MEDICAL SCIENCE

# Physician knowledge of radiation exposure and risk in medical imaging in Al-Qunfudha region

**To Cite:**
Albarakati AJA, Taha M, Alsuhabi H, Almoiedy MS, Alshardy FH, Alnaemi T, Alhayli AZM, Alzubaidi ZAI, Alrizqi AAZ, Alrizqi HAZ, Alqarni RSA. Physician knowledge of radiation exposure and risk in medical imaging in Al-Qunfudha region. *Medical Science* 2023; 27: e160ms2936.
doi: https://doi.org/10.54905/disssi/v27i133/e160ms2936

**Authors' Affiliation:**
[1]Surgery Department, College of Medicine, Al-Qunfudah Branch, Umm Al-Qura University, Makkah, Saudi Arabia
[2]Department of Anatomy, Al-Qunfudah Medical College, Umm Al-Qura University, Al-Qunfudhah, Saudi Arabia
[3]Department of Anatomy and Embryology, Faculty of Medicine, Mansoura University, Egypt
[4]Department of Mathematics, Al-Qunfudah University College, Umm Al-Qura University, Mecca, Saudi Arabia
[5]Department of Radiology, Armed Force Hospital, Southern Region, Saudi Arabia
[6]Department of Radiology, South Al-Qunfudah General Hospital, Al-Qunfudhah, Saudi Arabia
[7]Department of Radiology, Al-Qunfudah General Hospital, Al-Qunfudhah, Saudi Arabia
[8]Al-Qunfudah Medical College, Umm Al Qura University, Al-Qunfudhah, Saudi Arabia

[*]**Corresponding author**
Department of Anatomy, Al-Qunfudah Medical College, Umm Al-Qura University, Al-Qunfudhah, Saudi Arabia and Department of Anatomy and Embryology, Faculty of Medicine, Mansoura University, Mansoura, 35516
Egypt
Email: medhattaha53@yahoo.com

**Peer-Review History**
Received: 04 March 2023
Reviewed & Revised: 07/March/2023 to 17/March/2023
Accepted: 19 March 2023
Published: 20 March 2023

**Peer-review Method**
External peer-review was done through double-blind method.

Medical Science
pISSN 2321–7359; eISSN 2321–7367



**Alaa Jameel A Albarakati**[1], **Medhat Taha**[2,3*], **Hassan Alsuhabi**[4], **Mohammed salah almoiedy**[5], **Fatmah Hussein Alshardy**[6], **Talal Alnaemi**[7], **Abdulaziz Zaid Mohammed Alhayli**[8], **Zahra Aqeel Ibrahim Alzubaidi**[8], **Amal Abdulmalik Zaid Alrizqi**[8], **Hatim abdulmalik zaid alrizqi**[8], **Raghad Saleh Abdullah Alqarni**[8]

## ABSTRACT

*Background:* Radiation is a recognized and essential component of medical practice, X-rays and radiological procedures related to their use are becoming important diagnostic and therapeutic tools in medicine. Participants and *Methods:* A cross sectional observational study was conducted in Al-Qunfudhah Saudi Arabia from November 2022-January 2023 on 189 of the 5th, 6th year medical students, medical interns and residents' males, females at three governmental hospitals: Al- Qunfudhah general hospital, south Al-Qunfudhah general hospital and Al-Mudhaylif general hospital. Data was collected using an electronic form of self-administered questionnaire. *Results:* The prevalence of poor, fair and good knowledge about radiation exposure and risk in medical imaging among the participants was 82%, 17% and 1% respectively. 77% reported that MRI is a non-ionizing radiation, 63% classified mammography as ionizing radiation and 52% reported Uranium as the biggest source of radiation in daily life. About 65% reported that the most health risk caused by radiation exposure was cancer and 71.5% agreed that leukemia result from large radiation exposures. Only 29% reported that the amount of radiation dose induced cataract is 2.5 Gy, 33.5% reported gray is the unit of the equivalent dose and 28.5% reported the annual recommended dose to the whole body is 50 mSv (5rem). 37% of the medical staffs knows the ALARA principle, 35.5% of them aware about the radiation exposure hazards papers and 36% of them knows carcinogenic medical X-rays. *Conclusion:* A low level of knowledge about radiation exposure and risk was found among participants.

**Keywords:** Ionizing radiations, hazards, knowledge, physicians, Al-Qunfudhah

## 1. INTRODUCTION

Radiation defined as an energy emission moving subatomic particles or electromagnetic waves. Natural radiation is produced by a variety of radioactive substances that are present in the human body (Donya et al., 2014). Wilhelm Conrad Rontgen made the X-ray discovery in December 1895. Since radiation is a recognized and essential component of medical practice (Aldossari et al., 2019). The most prevalent artificial sources of radiation exposure for people today are X-ray machines, radiopharmaceuticals used in radiotherapy or diagnostic procedures and other medical devices (Donya et al., 2014). The radiological tests have examined a widerange of illnesses in daily practice (Aldossari et al., 2019).

X-rays and radiological procedures related to their use are becoming more and more important diagnostic and therapeutic tools in medicine. As the value of imaging increases, alternative non-radiation-based imaging techniques (including ultrasound and MRI) have been established and image-guided interventional methods have proliferated to treat patients (Beyer et al., 2021). The use of radiography has increased in various specialties, A combination of clinical, legal and economic factors have contributed to this growth (Chung et al., 2019). The primary goal of diagnostic radiology is to reduce needless exposures due to the significant benefits that medical radiation exposure offers patients (Ravikanth, 2018). According to radiation density exposed, Excessive radiation can cause damage to living tissues and organs and severe side effects such as nausea, vomiting, redness of the skin, hair loss, radiation burns, acute radiation syndrome and even death in very high doses (Donya et al., 2014).

The incidence of cancer increased with the exposure to radiation (Kamiya et al., 2015) and increases the risk of adverse health effects in children because young people have more rapidly dividing cells and growing tissues, cancers have more time to develop. Radiation doses that are too high can raise the long-term risk of developing some types of cancer (Donya et al., 2014). As a result, it is critical that clinicians requesting the imaging techniques are aware of the risks that may be involved for patients, as there is currently insufficient information available in Saudi Arabia about how physicians there view the patient's radioactive contamination (Alhawas et al., 2020). This study aimed to assess physicians' knowledge of radiation exposure and risk in medical imaging in Al-Qunfudha region, Saudi Arabia.

## 2. MATERIALS AND METHODS

**Study design, setting and time**

A cross sectional observational study was done in Al-Qunfudhah city, KSA from November 2022 to January 2023.

**Study participants**

5$^{th}$ and 6$^{th}$ year medical students, medical interns and residents were included.

**Sample size and sampling methodology**

A small enough sample size was 189 according to Rao soft Sample Size Calculator Software. A possible error range 5% and a confidence interval of (95%) were used for sample size calculation. The systemic random sampling technique was used to choose respondents.

**Data collection**

An online-administered questionnaire was distributed to the study participants. In a Google form through emails. The questionnaire included two sections, the 1$^{st}$ included items to collect data about the participants' demographics and work characters and career experience. The 2$^{nd}$ section included questions about exposure to radiation knowledge and its hazards on medical staff.

**Data analysis**

Data were statistically analyzed using the (SPSS) application version 26. To assess the association between the variables, the Chi-squared test ($\chi 2$) was applied to qualitative data that was expressed as numbers and percentages. Statistical significance was defined as a p-value of less than 0.05.

## 3. RESULTS

Table 1 shows that 52% if the participants were females, 88% had an age ranging from 20-30 years, 30.5% were 5$^{th}$ year medical students and 62% were working at the Al-Qunfudhah College of Medicine. For residents, the most common resident's specialty was surgery. And 81% of the respondents had no career experience.

**Table 1** Distribution of participants based on demographic and work data (n=200).

| Variable | | | n | % |
|---|---|---|---|---|
| 1 | Sex | Female | 104 | 52.00% |
| | | Male | 96 | 48.00% |
| 2 | Age | 20 – 30 | 176 | 88.00% |
| | | 31 – 40 | 22 | 11.00% |
| | | 41 – 50 | 1 | 0.50% |
| | | Over 50 | 1 | 0.50% |
| 3 | Profession | 5th year medical student | 61 | 30.50% |
| | | 6th year medical student | 57 | 28.50% |
| | | Medical intern | 44 | 22.00% |
| | | Medical residents | 38 | 19.00% |
| 4 | Workplace | Al-Muzaylif general hospital | 11 | 5.50% |
| | | Al-Qunfudhah College of Medicine | 124 | 62.00% |
| | | Al-Qunfudhah general hospital | 38 | 19.00% |
| | | South Qunfudhah general hospital | 27 | 13.50% |
| 5 | Resident's Speciality | ER | 8 | 4.00% |
| | | Medicine | 8 | 4.00% |
| | | Obstetrics and gynecology | 6 | 3.00% |
| | | ophthalmology | 1 | 0.50% |
| | | Pediatric | 6 | 3.00% |
| | | Surgery | 9 | 4.50% |
| | | Not Resident | 162 | 81.00% |
| 6 | Career Experience | 1 years | 7 | 3.50% |
| | | 2 years | 12 | 6.00% |
| | | 3 years | 8 | 4.00% |
| | | 4 years | 5 | 2.50% |
| | | 5 years | 1 | 0.50% |
| | | Over 5 years | 5 | 2.50% |
| | | No Experience | 162 | 81.00% |

Figure 1 illustrates that the prevalence of poor, fair and good knowledge regarding the dangers of radiation exposure in medical imaging among the participants was 82%, 17% and 1% respectively.

Table 2 demonstrates the participants' response to knowledge items related to risk from radiation exposure in medical imaging. It was found that 77% of the participants classified MRI as non-ionizing radiation, while 63% classified mammography as ionizing radiation. The majority (52%) reported that Uranium is the biggest source of radiation in their daily life and 40% reported that nucleal medicine is the most worrisome sources of radiation exposure. For 65.5% the most health risk caused by radiation exposure was cancer and 45% reported that the lung is the most susceptible tissue to ionization radiation. Most of them (70.5%) agreed that large radiation exposures can have predictable effects such as fibrosis, cataracts, erythema, or hematopoietic destruction. And 71.5% agreed that leukemia is one of the stochastic effects that can result from large radiation exposures. Almost one third of the participants (29%) reported that the amount of radiation dose induced cataract is 2.5 Gy and 33.5% reported that gray is the unit of the equivalent dose. About 28% (28.5%) reported that the annual recommended dose to the whole body of a radiation worker is 50 mSv (5rem). Only 37% were aware about the ALARA principle, 35.5% Know published articles on radiation hazards and 36% knew about FDA listing medical X-rays as a known carcinogen. Most of the participants (46.5%) did not know the total ionizing radiation the general public is exposed to from medical radiation and 44% did not know recommended patient dose limit for medical radiation (mSv).

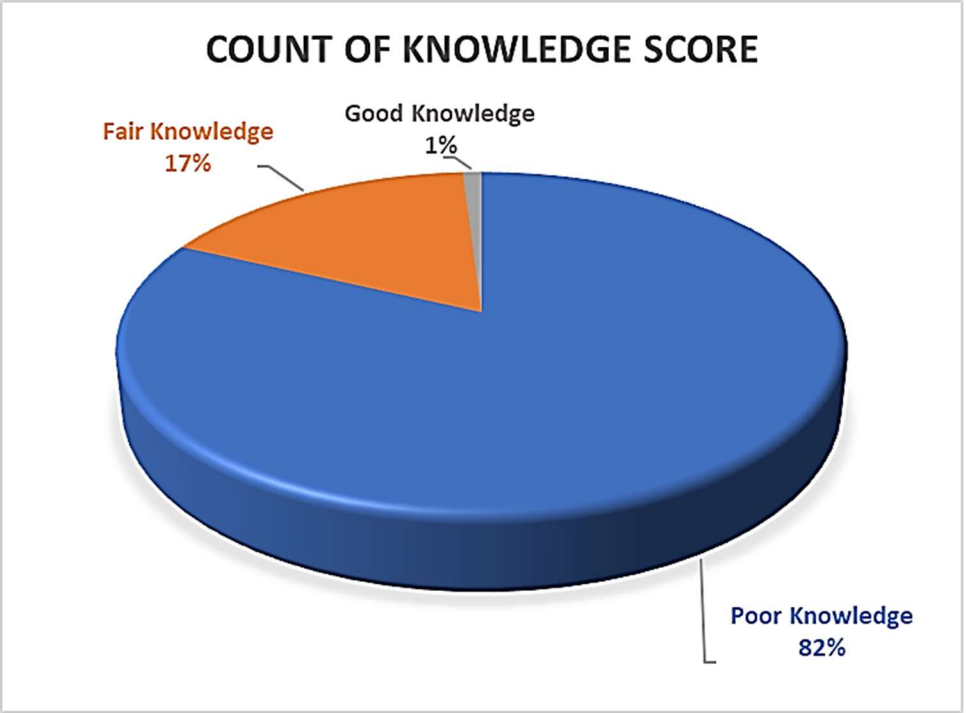


**Figure 1** Participant percentage distribution Level of understanding of exposure to radiation and problems in medical imaging (n=200).

**Table 2** Participant's responses to knowledge items concerning radiation exposure and hazards in medical imaging (n=200).

| Variable | | n | % |
|---|---|---|---|
| Is magnetic resonance Imaging (MRI) classified as non-ionizing radiation? | No | 45 | 22.50% |
| | Yes | 155 | 77.50% |
| Is mammography classified as ionizing radiation? | No | 74 | 37.00% |
| | Yes | 126 | 63.00% |
| What is the biggest source of radiation in our daily life? | Actinium | 13 | 6.50% |
| | Thallium | 21 | 10.50% |
| | Thorium | 36 | 18.00% |
| | Tritium | 26 | 13.00% |
| | Uranium | 104 | 52.00% |
| What are the most concerning sources of radiation exposure? | Consumer Products | 27 | 13.50% |
| | Medical/Dental X-rays | 37 | 18.50% |
| | Nuclear Medicine | 80 | 40.00% |
| | Radon gas, naturally produced | 42 | 21.00% |
| | Rocks & Soil | 14 | 7.00% |
| What is the most health risk caused by radiation exposure? | Acute Radiation Syndrome | 55 | 27.50% |
| | Cancer | 131 | 65.50% |
| | Cardiovascular disease | 3 | 1.50% |
| | Cataract | 1 | 0.50% |
| | Skin burns | 10 | 5.00% |
| What is the most susceptible tissue to ionization radiation? | Bladder | 18 | 9.00% |
| | Gonads | 55 | 27.50% |
| | Kidney | 19 | 9.50% |
| | Lungs | 90 | 45.00% |

| | | | |
|---|---|---|---|
| | Stomach | 18 | 9.00% |
| Is fibrosis, cataracts, erythema, or hematopoietic damage among the deterministic effects that can result from large radiation exposures? | No | 59 | 29.50% |
| | Yes | 141 | 70.50% |
| Is leukemia, one of the stochastic effects that can result from large radiation exposures? | No | 57 | 28.50% |
| | Yes | 143 | 71.50% |
| What is the radiation dose that induced the cataract? | 0.5 Gy | 19 | 9.50% |
| | 2.5 Gy | 58 | 29.00% |
| | 4 Gy | 44 | 22.00% |
| | 5.5 Gy | 43 | 21.50% |
| | 10 Gy | 36 | 18.00% |
| What is the unit of the equivalent dose? | Becquerel | 40 | 20.00% |
| | Coulomb/kg | 29 | 14.50% |
| | Curie | 21 | 10.50% |
| | Gray | 67 | 33.50% |
| | Sievert | 43 | 21.50% |
| What is the recommended annual dose for a whole body of a radiation worker? | 10 mSv (1rem) | 27 | 13.50% |
| | 20 mSv (2rem) | 51 | 25.50% |
| | 50 mSv (5rem) | 57 | 28.50% |
| | 150 mSv (15rem) | 40 | 20.00% |
| | 500 mSv (50rem) | 25 | 12.50% |
| Aware of ALARA principle | No | 126 | 63.00% |
| | Yes | 74 | 37.00% |
| Know any published articles on radiation risks? | No | 129 | 64.50% |
| | Yes | 71 | 35.50% |
| Know about FDA listing medical X-rays as a known carcinogen | No | 128 | 64.00% |
| | Yes | 72 | 36.00% |
| Total ionizing radiation the general public is exposed to from medical radiation | 1-10 | 36 | 18.00% |
| | 15-30 | 32 | 16.00% |
| | 35-45 | 25 | 12.50% |
| | 60-75 | 10 | 5.00% |
| | 80-95 | 4 | 2.00% |
| | I don't know | 93 | 46.50% |
| Recommended patient dose limit for medical radiation (mSv) | 5 | 17 | 8.50% |
| | 20 | 15 | 7.50% |
| | 50 | 26 | 13.00% |
| | 100 | 18 | 9.00% |
| | 0.5 | 18 | 9.00% |
| | I don't know | 88 | 44.00% |
| | No dose | 18 | 9.00% |

Table 3 shows that good knowledge level about radiation exposure and risk in medical imaging was significantly higher among participants with an age ranging from 31-40 years and with an age > 50 years ($p = < 0.05$). At the same time, good knowledge was significantly higher among none residents and among residents with obstetrics and gynecology specialty and among those having > 5 years of experience or those without career experience ($p = < 0.05$). On the other hand, a non-significant relationship was found between knowledge level and participants' sex, profession, or workplace ($p = > 0.05$).

**Table 3** Relationship between knowledge level regarding radiation acquaintance and threats in imaging in medical field knowledge and participants' demographic and work data (n=200)

| Variable | | Knowledge level | | | $\chi^2$ | p-value |
|---|---|---|---|---|---|---|
| | | Poor Knowledge (164) | Fair Knowledge (34) | Good Knowledge (2) | | |
| Sex | Female | 82 (50.00%) | 21 (61.76%) | 1 (50.00%) | 1.56 | 0.457 |
| | Male | 82 (50.00%) | 13 (38.24%) | 1 (50.00% | | |
| Age | 20 – 30 | 150 (91.46%) | 26 (76.47%) | 0 (0.00%) | 110.74 | < 0.001 |
| | 31 – 40 | 13 (7.93%) | 8 (23.53%) | 1 (50.00%) | | |
| | 41 – 50 | 1 (0.61%) | 0 (0.00%) | 0 (0.00%) | | |
| | Over 50 | 0 (0.00%) | 0 (0.00%) | 1 (50.00%) | | |
| Profession | 5th year medical student | 55 (33.54%) | 6 (17.65%) | 0 (0.00%) | 7.61 | 0.268 |
| | 6th year medical student | 47 (28.66%) | 9 (26.47%) | 1 (50.00%) | | |
| | Medical intern | 35 (21.34%) | 9 (26.47%) | 0 (0.00%) | | |
| | Medical residents | 27 (16.46%) | 10 (29.41%) | 1 (50.00%) | | |
| Workplace | Al-Muzaylif general hospital | 8 (4.88%) | 2 (5.88%) | 1 (50.00%) | 12.72589 | 0.476 |
| | Al-Qunfudhah College of Medicine | 107 (65.24%) | 17 (50.00%) | 0 (0.00%) | | |
| | Al-Qunfudhah general hospital | 28 (17.07%) | 9 (26.47%) | 1 (50.00%) | | |
| | South qunfudhah general hospital | 21 (12.80%) | 6 (17.65%) | 0 (0.00%) | | |
| Resident's Specialty | ER | 8 (4.88%) | 0 (0.00%) | 0 (0.00%) | 29.62 | 0.003 |
| | Medicine | 6 (3.66%) | 2 (5.88%) | 0 (0.00%) | | |
| | Obstetrics and gynecology | 2 (1.22%) | 3 (8.82%) | 1 (50.00%) | | |
| | ophthalmology | 0 (0.00%) | 1 (2.94%) | 0 (0.00%) | | |
| | Pediatric | 4 (2.44%) | 2 (5.88%) | 0 (0.00%) | | |
| | surgery | 7 (4.27%) | 2 (5.88%) | 0 (0.00%) | | |
| | Not Resident | 137 (83.54%) | 24 (70.59%) | 1 (50.00%) | | |
| Career Experience | 1 years | 5 (3.05%) | 2 (5.88%) | 0 (0.00%) | 28.29 | 0.005 |
| | 2 years | 9 (5.49%) | 3 (8.82%) | 0 (0.00%) | | |
| | 3 years | 6 (3.66%) | 2 (5.88%) | 0 (0.00%) | | |
| | 4 years | 3 (1.83%) | 2 (5.88%) | 0 (0.00%) | | |
| | 5 years | 0 (0.00%) | 1 (2.94%) | 0 (0.00%) | | |
| | Over 5 years | 4 (2.44%) | 0 (0.00%) | 1 (50.00%) | | |
| | No Experience | 137 (83.54%) | 24 (70.59%) | 1 (50.00%) | | |

## 4. DISCUSSION

The aim of the current study was to assess information of physicians about contact to radiation in Al-Qunfudha region, Saudi Arabia. In the current study, 44% of physicians did not know the recommended patient dose limit for medical radiation (mSv). The same poor knowledge regarding the dose limit was observed in a previous Saudi study, where only 2% of the participants correctly identified the patient's radiation dose limit (Najjar et al., 2022).

Only 63% of physicians in the present study were unaware of ALARA principle. About 70% of physicians reported being unaware of As Low as Reasonably Achievable (ALARA) principle in a previous Saudi study (Najjar et al., 2022). A similar response

was observed in the Palestine study (Hamarsheh and Ahmead, 2012). This is a shocking percentage since ALARA is considered the most basic concept of radiation safety that is even taught to the undergraduate students in medical schools nowadays (Justino, 2006). The very low level of knowledge in this study was also observed in a study done in at King Khalid University, Abha, Saudi Arabia to evaluate the level of medical students' and intern doctors' awareness of ionizing radiation exposure doses during common radiological procedures (Mohammed, 2020). This study found that 77% of the participants classified MRI as non-ionizing radiation. In a prior Saudi investigation, the level of knowledge was very poor and only 4.6% of students and intern doctors correctly identified the actual dose received from chest X-rays. Only 11.5% and 10.3% being aware that magnetic resonance imaging and Ultrasound are non-ionizing imaging modalities (Mohammed, 2020).

More than half of our medical staff knew that MRI was non-ionizing radiation and mammography is ionizing radiation in a previous Saudi study done at Saudi health institutions (Rafique et al., 2020). Almost one third of the participant physicians in the current study (29%) reported that the amount of radiation dose induced cataract is 2.5 Gy and 33.5% reported that gray is the unit of the equivalent dose. About 28% (28.5%) reported that the annual recommended dose to human full body of a radiation worker is 50 mSv (5rem). In a study that included multiple health providers organizations in Saudi Arabia, more than one-half of the participated members of the medical staff didn't know the quantity of CT scan that can be performed per year and didn't know the approximate effective radiation dose received from chest radiography (Rafique et al., 2020). Many studies have reported that the main of workers in heath givers have limited knowledge about the risk of radiation and its protection and radiation doses from commonly requested imaging modalities (Dellie et al., 2014; Zhou et al., 2010; Mubeen et al., 2008; Jo et al., 2014; Khafaji et al., 2022; Sarma et al., 2022). A study done in Saudi Arabia has found gaps in knowledge about radiation hazards in 73% of physicians. In that study, half of the physicians investigated were not able to classify mammography as ionizing radiation and, of them, 69.3% were unaware of the recommended dose limit for radiation workers' entire bodies (Saeed et al., 2018).

The current study discovered that there were more people with poor, fair and good understanding among the participants was 82%, 17% and 1% respectively. A previous study done in King Abdulaziz Medical City (KAMC) and King Abdullah Specialist Children's Hospital (KASCH), Riyadh found that poor knowledge was observed in 70.5% of physicians (Najjar et al., 2022). A previous work done in the Hospital of University of King Khalid, Saudi Arabia, including included 157 doctors. It was revealed that 58.6% of participants lacked understanding of radiation dose for a variety of routine radiological exams. Interestingly, there was no variation in the knowledge among radiologists and other physicians (Aldossari et al., 2018). Therefore, we evaluated the overall knowledge of the medical staff; only 31.7% of all participants showed overall high awareness, whereas more than one-half reported low awareness (Rafique et al., 2020). Another research was conducted on 450 medical doctors in 20 towns in Saudi Arabia reported that 30% only who received radiation safety training. Moreover, these results indicating that there is poorness in the cognizance between the doctors. As a result, leads to the risk of cancer occurrence will increase (Saeed et al., 2018). In Saudi Arabia, there is lack of radiation equipment protection like shields and lead glasses (Salama et al., 2016).

The poor knowledge observed in the current study agrees also with two other regional studies conducted in Palestine and Egypt (Hamarsheh and Ahmead, 2012; Abdellah et al., 2015). In contrast to the poor knowledge level observed in the present study, a study conducted in Italy in 2017 revealed that the majority of participants had very high knowledge levels an excellent level of knowledge (Campanella et al., 2017). Additionally, another study performed in 18 hospitals in Iran and indicating a good awareness between physicians regarding to safety on radiation coverage (Dehghani et al., 2015). However, in our study, it was surprising that two-third of the physicians who participated were unable to identify the gonads as the most susceptible organ to ionizing radiation (Saeed et al., 2018). Radiological courses have been proven effective in increasing awareness about radiation hazards. There is a need to bridge the gap of knowledge about radiation exposure relevant to medical imaging among medical students and interns to provide accurate information and proper protection measures to their patients (Mohammed, 2020; Khamtuikrua and Suksompong, 2020). This study found that 65.5% the most health risk caused by radiation exposure was cancer. According to Berrington et al., (2009), 29,000 cancers in the USA developed as a direct consequence of radiation exposure from CT examination. Another study was done by Aldossari et al., (2018), who reported that 58.6% of their participants healthcare knowing the common radiological testes dose whereas 28.1% correctly recognized them. The same disappointing results were revealed from a study that included healthcare providers. This study in Saudi Arabia revealed a low knowledge among the medical staff (68.3%) (Rafique et al., 2020).

The present study showed no gender difference according to the level of knowledge. While male physicians had significantly better knowledge than female physician in a previous Saudi study (Najjar et al., 2022). A Saudi study conducted on physicians showed that physician's information's was low among surgeons and orthopedists (Saeed et al., 2018). In the present study, good knowledge was significantly higher among no residents and among residents with obstetrics and gynecology specialty.

Radiologists had the best knowledge regarding the hazards of radiation followed by pediatricians, while orthopedists had the least knowledge in previous studies (Hamarsheh and Ahmead, 2012; Almalki et al., 2021). Good knowledge among the participants of the present study was significantly higher among those having > 5 years of experience. A Saudi study conducted on physicians showed that the overall knowledge of physicians was low among surgeons and orthopedists (Saeed et al., 2018). In addition, the study (Saeed et al., 2018) reported that the experience of the physicians didn't affect the knowledge and wasn't related to the knowledge, which was in agreement with our findings. A study compared the awareness and knowledge regarding radiation protection for medical students, and resident doctors showed that no variations amongst the resident doctors and students although medical students reported slightly higher knowledge (Bhadane and Bahadane, 2017).

**Limitations**

A self-reporting questionnaire may have a recall bias. Furthermore, using a cross-sectional study design could reveal associations between variables while ignoring casual relationships.

## 5. CONCLUSION

This study revealed a low knowledge regarding medical imaging among studied physicians as only 1% had a good knowledge level. Of the participants, 77% classified MRI as non-ionizing radiation and 65.5% reported that the most health risk caused by radiation exposure was cancer. Almost one third of the participants (29%) reported that the amount of radiation dose induced cataract is 2.5 Gy and 33.5% reported that gray is the unit of the equivalent dose. Only 28.5% reported that the annual recommended dose to full body workers in radiation field is 50 mSv (5rem). Only 37% were aware about the ALARA principle. About 46% did not know the total ionizing radiation the general public is exposed to from medical radiation and 44% did not know recommended patient dose limit for medical radiation (mSv). Good knowledge level was significantly higher among those aged 31-40 years and with an age > 50 years, among no residents, obstetrics and gynecology specialty and among those having > 5 years of experience. Knowledge about exposure to radiations is low among the physicians studied. This understanding could be increased by incorporating this information into medical curriculums as well as educational and training courses on radiation dose introduced to patients and radiation safety.

**Acknowledgments**

The authors declare no external financial assistance with the project.

**Author's contributions**

All the authors contributed evenly with regards to data collecting, analysis, drafting and proofreading the final draft.

**Ethical Approval**

The study was approved by the Medical Ethics Committee of the Medical Research of Umm Al-Qura University, Makkah. (Ethical approval code: HAPO-02-K-012-2022-11-1293).

**Informed consent**

Not applicable.

**Funding**

This study has not received any external funding.

**Conflict of interest**

The authors declare that there is no conflict of interests.

**Data and materials availability**

All data sets collected during this study are available upon reasonable request from the corresponding author.

## REFERENCES AND NOTES


1. Abdellah RF, Attia SA, Fouad AM, Abdel-Halim AW. Assessment of physicians' knowledge, attitude and practices of radiation safety at Suez Canal University Hospital, Egypt. Open J Radiol 2015; 5:250–258.
2. Aldossari H, Ahmed N, AlShammari A. Evaluation of awareness on radiation protection and knowledge about ionizing radiation among patients awaiting radiological examinations: A cross-sectional survey. Austin J Radiol 2019; 6(3):1100-1104.
3. Aldossari HM, Al Dosary A, AL Rashed A, Alamro S, Alqahtani F, Alanazi A, lmoammar N. Assessing the Level of Knowledge About Radiation Dose in Common Radiological Examinations Among Physicians in Riyadh. Int J Pharm Res Allied Sci 2018; 8(1):114-118.
4. Alhawas AY, Alaska Y, Almohaimede K, Almushayqih MH, Altassan BK, Homiedan M. To What Extent the Emergency Physicians in Riyadh City Are Aware of Patient Radiation Exposure from Diagnostic Imaging Requested in the Emergency Department. Cureus 2020; 12(6):e8623. doi: 10.7759/cureus.8623
5. Almalki AH, Almalki MA, Alballa RS, Alshaygy IS, Alrabai HM. The compliance with radiation protection and knowledge about radiation exposure among the orthopedic operating room personnel in Saudi Arabia. J Musculoskelet Surg Res 2021; 5:178–186.
6. Berrington de González A, Mahesh M, Kim KP, Bhargavan M, Lewis R, Mettler F, Land C. Projected cancer risks from computed tomographic scans performed in the United States in 2007. Arch Intern Med 2009; 169(22):2071-7. doi: 10.1001/archinternmed.2009.440.
7. Beyer T, Bailey DL, Birk UJ, Buvat I, Catana C, Cheng Z, Fang Q, Giove F, Kuntner C, Laistler E, Moscato F, Nekolla SG, Rausch I, Ronen I, Saarakkala S, Thielemans K, Van Elmpt W, Moser E. Medical Physics and Imaging–A Timely Perspective. Front Phys 2021; 9:634693. doi: 10.3389/fphy.2021.634693
8. Bhadane SH, Bahadane SS. Knowledge and awareness of the radiation safety among the medical students and resident doctors. Sch J App Med Sci 2017; 5(2A):353–5.
9. Campanella F, Rossi L, Giroletti E, Micheletti P, Buzzi F, Villani S. Are physicians aware enough of patient radiation protection? Results from a survey among physicians of Pavia District-Italy. BMC Health Serv Res 2017; 17(1):406. doi: 10.1186/s12913-017-2358-1
10. Chung JH, Duszak R Jr, Hemingway J, Hughes DR, Rosenkrantz AB. Increasing Utilization of Chest Imaging in US Emergency Departments From 1994 to 2015. J Am Coll Radiol 2019; 16(5):674-682. doi: 10.1016/j.jacr.2018.11.011
11. Dehghani A, Ranjbarian M, Mohammadi A, Soleiman-Zade M, Dadashpour-Ahangar A. Radiation safety awareness amongst staff and patients in the hospitals. Int J Occup Hyg 2015; 6:114–119.
12. Dellie ST, Daniel A, Yenework E. An assessment of final year medical students and interns' awareness of radiation exposure to common diagnostic imaging procedures. Advances in Radiology 2014; 7. doi: 10.1155/2014/426909
13. Donya M, Radford M, El Guindy A, Firmin D, Yacoub MH. Radiation in medicine: Origins, risks and aspirations. Glob Cardiol Sci Pract 2014; 2014(4):437-48. doi: 10.5339/gcsp.2014.57
14. Hamarsheh A, Ahmead M. Assessment of physicians' knowledge and awareness about the hazards of radiological examinations on the health of their patients. East Mediterr Health J 2012; 18(8):875-81. doi: 10.26719/2012.18.8.875
15. Jo K, Strzelczuk-judka L, Sz E, Stefaniak Ł. Medical students' awareness of radiation exposure related to radiological imaging procedures. J Med Sci 2014; 3(83):244–9.
16. Justino H. The ALARA concept in pediatric cardiac catheterization: Techniques and tactics for managing radiation dose. Pediatr Radiol 2006; 36(Suppl 2):146-53. doi: 10.1007/s00247-006-0194-2
17. Kamiya K, Ozasa K, Akiba S, Niwa O, Kodama K, Takamura N, Zaharieva EK, Kimura Y, Wakeford R. Long-term effects of radiation exposure on health. Lancet 2015; 386(9992):469-78. doi: 10.1016/S0140-6736(15)61167-9
18. Khafaji M, Kouzaba K, Tashkandi A, Almusallam S, Ghoneim A, Hagi S. Radiation protection: Are pediatrics health care providers up to date?. Medical Science 2022; 26:ms69e2043. doi: 10.54905/disssi/v26i120/ms69e2043
19. Khamtuikrua C, Suksompong S. Awareness about radiation hazards and knowledge about radiation protection among healthcare personnel: A quaternary care academic center-based study. SAGE Open Med 2020; 8:2050312120901733. doi: 10.1177/2050312120901733
20. Mohammed AA. Medical students' and intern doctors' awareness of ionizing radiation exposure doses during common radiological procedures: A cross-sectional study from Saudi Arabia. Int J Medi Develo Count 2020; 4(1):001–006.
21. Mubeen SM, Abbas Q, Nisar N. Knowledge about ionizing and non-ionizing radiation among medical students. J Ayub Med Coll Abbottabad 2008; 20(1):118-21.
22. Najjar RH, Alsulaiman AM, Alraddadi JS, Alrohaimi NH, Algarni BA, Al-Arafa AM, Alsubait RA. Assessment of Physicians' Knowledge and Awareness About the Hazards of Radiological Examinations on the Health of Their Patients

at a Tertiary Care Hospital, Riyadh, Saudi Arabia. Cureus 2022; 14(7):e27479. doi: 10.7759/cureus.27479
23. Rafique A, Alotaibi N, Alsuheel S, AlAjlani A. Medical staff awareness of radiation exposure and safety in Saudi health institutions 2020. Int J Medi Develo Count 2021; 5(5):1114–1118. doi: 10.24911/IJMDC.51.1609855318
24. Ravikanth R. Awareness of ionizing radiation and its effects among clinicians. World J Nucl Med 2018; 17(1):1-2. doi: 10.4103/wjnm.WJNM_60_17
25. Saeed MK, Al-shaari H, Almarzooq MMS, Alsareii SA, Aljerdah SA, Al-ayed MS. Radiation awareness among physicians about the hazards of radiological examinations on the health of workers and their patients in Saudi Arabia. J Radiat Res Appl Sci 2018; 11(4):299–304.
26. Salama KF, AlObireed A, AlBagawi M, AlSufayan Y, AlSerheed M. Assessment of occupational radiation exposure among medical staff in health-care facilities in the Eastern Province, Kingdom of Saudi Arabia. Indian J Occup Environ Med 2016; 20(1):21-5. doi: 10.4103/0019-5278.183832
27. Sarma AD, Sangma P, Das C. A survey study on radiology and imaging students about radiation protective devices. Medical Science 2022; 26:ms66e2031. doi: 10.54905/disssi/v26i120/ms66e2031
28. Zhou GZ, Wong DD, Nguyen LK, Mendelson RM. Student and intern awareness of ionizing radiation exposure from common diagnostic imaging procedures. J Med Imaging Radiat Oncol 2010; 54(1):17-23. doi: 10.1111/j.1754-9485.2010.02132.x