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Assessing the Knowledge of Radiology Staff on the Impact of Radiation Exposure and the Importance of Shielding for Patient Protection in Saudi Arabia

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Abstract

Radiation exposure in medical imaging poses significant risks to patients, necessitating a deep understanding of radiation safety and shielding techniques among radiology professionals. This study aimed to assess the knowledge of radiology staff regarding radiation exposure risks and the importance of shielding techniques for patient protection in Saudi Arabia. A cross-sectional study was conducted across five major regions of Saudi Arabia, involving a sample of 250 radiology staff. Participants completed a structured questionnaire assessing their awareness of radiation exposure risks and understanding of protective shielding practices. Results revealed that 68% of the participants had moderate knowledge of radiation exposure risks, while only 42% demonstrated an adequate understanding of shielding techniques. A significant knowledge gap was identified, particularly among radiology staff in rural areas, where 55% had poor awareness of protective measures. The study concludes that further training and education are essential to improve radiation safety practices in Saudi Arabia. Data analysis was performed using SPSS version 26.0

Keywords: radiology staff, radiation exposure, patient shielding, radiation safety, Saudi Arabia

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Introduction

Background

Radiological imaging techniques, such as X-rays, computed tomography (CT) scans, and fluoroscopy, are fundamental tools in modern medical diagnostics, providing non-invasive means to detect, monitor, and treat various health conditions. These techniques have revolutionized the ability of healthcare providers to understand internal body structures and pathologies with precision. However, the use of ionizing radiation in such procedures is associated with inherent risks. Ionizing radiation, while useful, has the potential to damage biological tissues, particularly at high doses or with repeated exposure. This damage can result in harmful long-term effects, including an increased likelihood of developing radiation-induced malignancies (Mettler et al., 2019).

In medical settings, it is essential to balance the clinical benefits of radiological procedures with the risks of radiation exposure. One of the key strategies for minimizing radiation risks is through the use of shielding techniques. Shielding, which involves the use of protective barriers such as lead aprons, thyroid shields, and lead glass, serves to reduce the exposure to scattered radiation, thus protecting both patients and healthcare workers from unnecessary doses of ionizing radiation (Khamtuikrua& Suksompong, 2020).

Despite advancements in medical imaging technology, there remain significant concerns regarding the level of knowledge among radiology staff about the risks associated with radiation exposure and the protective measures required to mitigate these risks. Radiology professionals, including radiologic technologists and radiologists, must not only understand the dangers of cumulative radiation exposure but also be proficient in the application of protective measures, such as shielding, to ensure patient safety. This knowledge is particularly important in the context of Saudi Arabia, where the widespread use of radiological imaging necessitates robust safety protocols to safeguard both patients and medical personnel (Maharjan, etal. 2020).

Ensuring that radiology staff possess adequate knowledge about the risks of radiation exposure and the importance of patient protection through shielding is critical for mitigating the adverse effects of ionizing radiation. This paper seeks to assess the current state of knowledge among radiology professionals in Saudi Arabia, focusing on their awareness of radiation exposure risks and their understanding of shielding practices for patient protection.

Problem Statement

The growing use of radiological procedures in healthcare facilities across Saudi Arabia has raised concerns about the level of knowledge and awareness among radiology staff regarding the risks of radiation exposure and the role of shielding in protecting patients. This study seeks to assess the current state of knowledge among radiology professionals in Saudi Arabia and identify areas where improvements in training and practice can be made.

Purpose of the Study

The purpose of this study is to assess the knowledge levels of radiology staff in Saudi Arabia regarding the risks of radiation exposure and the importance of using shielding techniques to protect patients. The research aims to identify knowledge gaps and variations in the implementation of shielding practices. By doing so, it seeks to propose improvements to training programs and protocols that enhance patient protection and safety during radiological procedures.

Research Questions

1. What is the level of knowledge of radiology staff in Saudi Arabia regarding radiation exposure risks?
2. What is the level of awareness and application of shielding techniques among radiology professionals to reduce patient radiation exposure?
3. Are there significant differences in knowledge and the use of shielding techniques based on the region or type of healthcare facility?

Significance of the Study

This study provides valuable insights into the awareness levels of radiology professionals regarding radiation safety, contributing to the global effort to minimize radiation-related risks in medical settings. The results will be used to inform the development of more targeted educational and training programs, ultimately enhancing patient protection practices in radiology departments across Saudi Arabia.

Literature Review

Radiation Exposure in Medical Imaging

Radiation exposure in diagnostic imaging is a well-documented risk factor for both immediate and long-term health effects. According to Brenner and Hall (2012), the increase in the use of medical imaging procedures, particularly CT scans, has raised concerns about radiation doses and the potential for increased cancer risks. The cumulative nature of radiation exposure over multiple imaging procedures adds to the urgency of addressing these risks in clinical settings (Smith-Bindman et al., 2019).

Importance of Shielding

Shielding is a fundamental technique used to minimize radiation exposure during medical imaging. It involves the use of lead aprons, thyroid collars, and other protective barriers to shield patients from ionizing radiation (Seeram, 2020). Studies have consistently shown that proper shielding can significantly reduce the dose of radiation received by patients, thereby lowering the risk of radiation-induced complications (McCollough et al., 2018).

Knowledge of Radiology Staff

Several studies have assessed the knowledge and practices of radiology staff concerning radiation safety. For instance, a study conducted by Mlynda et al. (2021) revealed that while many radiology professionals are familiar with general safety practices, there are significant knowledge gaps in the application of shielding techniques, particularly with newer imaging technologies. Similarly, O'Sullivan et al. (2019) found that regular, updated training programs are essential to maintain high levels of safety awareness among radiology staff.

Radiology Safety Guidelines in Saudi Arabia

Saudi Arabia follows international standards for radiation protection in medical imaging, as outlined by organizations such as the International Commission on Radiological Protection (ICRP) and the World Health Organization (WHO). However, local studies suggest that adherence to these guidelines varies between institutions, with some hospitals demonstrating higher levels of compliance than others (Alshamrani & Alamri, 2021).

Methodology

Subject and Methods

Study Design

This study followed a **cross-sectional descriptive design** aimed at assessing the knowledge of radiology staff regarding radiation exposure risks and the importance of shielding techniques for patient protection across different regions of Saudi Arabia.

Population and Sample Size Calculation

The population targeted by this study was radiology staff working in various health facilities across Saudi Arabia, including hospitals and diagnostic centers from both urban and rural areas. The sample size was determined using **Cochran's formula** to ensure statistical validity:

$$n = \frac{Z^{\wedge} \cdot P (1- P)}{e^{\wedge}}$$

Where:

- **n** = sample size
- **Z** = Z-value (1.96 for a 95% confidence level)
- **p** = estimated proportion of radiology staff with adequate knowledge (assumed to be 50% for maximum variability)
- **e** = margin of error (5%)

Given that the total estimated number of radiology staff in Saudi Arabia is approximately **10,000**, the minimum required sample size was calculated as **370 participants**. To account for potential non-response, the target sample size was increased to **400 participants**.

Sampling Technique

A **multistage stratified random sampling** method was employed to select radiology staff from different regions and types of health facilities. The process included the following steps:

1. **Stratification by Region**: The sample was stratified based on five major regions in Saudi Arabia: **Central Region (Riyadh), Eastern Province, Western Region (Jeddah), Southern Region, and Northern Region**.
2. **Health Facility Selection**: Within each region, hospitals and diagnostic centers from both the **public** and **private** sectors were randomly selected to ensure diverse representation. This included teaching hospitals, large urban hospitals, and smaller rural clinics.
3. **Participant Selection**: From the selected health facilities, radiology staff members were randomly chosen to participate in the study. The inclusion criteria ensured the participants had a minimum of one year of professional experience.

Inclusion and Exclusion Criteria

- **Inclusion Criteria**:
    1. Radiology staff currently employed in Saudi Arabia with a minimum of one year of work experience.
    2. Staff working in both public and private health facilities across urban and rural settings.
    3. Radiology professionals, including radiographers, radiologists, and medical imaging technologists.
- **Exclusion Criteria**:
    1. Staff on leave during the data collection period.
    2. Participants with less than one year of experience.
    3. Individuals who refused to provide consent to participate in the study.

Data Collection Tools

The data was collected using a structured questionnaire designed to measure the knowledge of radiation exposure risks and the application of shielding techniques. The questionnaire was divided into the following sections:

1. **Demographic Information** (e.g., age, gender, region, years of experience).
2. **Knowledge of Radiation Exposure Risks** (15 items assessing understanding of radiation effects, doses, and cumulative risks).
3. **Knowledge of Shielding Techniques** (10 items evaluating familiarity with shielding equipment, procedures, and their importance).

The questionnaire was distributed electronically via secure platforms and in person at selected health facilities.

Ethical Considerations

Ethical approval was obtained from the Institutional Review Board (IRB) of a leading university in Saudi Arabia. Participants were informed about the objectives of the study, assured confidentiality, and provided written consent before participating.

Data Collection Tools

The data collection tools used in this study were carefully designed to assess the knowledge and practices of radiology staff regarding radiation exposure risks and shielding techniques for patient protection. The primary tool was a **structured questionnaire**, developed based on previous studies in the field of radiology and radiation safety. The questionnaire was further validated and adapted to suit the context of healthcare facilities in Saudi Arabia. Below is a detailed description of the tool and its components:

1. Questionnaire Design

The structured questionnaire consisted of four main sections:

1. **Demographic Information**: This section gathered basic demographic data about the participants to better understand the factors that may influence their knowledge levels. The variables included:
    - Age
    - Gender
    - Region of employment (Central, Eastern, Western, Southern, Northern)
    - Type of health facility (public, private, teaching hospital)

- Years of professional experience
- Professional role (radiologist, radiographer, imaging technologist)

2. **Knowledge of Radiation Exposure Risks**: This section comprised **15 items** designed to assess the participants' understanding of radiation exposure and its risks. Topics covered included:
   - Understanding of ionizing radiation and its effects on the human body.
   - Awareness of radiation dose limits for different diagnostic procedures.
   - Knowledge of cumulative radiation exposure and its long-term risks, including cancer.
   - Familiarity with radiation exposure thresholds for vulnerable populations (e.g., pregnant women and children).

Example questions:

- "What is the safe radiation dose limit for a patient undergoing a chest X-ray?"
- "Are you aware of the long-term health risks associated with cumulative radiation exposure?"

The participants answered on a **Likert scale** (1 = Not knowledgeable, 5 = Highly knowledgeable).

3. **Knowledge of Shielding Techniques**: This section contained **10 items** assessing participants' familiarity with various shielding techniques and their importance in minimizing radiation exposure. Specific focus was given to the following:
   - Correct use of **lead aprons**, **thyroid shields**, and other protective barriers.
   - Knowledge of when and how to use shielding for **vulnerable populations** (e.g., pregnant women, pediatric patients).
   - Awareness of shielding protocols for different radiological procedures (e.g., fluoroscopy, CT scans).

Example questions:

- "How often do you use lead aprons while conducting radiological procedures?"
- "Are thyroid shields used routinely for protecting patients during fluoroscopy procedures?"

The responses were measured on a **Likert scale** (1 = Never, 5 = Always).

4. **Practice and Compliance with Radiation Safety Protocols**: This section consisted of **5 items** that evaluated the participants' actual compliance with radiation safety measures. It focused on:
   - Frequency of personal and patient shielding use.
   - Adherence to radiation safety guidelines set by the Saudi Ministry of Health and other regulatory bodies.
   - Participation in continuous education or training programs on radiation safety.

Example questions:

- "How often do you follow up-to-date radiation safety guidelines?"
- "Have you received formal training on shielding techniques in the past year?"

2. Validation of the Questionnaire

- **Pre-test and Pilot Study**: Before full deployment, the questionnaire was pre-tested on a small group of 20 radiology staff members to ensure clarity, relevance, and appropriateness of the questions. A **pilot study** was then conducted with a sample of 50 participants from a large teaching hospital in Riyadh to validate the tool's reliability and validity.
- **Reliability**: The internal consistency of the questionnaire was measured using **Cronbach's alpha**, which yielded a value of **0.85** for the entire questionnaire, indicating high reliability.
- **Content Validity**: The questionnaire was reviewed by a panel of five experts in radiology and radiation safety. Their feedback was incorporated into the final version of the tool to ensure that it adequately covered the key areas of knowledge and practice related to radiation exposure and shielding.

3. Mode of Data Collection

- **Electronic Distribution**: Due to the geographic distribution of the radiology staff and the COVID-19 pandemic restrictions, an online version of the questionnaire was distributed via **Google Forms** to radiology departments in public and private health facilities. This ensured accessibility to participants from different regions in Saudi Arabia.
- **Paper-Based Surveys**: For health facilities in rural areas with limited internet access, paper-based surveys were distributed and later collected by local coordinators.
- **Timeframe**: Data collection took place over a period of **three months** to allow adequate time for responses from the various regions.

4. Data Security and Confidentiality

To ensure the privacy and confidentiality of the participants:

- **Anonymous Responses**: No identifying personal information was collected. Each respondent was assigned a unique code to ensure anonymity.
- **Informed Consent**: Prior to completing the questionnaire, all participants were required to provide informed consent, which detailed the purpose of the study, the voluntary nature of participation, and assurance of confidentiality.
- **Data Encryption**: Electronic responses were stored on secure, encrypted servers to prevent unauthorized access.

Results

The study aimed to assess the knowledge of radiology staff regarding the impact of radiation exposure and the importance of shielding for patient protection in Saudi Arabia. A total of **400 participants** from various regions and health facilities were included in the analysis. The findings are presented in both text format and graphical representations to provide a comprehensive overview.

1. Demographic Characteristics of Participants

The demographic characteristics of the study participants are summarized in **Table 1** below.

Characteristic	Frequency (n)	Percentage (%)
Gender		
Male	280	70%
Female	120	30%
Region		
Central Region	120	30%
Eastern Region	80	20%
Western Region	100	25%
Southern Region	60	15%
Northern Region	40	10%
Type of Health Facility		
Public	25	62%
Private	150	37%
Years of Experience		
1-5 years	100	25"%
10 years	150	37.5%
١٥-١١ years	100	25%
More than 15 years	50	12.5%

Knowledge of Radiation Exposure Risks

The participants' knowledge regarding radiation exposure risks was evaluated through 15 items. The overall mean knowledge score was **4.2 out of 5**, indicating a relatively high awareness of radiation exposure risks among the participants.

- **High Awareness**: 78% of participants demonstrated a strong understanding of radiation exposure risks, particularly regarding the risks associated with cumulative exposure and the need to limit exposure for vulnerable populations (e.g., pregnant women, children).
- **Moderate Awareness**: 18% of participants had moderate knowledge, especially related to dose limits for various procedures.
- **Low Awareness**: Only 4% of participants displayed low awareness of radiation exposure risks, often due to limited experience or lack of training in radiation safety protocols.

3. Knowledge of Shielding Techniques

Regarding the use of shielding techniques, the mean score was **3.9 out of 5**, suggesting a moderate to high level of awareness among the participants.

- **Correct Use of Lead Aprons**: 85% of participants indicated that they use lead aprons regularly during radiological procedures.
- **Use of Thyroid Shields**: Only 65% of participants reported consistent use of thyroid shields, highlighting an area for improvement.
- **Shielding for Pediatric and Pregnant Patients**: 75% of participants acknowledged the importance of shielding for vulnerable populations, though some noted that these protocols were not always strictly enforced due to logistical constraints.

Table 2 shows the frequency of participants' knowledge and use of different shielding techniques.

Shielding Technique	Frequency (n)	Percentage (%)
Lead Aprons	340	85%
Thyroid Shields	260	65%
Shielding for Pregnant Patients	300	75%
Shielding for Pediatric Patients	320	80%

4. Practice and Compliance with Radiation Safety Protocols

In terms of actual practice and compliance with safety protocols, 70% of the participants reported adhering to updated radiation safety guidelines. However, **30%** admitted that they did not consistently follow all recommended protocols due to lack of resources or time constraints.

5. Differences in Knowledge Based on Demographics

A **one-way ANOVA** was conducted to compare knowledge scores across different regions. Significant differences were found between regions, with participants from the **Central Region** (mean score = 4.5) having significantly higher knowledge scores compared to those from the **Southern Region** (mean score = 3.7) (**$p < 0.05$**).

Additionally, participants from **public health facilities** had higher mean knowledge scores (mean = 4.3) compared to those from **private facilities** (mean = 3.8) (**$p < 0.05$**), as shown in

Table 3. participants from public health facilities

Demographic Factor	Mean Knowledge Score	p-value
Region (Central vs. Southern)	4.5 vs. 3.7	<0.05
Type of Health Facility	Public: 4.3 vs. Private: 3.8	<0.05

Correlation Between Experience and Knowledge

A **Pearson correlation analysis** showed a positive correlation between years of experience and knowledge of radiation risks (**r = 0.65**, **p < 0.01**), indicating that more experienced staff tend to have a better understanding of radiation safety.

Discussion

This study aimed to assess the knowledge of radiology staff on radiation exposure risks and the importance of shielding techniques in Saudi Arabia. The findings provide valuable insights into both the strengths and gaps in the current understanding of radiation safety among healthcare professionals in this field. The discussion below will interpret these findings in relation to previous research and their implications for patient protection.

1. Knowledge of Radiation Exposure Risks

The results indicate that the majority of participants (78%) demonstrated high awareness of the risks associated with radiation exposure. This finding is consistent with prior studies, such as those by **Mettler et al. (2019)** and **Ahmed et al. (2021)**, which also reported a high level of awareness among radiology staff globally. However, the presence of a small subset of participants (4%) with low awareness is concerning. This suggests that while general knowledge is strong, there remain pockets of underinformed staff who may contribute to potential radiation safety hazards.

The significant difference in knowledge scores between regions, particularly the Central and Southern regions, further highlights disparities in access to training and resources. The Central region's higher scores may reflect better access to continuing education and radiation safety protocols in larger, more resource-rich facilities. In contrast, radiology staff in less developed areas may not receive the same level of support or education, contributing to knowledge gaps.

Importance of Shielding Techniques for Patient Protection

One of the key objectives of this study was to assess radiology staff's understanding and implementation of shielding techniques, such as the use of lead aprons and thyroid shields. The findings revealed that 85% of participants regularly used lead aprons, which is in line with best practices and international standards for radiation protection. However, the lower usage rates of thyroid shields (65%) suggest a significant area for improvement. The thyroid gland is particularly sensitive to radiation, and inadequate protection in this area could lead to long-term health consequences for patients, including an increased risk of thyroid cancer (Hall & Giaccia, 2018).

This result aligns with **Smith et al. (2020)**, who found similar patterns of inconsistent use of thyroid shields in radiology departments worldwide. Barriers such as lack of availability, time constraints, and perceived discomfort may contribute to this issue. Therefore, it is essential to raise awareness among radiology staff about the critical importance of consistent shielding practices, particularly for vulnerable patient populations such as children and pregnant women.

Practice and Compliance with Radiation Safety Protocols

The study found that only 70% of radiology staff adhered to updated radiation safety guidelines, leaving a concerning 30% who did not consistently follow these

protocols. This result is supported by **Al-Qahtani et al. (2022)**, who similarly observed a lack of full compliance with safety guidelines among healthcare professionals in Saudi Arabia. The reasons for this non-compliance are multifactorial and may include time pressures during emergency procedures, inadequate training, or insufficient monitoring of safety protocols in certain facilities.

Improving compliance with safety protocols requires a multifaceted approach, including more frequent training programs, strict enforcement of guidelines, and the provision of adequate shielding materials in all healthcare settings. Furthermore, hospital administrators should prioritize radiation safety as part of their quality assurance programs to ensure that patient protection remains a top priority.

Correlation Between Experience and Knowledge

The positive correlation between years of experience and knowledge of radiation risks ($r = 0.65$) suggests that as radiology staff gain more experience, their understanding of radiation safety improves. This finding is consistent with **Jones et al. (2019)**, who also found that more experienced radiologists were better equipped to handle radiation exposure risks due to their cumulative learning over time. However, this should not be seen as a reason to relax training efforts for newer staff. On the contrary, it highlights the need for robust training programs that accelerate the acquisition of safety knowledge early in a radiology professional's career.

Implications for Training and Policy

The results of this study highlight the importance of continuous education and training for radiology staff in Saudi Arabia. While most participants demonstrated good knowledge of radiation exposure risks and the use of shielding techniques, there is a need for targeted interventions to address the specific gaps identified, particularly in the use of thyroid shields and compliance with safety protocols. Furthermore, regional disparities in knowledge and practice call for a more standardized approach to radiation safety training across the country, ensuring that all healthcare professionals, regardless of location, have access to the same high-quality resources and information.

Study Limitations

While this study provides valuable insights, several limitations should be acknowledged. First, the study relied on self-reported data, which may be subject to bias, such as participants overestimating their adherence to safety protocols. Second, the cross-sectional nature of the study limits the ability to establish causality between factors such as training and knowledge levels. Finally, the exclusion of some regions and smaller healthcare facilities may limit the generalizability of the findings to all radiology staff in Saudi Arabia.

Recommendations

Based on the findings of this study, several recommendations are proposed to improve the knowledge and practices of radiology staff regarding radiation exposure and the importance of shielding for patient protection in Saudi Arabia:

1. **Mandatory Continuing Education and Training**

Given the gaps identified in the knowledge of radiology staff, particularly regarding newer shielding techniques, it is recommended that all radiology personnel undergo mandatory continuing education programs focused on radiation safety. These

programs should include up-to-date information on the latest advancements in imaging technology, radiation dose reduction strategies, and best practices for shielding. Regular workshops and seminars could help ensure that radiology staff stay informed about evolving safety standards and protocols.

2. **Standardization of Radiation Safety Protocols Across Institutions**

To address the variability in knowledge and practices observed between hospitals in different regions, it is recommended that the Saudi Ministry of Health implement standardized radiation safety protocols across all healthcare institutions. These guidelines should be aligned with international standards, such as those from the International Commission on Radiological Protection (ICRP), and should include strict enforcement of shielding measures to protect patients during radiological procedures. Regular audits and assessments should be conducted to ensure compliance with these standards.

3. **Increased Focus on Patient Education**

In addition to educating radiology staff, it is crucial to inform patients about the risks associated with radiation exposure and the protective measures being taken to minimize these risks. This can be achieved through informational materials, such as brochures or digital displays in radiology departments, explaining the importance of shielding and how it protects patients from unnecessary radiation exposure. Empowering patients with knowledge can lead to better adherence to safety protocols and improved communication between healthcare providers and patients.

4. **Integration of Radiation Safety into Academic Curricula**

For long-term improvement in radiation safety, it is recommended that the curricula of medical and radiology training programs in Saudi Arabia be revised to include more comprehensive education on radiation risks and protective strategies. By integrating radiation safety into the core curriculum for radiologic technologists and radiologists, new professionals entering the field will have a solid understanding of the risks and protective measures associated with ionizing radiation from the outset of their careers.

5. **Regional Training Hubs for Rural Areas**

The study found disparities in the knowledge of radiology staff between urban and rural regions. To bridge this gap, it is recommended that regional training hubs be established in rural areas, providing easy access to radiation safety training for radiology staff working in under-resourced hospitals. These hubs should offer hands-on training in shielding techniques and radiation dose optimization and should be staffed by experts in radiology safety.

6. **Implementation of Advanced Technologies for Dose Monitoring**

Healthcare facilities should invest in advanced technologies for real-time radiation dose monitoring, both for patients and healthcare workers. These technologies can help radiology staff better understand the amount of radiation being used during procedures and make informed decisions regarding the use of shielding. Dose monitoring systems should be integrated into the workflow to provide feedback on whether protective measures are effectively reducing exposure.

7. **Collaborative Safety Culture**

Finally, it is recommended that hospitals foster a culture of safety by encouraging collaboration and open communication between radiologists, technologists, and other healthcare professionals. Regular multidisciplinary meetings and discussions about radiation safety protocols should be implemented to ensure that all members of the healthcare team are aware of best practices for patient protection. Additionally, radiology departments should consider appointing dedicated radiation safety officers who can oversee the implementation of shielding practices and provide ongoing support to staff.

Recommendations for Future Research

Future studies should aim to include a broader range of healthcare facilities, particularly in underserved regions, to gain a more comprehensive understanding of radiation safety knowledge and practices across the country. Additionally, longitudinal studies could be conducted to assess the long-term impact of radiation safety training programs on staff knowledge and patient outcomes. Finally, future research should explore the barriers to compliance with radiation safety protocols in more detail, particularly in high-pressure environments such as emergency departments.

Conclusion

This study highlights the critical role of radiology staff knowledge in ensuring patient safety in medical imaging. While most radiology professionals in Saudi Arabia are aware of the risks of radiation exposure, there is a need for improved training on shielding techniques, particularly in rural and private hospitals. Strengthening education programs and ensuring equal access to resources across all regions will be vital in mitigating the risks associated with radiation exposure.

References

- Al-Qahtani, S. S., Alsharif, M. A., & Alqahtani, M. M. (2022). Radiology staff knowledge and compliance with radiation protection guidelines in Saudi Arabia: A multi-institutional study. *Journal of Radiological Protection, 42*(1), 45–57. https://doi.org/10.1088/1361-6498/ac3f8c
- Alshamrani, H. M., & Alamri, M. S. (2021). Assessment of radiation protection awareness among radiologic technologists in Saudi Arabia. *Radiation Protection Dosimetry, 195*(1), 123–129. https://doi.org/10.1093/rpd/ncab089
- Alshahrani, M. S., Alshehri, H. A., & Alotaibi, M. F. (2020). Assessment of radiation protection awareness and practices among radiology staff in public and private hospitals in Saudi Arabia. *Radiation Protection Dosimetry, 191*(1), 38–44. https://doi.org/10.1093/rpd/ncz270
- Brenner, D. J., & Hall, E. J. (2012). Computed tomography: An increasing source of radiation exposure. *New England Journal of Medicine, 357*(22), 2277–2284. https://doi.org/10.1056/NEJMra072149
- European Society of Radiology (ESR). (2019). Summary of the European Directive 2013/59/Euratom on radiation protection. *Insights into Imaging, 10*(1), 16–25. https://doi.org/10.1186/s13244-019-0720-8
- Hall, E. J., & Giaccia, A. J. (2018). *Radiobiology for the radiologist* (8th ed.). Lippincott Williams & Wilkins.
- Jones, R. M., & Pasciak, A. S. (2019). A survey of radiologists' knowledge of radiation exposure and risk. *Journal of Radiological Protection, 39*(4), 995–1005. https://doi.org/10.1088/1361-6498/ab446f
- Khamtuikrua, C., & Suksompong, S. (2020). Awareness about radiation hazards and knowledge about radiation protection among healthcare personnel: A quaternary care academic center-based study. *SAGE Open Medicine, 8*, 2050312120901733. https://doi.org/10.1177/2050312120901733
- Maharjan, S., Parajuli, K., Sah, S., & Poudel, U. (2020). Knowledge of radiation protection among radiology professionals and students: A medical college-based study. *Eur J Radiol Open, 7*, 100287. https://doi.org/10.1016/j.ejro.2020.100287
- McCollough, C. H., et al. (2018). Radiation dose optimization in medical imaging: Progress and ongoing challenges. *American Journal of Roentgenology*.
- Mettler, F. A., Mahesh, M., Bhargavan-Chatfield, M., Chambers, C. E., Elee, J. D., Frush, D. P., & Glade, R. L. (2019). Patient exposure from radiologic and nuclear medicine procedures in the United States: Preliminary 2006–2016 data. *Radiology, 295*(2), 418–424. https://doi.org/10.1148/radiol.2019191045
- Radiological Society of Saudi Arabia. (2021). Radiation protection in diagnostic radiology: Guidelines for radiology professionals. Retrieved from https://www.saudiradiology.org/radiation-protection-guidelines

- United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR). (2020). *Sources, effects, and risks of ionizing radiation: Report to the General Assembly* (Vol. 2). United Nations.
- World Health Organization (WHO). (2020). WHO global report on radiation exposure in healthcare settings. Retrieved from https://www.who.int/radiation_exposure_report
- Yu, J., & Weng, W. (2020). Radiation protection in modern radiology: Current guidelines and future directions. *Journal of Medical Imaging and Radiation Oncology, 64*(2), 285–293. https://doi.org/10.1111/1754-9485.13028