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# Knowledge of Radio Protective Techniques and Awareness of Radiation Hazards among Radiologists and Non-Radiology Healthcare Professionals in Saudi Arabia 2024

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**Abstract:**
**Background:** Medical imaging procedures involving the use of ionizing radiation are associated with potentially harmful biological effects, especially after long-term exposure or high doses of radiation. The use of medical radiation in diagnosis and procedural and surgical treatment is increasing. Therefore, healthcare personnel should be adequately aware and knowledgeable about radiation hazards to protect themselves and their patients from its adverse effects. The application of ionizing radiation in healthcare has grown. Healthcare professionals must therefore be aware of the risks associated with radiation and take the appropriate precautions to lower occupational exposure. **This study aimed:** To assess the knowledge of radio protective techniques and awareness of radiation hazards among radiologists and non-radiology professionals. These findings may improve the application of various safety measures during medical interventions involving radiation. **Methods:** A cross-sectional questionnaire-based study among 200 medical personnel was conducted, including consultant surgeons, physicians, radiologists, nurses, and radiographers, across five hospitals in Saudi Arabia from January to April 2024. The questionnaire collected data on demographic characteristics, awareness of radiation hazards, and knowledge of radio protective techniques. **Results:** Overall, the knowledge of radiation protection and awareness of radiation hazards among the participants were poor (51.55% and 37.17%, respectively). No significant difference was detected between the medical disciplines in terms of the level of knowledge of radiation protection; however, radiographers were significantly more aware of radiation hazards. **Conclusions:** According to the present findings, medical personnel generally have poor awareness of radiation hazards and radiation protection protocols. However, this understanding can be enhanced through periodic in-service training and regular monitoring of occupational radiation exposure by health professionals.
**Keywords:** Ionizing radiation, Radiation hazard, Radio protective measure, Healthcare professional

## Introduction:

In everyday medical practice, both ionizing and nonionizing radiations are frequently employed. It is crucial to both therapeutic and diagnostic approaches. Interventionists and anesthetic staff who are exposed to ionizing radiation at work, however, may suffer dangerous consequences. Radiation is a part of man`s physical condition and is extensively arranged into ionizing and non-ionizing radiation. The most vigorous structure and of significant general wellbeing noteworthiness is ionizing radiation [(1)]. In ordinary conditions, 80% of our introduction to ionizing radiation originates from regular wellsprings of which radon gas is by a long shot the most noteworthy, while the other 20% originates from manmade sources, principally clinical X rays [(1, 2)].

Utilization of ionizing radiation in clinical imaging for indicative and interventional purposes has risen drastically lately with an attending increment in the presentation of patients and wellbeing laborers to radiation risks, clinical and dental X rays currently establish the significant manmade wellsprings of radiation exposure [(3)]. The process by which electromagnetic waves or subatomic particles with enough energy are transferred from a source and absorbed by a material or area is known as ionizing radiation. The technology used to produce photographs of different bodily parts for diagnostic and therapeutic purposes is known as medical imaging. Radiation exposure, however, presents significant health risks despite its numerous beneficial uses, such as skin erythema, burns, cataracts, infertility, and bone marrow suppression [(4)].

Radiation protection provides individuals a sufficient degree of defense without reducing the benefits of radiation exposure. In order to protect employees from radiation exposure during interventional radiology procedures, a variety of personal protection equipment (PPE) has been designed, including gloves, glasses, thyroid shields, and aprons. Unless they are positioned behind a protective screen, all operating room staff is required to wear PPE during fluoroscopy. Lead PPE clothing offers radiation protection comparable to that of lead that is 0.25 to 1 mm thick. A lead-equivalent thickness of at least 0.5 mm is required by most laws since it can attenuate over 90% of scatter radiation [(5)].

Additionally, radiation absorption pads have been demonstrated to lessen scatter radiation exposure for interventional radiologists, especially in the upper body [(6)]. In all fields of medicine, protecting workers from ionizing radiation exposure tries to reduce the chance of stochastic consequences, such cancer induction, and avoid deterministic ones. This entails keeping an eye on dose limits and ensuring that employees and members of the public are kept at suitable safety distances from the radiation source. Since the patient's dose greatly influences the degree of scatter, the distance between workers and patients during radiological intervention is typically the most significant predictor of occupational exposure. In order to minimize occupational exposure, dosages are tailored to achieve the desired medical goal at the lowest required radiation dose [(7)].

Numerous studies have shown that medical radiation exposure raises the risk of multiple cancers, particularly thyroid carcinoma, infertility, cataracts, bone marrow suppression, and birth abnormalities [(8-10)]. Different radiation-related disorders have different threshold doses. For instance, 500 mGy is linked to cataracts, while 100–200 mGy is linked to teratogenicity consequences and cancer [(11)]. Therefore, lowering radiation exposure among healthcare professionals requires knowledge and awareness of radiation hazards and protective measures.

According to the International Commission on Radiological Protection's (ICRP) fundamental principle of radiation protection, radiation protection is founded on three principles: dose limitation, optimization (as low as reasonably attainable, or ALARA), and justification [(12)]. Strategies for radiation protection are based on this. Although a lot of research has been done on healthcare workers' awareness of radiation risks and safety measures, findings have been mixed across various medical disciplines. It has been discovered that Nigerian dentists, radiologists, and radiotherapists possess adequate levels of

understanding regarding radiation risks and the application of personal protective equipment [13].

This can be compared to the results of another study that was carried out among Italian pediatric fellows and residents. In particular, just 27 percent of participants answered questions measuring their understanding of radiation protection (ALARA) properly [14]. The two study samples' variations could be the cause of these contradictory results. To put it another way, the Italian study had pediatric residents and fellows, while the majority of participants in the Nigerian study had been employed in a radiology department. Studies have also looked at healthcare workers' awareness of radiation safety in Asia-Pacific nations. For instance, in-depth interviews with Indian medical and dental professionals revealed that they were not well-informed on the risks associated with radiation [15].

Nevertheless, research has shown that while healthcare professionals are sufficiently aware of the risks associated with radiation exposure, they are not well-versed in radiation safety procedures. As a result, healthcare workers require ongoing radiation protection training. This study used an online survey questionnaire to find out how well radiologists and non-radiologists understood radiation safety for people who work with medical radiation and could be exposed to it. Additionally, we sought to reduce the harmful health effects of radiation that result from the inappropriate, dangerous, and uncontrolled use of radiation sources in medical practice.

**Methods**

A cross-sectional questionnaire-based study was conducted from January to April 2024. This study was approved by the ethics committee. All methods were performed in accordance with the relevant guidelines and regulations. Written informed consent was provided by the participants at the beginning of the survey. All healthcare professionals, including radiologists and radiographers, as well as non-radiology consultants, surgeons, staff nurses, and general practitioners, from five different hospitals in Saudi Arabia were included in the survey distribution process.

In order assess medical personnel's knowledge of radiation safety, researchers distributed out 200 electronic copies of the same survey. After a comprehensive assessment of the literature, the questionnaire was created, and questions were selected after consulting with a number of medical colleagues. There were three primary parts to the questionnaire. Nine questions pertaining to demographic information, including sex, age, experience, and daily workload, made up the first component. Ten multiple-choice questions about awareness and knowledge of radiology hazards made up the second component. These questions included whether childhood abdominal computed tomography raises the lifetime risk of cancer, which organ has the highest radio sensitivity, and which cells are most sensitive to ionizing radiation.

In the third section, there were eleven multiple-choice questions about protection and the safety rules of using radiation protection, like wearing personal protective equipment (PPE) like an apron, lead glasses, or a thyroid shield when dealing with radiation. For every right response, one point was given. A score ranging from 0 to 100% was then calculated using the combined average of (1) radiation protection knowledge and (2) radiation hazard awareness. The purpose of the study was to examine the advantages of providing participants with a targeted course that educated them on radiation safety and hazards. Participants who completed a radiation safety training course were compared to those who did not. The outcomes show how beneficial it is to educate everyone involved who handles radiation on safety precautions and guidelines.

For statistical analysis, SPSS software (version 28) was used. The means ± standard deviations are used to express quantitative continuous variables. The chi-squared test was used to compare categorical data. The Student's t test with a 95% confidence interval was used to compare continuous data. A two-tailed test of significance and Pearson's correlation coefficient were used to assess correlations. Significant differences were defined as P values $< 0.05$. The participants' awareness of radiation dangers and their understanding of radiation protection were evaluated by a questionnaire.

Scores on the questionnaire ranged from 0% to 100%. After the participants were split up into groups, the results of the questionnaire were compared.

**Results:**

In total, 200 responses were received, with a response rate of 66%. **Table (1)** shows the demographic data of the participants. The mean age of the participants was 34 years, and approximately 57.5% were men. The participants' knowledge of radiation protection and awareness of radiation hazards were poor (51.55% and 37.17%, respectively).

**Table (1):** Demographic characteristics of the participants

| Characteristics | Minimum | Maximum | Mean | SD |
|---|---|---|---|---|
| Age (years) | 22 | 70 | 34.42 | 7.681 |
| Years in service (years) | 1 | 48 | 8.81 | 7.715 |
| Patients seen per day | 0 | 250 | 29.93 | 37.233 |
| Radiology images requested per day | 0 | 350 | 17.87 | 38.852 |
| Knowledge of radiation protection | 9 | 82 | 51.55 | 14.499 |
| Awareness of radiation hazards | 0 | 100 | 37.17 | 27.457 |

SD standard deviation

**Table (2)** shows the classification of the participants based on their profession and department. Most participants were medical doctors (70.5%) with a radiological background (31.5%).

**Table (2):** Classification of the participants based on their profession and department

| | Number | % |
|---|---|---|
| **Profession** | | |
| Nurses | 39 | 19.5 |
| Physicians | 141 | 70.5 |
| Radiographers | 13 | 6.5 |
| Others | 7 | 3.5 |
| **Department** | | |
| Anesthesiology | 13 | 6.5 |
| Emergency | 9 | 4.5 |
| Oncology | 4 | 2.0 |
| Radiology | 63 | 31.5 |
| Surgery | 38 | 19.0 |
| Others | 73 | 36.5 |

**Table (3)** shows the effect of sex on knowledge and awareness scores. No significant differences were observed between male and female participants regarding their knowledge of radiation protection or awareness of radiation hazards (Table 3).

**Table (3):** Effect of sex on knowledge and awareness scores

| Sex | Knowledge of radiation protection Mean (SD) | Awareness of radiation hazards Mean (SD) |
|---|---|---|
| Males | 52.87% (12.24%) | 37.33% (27.02%) |
| Females | 49.79% (16.94%) | 36.95% (28.18%) |

| Sex | Knowledge of radiation protection Mean (SD) | Awareness of radiation hazards Mean (SD) |
|---|---|---|
| *P* value | 0.137 | 0.923 |

*P* values < 0.05 were considered significant *SD* standard deviation

**Table (4)** shows the effect of profession on knowledge and awareness scores No significant difference was observed between the professions in terms of knowledge regarding radiation protection; however, radiographers had a significantly greater awareness of radiation hazards (58.97%).

**Table (4):** Effect of profession on knowledge and awareness scores

| Profession | Knowledge of radiation protection Mean (SD) | Awareness of radiation hazards Mean (SD) |
|---|---|---|
| Nurse | 47.09% (17.18%) | 31.05% (27.71%) |
| Physician | 52.55% (13.44%) | 36.49% (27.16%) |
| Radiographer | 55.24% (13.10%) | 58.97% (21.46%) |
| Others | 49.35% (18.82%) | 44.44% (25.66%) |
| *P value* | 0.146 | 0.012 |

*P* values < 0.05 were considered significant *SD* standard deviation

**Table (5)** shows the effect of the department on knowledge and awareness scores. A significant difference was observed between the different departments in terms of knowledge of radiation protection and radiology hazard scores, with the highest scores recorded by the radiology department personnel (55.70% and 52.56%, respectively).

**Table (5):** Effect of the department on knowledge and awareness scores

| Department | Knowledge of radiation protection Mean (SD) | Awareness of radiation hazards Mean (SD) |
|---|---|---|
| Anesthesiology | 48.25% (11.96%) | 25.64% (22.85%) |
| Emergency | 50.51% (10.27%) | 37.04% (36.43%) |
| Oncology | 45.45% (19.63%) | 33.33% (9.07%) |
| Radiology | 55.70% (13.31%) | 52.56% (25.18%) |
| Surgery | 53.35% (13.72%) | 31.29% (24.35%) |
| Others | 48.07% (15.70%) | 29.22% (26.09%) |
| *P* value | 0.042 | < 0.001 |

*P* values < 0.05 were considered significant *SD* standard deviation

**Table (6)** shows correlations between service years, patients seen daily, and images requested daily and knowledge and awareness scores. The number of years in service, patients seen per day, and images requested per day were weakly correlated with knowledge of radiation protection and radiation hazard scores; however, these correlations were not significant.

**Table (6):** Correlations between service years, patients seen daily, and images requested daily and knowledge and awareness scores

| | Knowledge of radiation protection | Awareness of radiation hazards |
|---|---|---|
| **Service years** | | |
| Pearson correlation | - 0.041 | 0.093 |
| *P* value | 0.565 | 0.190 |
| **Patients seen per day** | | |
| Pearson correlation | - 0.057 | 0.085 |
| *P* value | 0.425 | 0.234 |
| **Images requested per day** | | |
| Pearson correlation | - 0.042 | 0.089 |
| *P* value | 0.559 | 0.210 |

*Sig* significance *P* values < 0.05 were considered significant (two-tailed)

**Table (7)** shows the effect of occupational radiation exposure course attendance on knowledge and awareness scores. Attending an occupational radiation exposure education course had a significant positive impact on knowledge of radiation protection and radiation hazard scores.

**Table (7):** Effect of occupational radiation exposure course attendance on knowledge and awareness scores

| Occupational radiation exposure course attendance | Knowledge of radiation protection Mean (SD) | Awareness of radiation hazards Mean (SD) |
|---|---|---|
| Course attended | 55.44% (14.34%) | 51.37% (26.46%) |
| Course not attended | 49.84% (14.28%) | 30.94% (25.58%) |
| *P* value | 0.012 | < 0.001 |

*P* values < 0.05 were considered significant *SD* standard deviation

**Discussion:**

The present study confirmed that the participants had a low level of awareness of radiation dangers and radiation protection knowledge. Furthermore, there was no discernible difference in the medical professions' levels of radiation safety knowledge; on the other hand, radiographers knew a lot more about radiation risks. Prolonged exposure to ionizing radiation raises the risk of developing cancer and may have other negative consequences [16]. The majority of leukemia types and cancer in numerous organs are known to be linked to ionizing radiation. Medical doctors at different levels (consultants vs. residents) have varying understandings of how radiation causes cancer, according to numerous studies that assessed healthcare professionals' awareness of the risks of ionizing radiation exposure and protection from hazards [17]. Furthermore, healthcare professionals who deal with ionizing radiation lack general knowledge about radiation, radiation protection, health risks, and doses given to patients during radiological interventions, according to a study on awareness of protection and knowledge about radiological examinations.

In this study, we assessed the understanding, perception, and mitigation of risks connected to radiological intervention and concentrated on medical professionals who employ ionizing radiation in their work but do not work in radiation-related fields [18]. Overall, there was a lack of awareness about the health dangers of ionizing radiation, which was in line with other studies' findings [19]. A prior study looked at radiologists' and non-radiologists' understanding of radiation dosages for routine radiography

procedures. A third of non-radiologists were unable to tell the difference between ionizing radiation and non-ionizing radiation radiological tests [(20)]. The majority of doctors underestimated radiation doses, according to a different study that gathered quantitative and qualitative data on their attitudes and knowledge on medical radiation exposure [(21)].

The current study showed a considerable variation in the level of understanding of radiation safety and radioactive dangers among departments, which is not surprising considering that the primary participants were medical doctors. Although the percentage was larger among the staff of the radiology department, it did not differ significantly from that of other professions. Of the participants, about half (51.55%) had a general understanding of radiation safety. Compared to those in other occupations (37.71%), radiographers had a higher awareness of radiation threats (58.97%). Regarding knowledge of radiation safety and awareness of radiation dangers, no discernible differences between men and women were found. In terms of radiation hazard awareness and radiation protection expertise, the surgical and emergency department staff came in second and third, respectively.

On the other hand, staff members in the anesthesiology department expressed the least knowledge of radiation threats and safety. This result is in line with a research that found a significant portion of anesthesiologists were unaware of the hazards associated with radiation [(4)]. The minimal usage of medical radiation in this field may be the cause of this; however anesthesiologists are particularly vulnerable to radiation exposure during surgical operations that call for medical radiation. Therefore, it is essential to be aware of radiation risks. We showed that employees who took a course on occupational radiation exposure were more knowledgeable about radiation safety and more conscious of radiation hazards. This finding supports the findings of another study, which showed that practitioners who had received radiation exposure training and were familiar with European radiation protection and safety standards were more likely to inform patients of the risks of medical radiation [(21)].

Moreover, this study showed that the number of years in service, number of patients seen per day, and number of images requested per day were weakly associated with the level of knowledge about radiation protection and radiation hazards. This finding is consistent with a study that evaluated physicians' knowledge of the harmful effects of ionizing radiation and demonstrated that medical doctors in various stages of their careers (consultants vs. residents) had varying levels of understanding about radiation risks, indicating that awareness of ionizing radiation is not acquired over time [(18)]. After performing a literature review, we found variable outcomes in previous studies. Awosan et al. (2016) [(13)] found poor radiation protection practices despite good knowledge of radiation hazards among the participants, but radiation exposure and prevalence of abnormal clinical conditions were found to be low. Periodic in-service training and monitoring on radiation safety was suggested.

Behzadmehr et al., (2020) [(22)] conducted a systematic review of published articles on radiation protection among health care worker. Their results indicate that in most studies, more than half (50%) of the participants had average knowledge. Furthermore, 60% of the participants had a positive attitude toward radiation protection, but in most studies, they had only average practices regarding radiation protection. In summary, the present study demonstrated varied levels of knowledge regarding radiation protection among participants; however, their awareness of radiation hazards was inadequate. Therefore, we propose that physicians, nurses, and all those who work with or are exposed to medical radiation should receive formal education and training and those courses should be mandatory to renew their license to practice. Hospitals should also ensure the correct use of PPE and safety measures during medical radiation interventions. Furthermore, physicians should continually research radiation hazards and the latest radio protective practices to increase their awareness.

**Conclusions**

The current study indicates that medical staff members typically lack knowledge about radiation risks and radiation safety procedures. However, continuous monitoring of occupational

radiation exposure by health professionals and periodic in-service training can improve this understanding.

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