had attended a radiation protection course. Two (13.3%) of these 15 students were in year 4, two (13.3%) were in year 5, and 11 (73.3%) were in year 6. A statistically significant difference was observed in the likelihood of attending a radiation protection course as students moved from clinical year 5 to 6 ($P = 0.006$, chi-square test) but not according to gender ($P = 0.337$, chi-square test). The students who attended a radiation protection course had significantly higher scores in the radiation safety principles section ($P = 0.015$, independent samples t test, two-tailed) but not in the other sections [Table 2].

Forty-five respondents (31%) agreed that they had adequate information about the risks of radiation, 18 (12.4%) disagreed, and 82 (56.6%) were unsure. A statistically significant difference was observed in the responses to this question according to the clinical year of study ($P = 0.010$,

Table 1: Sample distribution according to clinical year and gender

Clinical year	Gender	Participants, *n*	Percentage
4	Female	24	16.6
	Male	31	21.4
	Total	55	37.9
5	Female	22	15.2
	Male	16	11.0
	Total	38	26.2
6	Female	29	20.0
	Male	23	15.9
	Total	52	35.9

chi-square test) but not according to gender ($P = 0.396$, chi-square test). Students in year 6 were more confident that they had adequate information about radiation risks than those in the earlier clinical years.

Sixteen respondents (11%) agreed that they were adequately informed about radiation protection measures, 71 (49%) disagreed, and 58 (40%) were unsure. Of 75 female students, 6 (8%) agreed that they were adequately informed, 46 (61.3%) disagreed, and 23 (30.7%) were unsure. Of 70 male students, 10 (14.3%) agreed that they were adequately informed, 25 (35.7%) disagreed, and 35 (50%) were unsure. A statistically significant difference was observed in the responses to this question according to gender ($P = 0.009$, chi-square test) but not according to the clinical year of study ($P = 0.309$, chi-square test).

A statistically significant difference was observed in the overall scores between students in years 4, 5, and 6 ($F_{2,142} = 29.170$, $P = 0.000$, ANOVA). *Post hoc* comparisons using Tukey's honestly significant difference test indicated that the mean score for year 6 was significantly higher than that for years 4 and 5 ($P = 0.000$). However, no significant difference was observed in the scores between years 4 and 5 ($P = 0.629$). The scores are shown in Table 3.

DISCUSSION

This cross-sectional study evaluated the level of awareness and knowledge about common imaging modalities, the risks of radiation, and radiation protection measures among medical students in their clinical years of study. According to its results, only 10.3% of students had attended a radiation protection course. Statistically significant differences were observed in course attendance rates between the three clinical years, with the highest attendance rate of 73.3% reported by students in year 6. The students who attended a radiation protection course had significantly higher scores in the radiation safety principles section ($P = 0.015$, independent samples t test, two-tailed). This result indicates that attendance at a radiation protection course can significantly improve students' knowledge about radiation safety and is consistent with the finding of a study by Hagi and Khafaji.[15]

In general, the level of awareness among these students was poor, with statistically significant differences in mean scores between the clinical years of study. Overall, 31% considered that they had adequate knowledge about the risks of radiation and 11% reported that they had adequate knowledge about radiation protection measures.

We found that awareness of the imaging modalities and the risks of radiation improved as the number of clinical years increased, which is in agreement with a report by O'Sullivan *et al.*,[16] who found that medical students' awareness of radiation exposure improved in their final years of medical school but it was still unsatisfactory. The study by Hagi and Khafaji[15] yielded similar results, and the authors concluded that the subject of radiation safety needed to be addressed at the undergraduate level.

Table 2: Relationship between attendance of a radiation protection course and knowledge about radiation risks and safety principles

Section	Course attendance	Mean	95% Confidence interval		Mean difference	*P* value
			Lower	Upper		
Overall results	Yes	8.80	7.16	10.44	0.831	0.450
	No	7.97	7.25	8.68		
Knowledge about different imaging modalities	Yes	3.87	2.84	4.89	0.264	0.635
	No	4.13	3.77	4.49		
Knowledge about radiation risks	Yes	3.60	2.69	4.51	0.485	0.365
	No	3.12	2.77	3.46		
Knowledge about radiation safety principles	Yes	1.33	0.75	1.91	0.610	0.015
	No	0.72	0.57	0.88		

Table 3: Mean scores according to clinical years

Clinical year		Overall results	Knowledge about imaging modalities	Knowledge about radiation risks	Knowledge about radiation safety principles
4	Mean	6.18	3.44	2.24	0.51
	SD	3.59	1.98	1.66	0.87
5	Mean	6.84	3.63	2.66	0.55
	SD	3.37	1.71	1.77	0.89
6	Mean	10.92	5.15	4.52	1.25
	SD	3.22	1.88	1.60	0.81

SD = standard deviation

In our study, the lowest score was found in the section on knowledge about safety principles in radiology; the mean score of 0.79 ± 0.922 of 8 indicates that the students had a very low level of knowledge regarding how to protect themselves and their patients in the radiology field, which is similar to previous reports, and signals a very serious patient and occupational safety issue.[6-11]

An important limitation of this study was that it targeted knowledge about radiation protection among medical undergraduates in their clinical years of study. Further studies are required to assess the knowledge of interns.

In summary, the findings of this study indicate that medical students at the University of Hail, Hail, Saudi Arabia, have very limited knowledge about radiation risks and safety measures. These results highlight the need for urgent action to improve students' knowledge about these important issues.

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Conflicts of interest

There are no conflicts of interest.

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APPENDIX 1

Awareness and Knowledge of Clinical Phase Medical Students at Hail University about Common Imaging Modalities, Radiation Risk, and Protection Applied in Radiology

We are medical students in the college of medicine at University of Hail, conducting a research study about the awareness and knowledge of Hail University clinical years' medical students about radiation risks and safety measures. Our objective is evaluation of awareness and knowledge of these students to assess the need for basic radiation safety course.

You have been chosen randomly through research randomizer website although this, your participation in this study, is voluntary. Your participation is very important to us and remember your response will be kept confidential, only the research team involved in this study will read your response. Filling out the questionnaire will take only few minutes.

For any inquiry, please contact us via me.shaal2010@hotmail.com

▫ I have read the above information and I consent to take part in the study

1st section

Q1. Gender:
- ▫ Female
- ▫ Male

Q2. Which clinical year you're in?
- ▫ 4th year
- ▫ 5th year
- ▫ 6th year

Q3. Nationality:
- ▫ Saudi
- ▫ Non-Saudi

Q4. Marital status:
- ▫ single
- ▫ married
- ▫ divorced
- ▫ widow

Q5. Have you attended a radiation protection course?
- ▫ Yes, I have
- ▫ No, I have not

Q6. Do think that you have adequate information about radiation risks?
- ▫ yes
- ▫ No
- ▫ Maybe

Q7. Do think that you have adequate information about radiation protection measures?
- ▫ yes
- ▫ No
- ▫ Maybe

2nd section

Q8. A medical imaging technology that combines multiple X-ray projections taken from different angles to produce detailed cross-sectional images of areas inside the body
- ▫ CT
- ▫ MRI
- ▫ Ultrasound
- ▫ X-ray
- ▫ I do not know

Q9. A medical imaging technology that uses radio waves and a magnetic field to create detailed images of organs and tissues
- ▫ CT
- ▫ MRI
- ▫ Ultrasound
- ▫ X-ray
- ▫ I do not know

Q10. A medical imaging technology that uses high-frequency sound waves to create images of the inside of the body
- ▫ Nuclear medicine
- ▫ MRI
- ▫ Ultrasound
- ▫ X-ray
- ▫ I do not know

Q11. The oldest and most commonly used form of medical imaging that uses ionizing radiation to produce images of the internal structure
- ▫ Nuclear medicine
- ▫ MRI
- ▫ Ultrasound
- ▫ X-ray
- ▫ I do not know

Q12. A medical imaging technology that uses a radioactive material (radiopharmaceutical) to produce images of the internal structure
- ▫ CT
- ▫ MRI
- ▫ Ultrasound
- ▫ Nuclear medicine
- ▫ I do not know

Q13. All the following imaging modalities use ionizing radiation except:
- CT
- X-ray
- Ultrasound
- Mammography
- I do not know

Q14. What is the approximate effective radiation dose from a chest x-ray?
- 0.1 mSv
- 0.9 mSv
- 1 mSv
- 3 mSv
- I do not know

Q15. Chest X-ray when compared to natural background radiation is equal to:
- 10 days
- 2 months
- 1 year
- 3 years
- I do not know

Q16. What is the approximate effective radiation dose of abdomen and pelvis computed tomography (CT) scan?
- 10 mSv
- 20 mSv
- 30 mSv
- 50 mSv
- I do not know

Q17. What is the approximate effective radiation dose from a Computed Tomography (CT) exam of the Head?
- 1mSv
- 2 mSv
- 3 mSv
- 4 mSv
- I do not know

3rd section

Q18. Regarding the risk of cancer as long-term effect of radiation exposure, which statement of the following is true:
- cancer will not always occur, but its likelihood is proportional to the radiation dose
- cancer will not always occur, and its likelihood is **not** proportional to the radiation dose
- Cancer risk is one of the deterministic effects of radiation exposure
- Cancer after radiation exposure occurs in children only
- I do not know

Q19. Which of the following tissues is more radiosensitive to ionizing radiation damage?
- Kidney
- Breast
- Liver
- Muscle
- I do not know

Q20. Which of the following diseases may be a result of stochastic effects of exposure to ionizing radiation?
- Dermatitis
- Leukemia
- Cataract
- All of the above
- I do not know

Q21. As a result of eye exposure to radiation the patient might be at risk of which of the following:
- Glaucoma
- cataract
- optic neuritis
- corneal ulcers
- I do not know

Q22. At which of the following periods the fetus is more sensitive to radiation:
- 2nd week until 18th week
- 4th week until the 20th week
- 5th week until 14th week
- 6th week until 16th week
- I do not know

Q23. Deterministic effects of radiation exposure during pregnancy depend only on the radiation dose
- True
- False
- I do not know

Q24. Pregnant women should avoid **all types of medical imaging**
- true
- false
- I do not know

Q25. Is it safe for pregnant women to have a mammography?
- yes
- No
- I do not know

Q26. Hair loss is one of the localized short-term injuries that might happen after radiation exposure. At which dose you will expect it to be a result of the radiation exposure?
- 1 Gy
- 2 Gy
- 3 Gy

- 4 Gy
- I do not know

Q27. Cutaneous necrosis is one of the localized short-term injuries that might happen after radiation exposure. At which dose you will expect it to be a result of the radiation exposure?
- 30 Gy
- 40 Gy
- 50 Gy
- 60 Gy
- I do not know

Q28. The dose threshold for acute radiation syndrome is about:
- 1 Sv
- 3 Sv
- 6 Sv
- 10 Sv
- I do not know

Q29. Any metal device is considered as a contraindication to use in which of the followings medical imaging modalities?
- CT scan
- MRI
- ultrasonography
- X-ray
- I do not know

Q30. The metformin should be withheld at the time of intervenous contrast administration in patients who are known to have kidney disease and discontinued for
- 12 h afterward
- 24 h afterward
- 48 h afterward
- 72 h afterward
- I do not know

4th section

Q31. Which of the following substances are used to coat the walls of a CT scan room for radiation shielding?
- Tungsten
- Glass
- Lead
- Iron
- I do not know

Q32. Dosimeter is:
- a device that measures exposure to ionizing radiation
- a device that measures the distance from the source of ionizing radiation
- a device that provides physical protection from ionizing radiation
- a device that measures the safe area
- I do not know

Q33. Which one of the International Commission on Radiological Protection (ICRP) principles can't be applied in medical radiation exposure?
- justification
- Dose limit
- optimization
- All of the above
- I do not know

Q34. As low as reasonably achievable (ALARA) principle is equivalent to which one of the following ICRP principles?
- justification
- Dose limit
- optimization
- None of the above
- I do not know

Q35. All the following are methods used to reduce the amount of exposure to ionizing radiation except:
- Time
- Distance
- Source
- None of the above
- I do not know

Q36. How far from the X-ray, should you stand without any protection during the radiological-guided procedure (e.g.,C-arm)?
- 1 m
- 2 m
- 5 m
- 8 m
- I do not know

Q37. What is the annual effective dose limit for occupational exposure?
- 10 mSv
- 20 mSv
- 30 mSv
- 40 mSv
- I do not know

Q38. The use of diagnostic reference levels is an important tool in which of the following ICRP radiation protection principles
- justification
- Dose limit
- optimization
- None of the above
- I do not know