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Understanding Ionizing Radiation Hazards: An Assessment of Awareness Levels Among Healthcare Professionals in Helmand Hospitals

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Abstract: The utilization of ionizing radiation in diagnostic and therapeutic procedures is on the rise, necessitating a comprehensive understanding of its associated risks among healthcare professionals. This study aims to evaluate the awareness levels of doctors and radiographers regarding the hazards of ionizing radiation. A quantitative, descriptive cross-sectional study was conducted involving 100 doctors and radiographers from hospitals in Helmand, Afghanistan. Participants completed a structured questionnaire designed to collect demographic data and assess their awareness of ionizing radiation hazards. The questionnaire included multiple-choice items addressing the nature of radiation, radiation reduction strategies, safe distances from X-ray machines, and the sensitivity of various organs. Majority of the participants (92.3%) were (20-30) years old, with a predominance of males (84.6%). Most participants were employed as medical doctors and radiographers, with work experience ranging from 1 to 10 years. Findings revealed that 24% of participants exhibited a moderate level of knowledge, 50% demonstrated low awareness, and only 4% achieved a high level of understanding of radiation hazards. This study indicates a moderate level of awareness among healthcare professionals, yet significant gaps in knowledge and misconceptions regarding radiation hazards remain. To address these deficiencies, the implementation of targeted workshops, training courses, and educational resources on radiation safety and protection is strongly recommended.

Keywords: Ionizing Radiation, Awareness, Healthcare Professionals, Radiation Safety, Diagnostic Imaging, Knowledge Assessment

1. Introduction

The utilization of ionizing radiation in medical imaging and treatment has advanced significantly since the early 20th century. While it plays a crucial role in diagnosing and treating various conditions, it also raises important safety considerations for both patients and healthcare providers (Williams, Rana, & Dwivedi, 2015). Annually, the average individual is exposed to about 3 mSv of radiation, with approximately 20% stemming from medical interventions. Excessive exposure can lead to adverse health effects, including an increased risk of cancer (Thompson et al., 2018). To ensure patient safety, it is vital that imaging techniques are conducted by trained professionals who adhere to stringent safety protocols. The implementation of the ALARA (as Low as Reasonably Achievable) framework is essential in minimizing unnecessary radiation exposure during medical procedures (Hoeschen et al., 2016).

Interventional radiology (IR) encompasses a range of minimally invasive procedures that utilize various imaging modalities, including ultrasound, computed tomography (CT), magnetic resonance imaging (MRI), and X-ray fluoroscopy, to deliver targeted interventions. This field intersects with multiple specialties, such as vascular radiology, pain management, and pediatric radiology, each requiring specific expertise (IDSA & SHEA, 2021). Despite its advantages, IR procedures carry inherent risks to patient safety, similar to those found in traditional diagnostic radiology. It is crucial that established safety protocols from other radiological practices are rigorously applied in IR settings (Koetser et al., 2013). Furthermore, patients may face risks of complications or adverse events if adequate preventive measures are not implemented before and during these procedures (Allam, Abd Algany, & Khider, 2024).

The International Commission on Radiological Protection (ICRP) outlines three fundamental principles: optimization, justification, and dose limitation. These principles are essential given the unique health risks associated with radiation

exposure in patients. When ionizing radiation is administered at appropriate levels for specific medical purposes, it can significantly outweigh potential harms, making strict dose limits less applicable (Behzadmehr et al., 2020)
As a result, Diagnostic Reference Levels (DRLs) are often utilized as benchmarks for medical radiation practices, providing guidance in situations where formal dose limits are not established (Bolowia, 2025).
To mitigate the risks associated with radiation exposure, it is essential that each medical use of ionizing radiation is justified, and that imaging procedures are optimized for safety. Justification means that the imaging examination must provide significant clinical benefits and be deemed medically necessary (Anim-Sampong et al., 2023). Conversely, optimization involves ensuring that radiation doses are kept to the minimum necessary for effective imaging, adhering to the principle of as Low as Reasonably Achievable (ALARA) (Khalilia, 2025).
The aim of this study is to assess the awareness levels among radiology professionals in 11 hospitals located in Helmand City, investigate the underlying reasons for their inadequate performance in healthcare, and explore the effects of ionizing radiation on the human body.

Problem Statement
Radiology plays a critical role in healthcare delivery; however, there are significant deficiencies in the understanding of ionizing radiation risks and protective strategies among radiology personnel in Helmand, Afghanistan. This lack of awareness poses serious threats to the safety of both patients and healthcare workers. When staff members are not adequately informed about the dangers of radiation and the necessary precautions, it can lead to unnecessary exposure, which may have lasting health implications (Fujiwara et al., 2024). Therefore, it is essential to prioritize education and training on radiation safety to improve practices and protect all individuals involved in radiological procedures within Helmand's medical institutions.

Significance of the Study
This study is significant as it seeks to illuminate the awareness levels of radiology professionals in Helmand City, which is crucial for enhancing patient safety and healthcare quality. By identifying the factors contributing to inadequate performance in healthcare settings, the research aims to address knowledge gaps and implement effective training programs. Furthermore, understanding the effects of ionizing radiation on the human body will contribute to the development of improved safety protocols, ultimately safeguarding both patients and healthcare workers. This study's findings could serve as a foundation for policy changes and educational initiatives, fostering a culture of safety and awareness in radiological practices.

Scope of the Study
This study focuses on evaluating the awareness levels of radiology workers in 6 hospitals in Helmand City, Afghanistan. It encompasses a comprehensive assessment of knowledge regarding ionizing radiation risks and safety measures. The research will examine the potential health effects of ionizing radiation for both Government and private hospitals. The findings will be relevant to healthcare providers, policymakers, and educational institutions aiming to enhance radiation safety practices and improve overall healthcare delivery in the region.

Research Questions
This study aims to explore the following questions:
1. What is the current level of awareness regarding ionizing radiation risks and protective measures among radiology workers in Helmand City hospitals?
2. What factors contribute to the inadequate performance of radiology staff in adhering to safety protocols related to ionizing radiation?
3. What are the perceived health effects of ionizing radiation among healthcare workers and patients in the radiology departments of hospitals in Helmand City?

2. Materials and Method

Study Design
This research utilized a descriptive design to assess the awareness levels of radiological staff in the outpatient department (OPD).

Participants
The study involved 100 healthcare professionals, including radiologists, doctors, and nurses, sampled from eleven hospitals in Helmand City.

Data Collection
A structured questionnaire was developed to gather information on participants' understanding of ionizing radiation hazards and safety protocols. The questionnaire comprised two sections:

1. Demographic Information: This section collected details such as age, gender, marital status, work experience, profession, qualifications, health status, and concerns regarding radiation exposure.

2. Awareness Assessment: The second section evaluated the staff's awareness of the risks associated with hazardous radiation in their practice.

Scoring and Analysis

Responses were scored with one point for each correct and incorrect answer. The total scores were categorized into three awareness levels: low (0-7 points), medium (8-14 points), and high (15-20 points). Data analysis was performed using SPSS software to calculate descriptive statistics. The analysis process included data transcription and coding to identify key themes and insights.

3. Results

A total of 78 questionnaires were distributed across various hospitals, yielding a response rate of 78% (N=100). All participants completed the questionnaire in full. The dataset includes biographical information and responses regarding awareness levels, assessed through multiple questions.

Average Age: Participants had an average age of 33.3 years, with a range from 20 to 50 years.

Gender Distribution: The majority of respondents were male (84.6%) and female (15.4%).

Professional Background*:* Participants primarily consisted of medical doctors and radiographers.

Work Experience*:* Participants' work experience varied from 1 to 30 years.

Detailed profiles of the healthcare workers from the eleven hospitals in Helmand City are summarized in Table 1.

Table 1: Distribution of the demographic features of doctors and Radiographers

	Doctors	Radiographers	Total Number	Percentage (%)
Sex (n)				
Male	56	10	66	84.6%
Female	12	0	12	15.4%
Age(year)				
20-30	64	8	72	92.3%
31-40	4	2	6	7.7%
41-50	0	0	0	0.0%
Marital status				
Single	22	0	22	28.2%
Married	46	10	56	71.8%
Qualification				
Bachelor	68	10	78	100.0%
Master	0	0	0	0%
Profession	68	10	78	100.0%

Table 2: Distribution of Participant Characteristics

Characteristics	Total Number	Percentage
Fear		
Yes	56	71.8%
No	22	28
Health Status		
Normal	78	100%
Work Experience (Year)		
1-10	76	97.4%

21-30	2	2.6%
31-40	0	0%

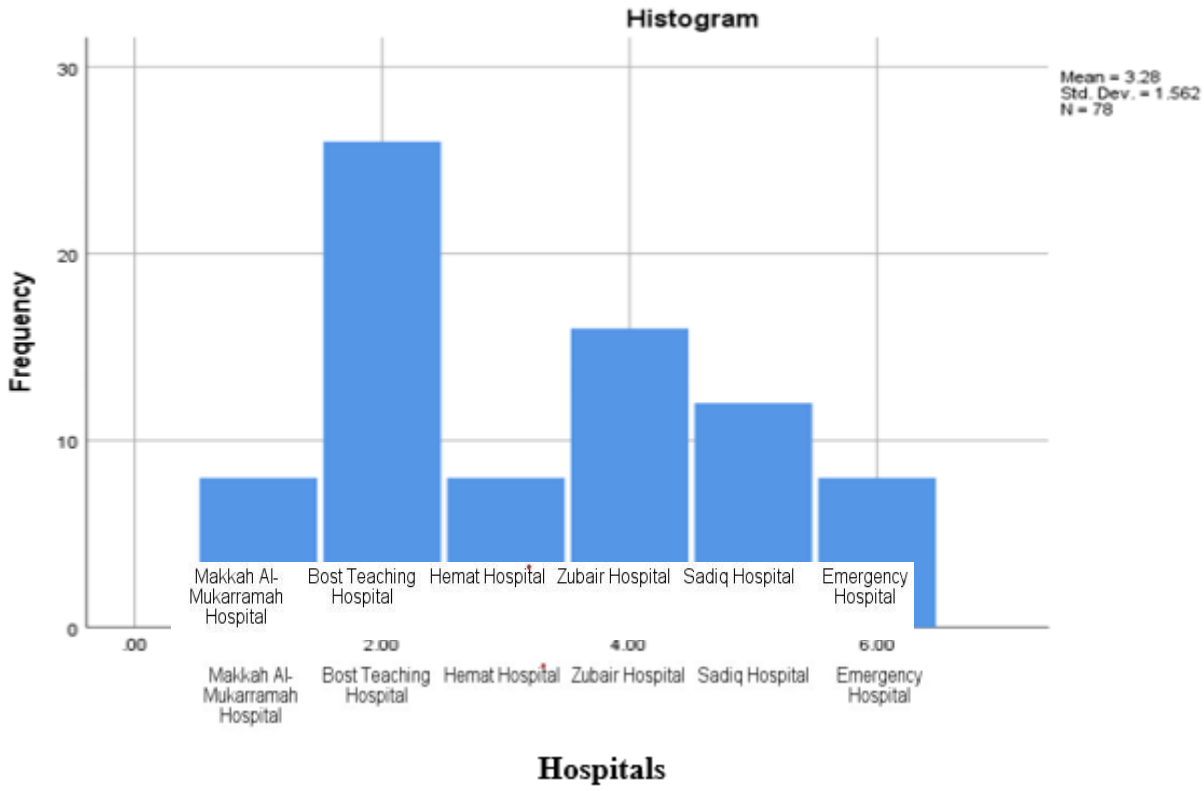

Figure 1. Participation of hospitals staff

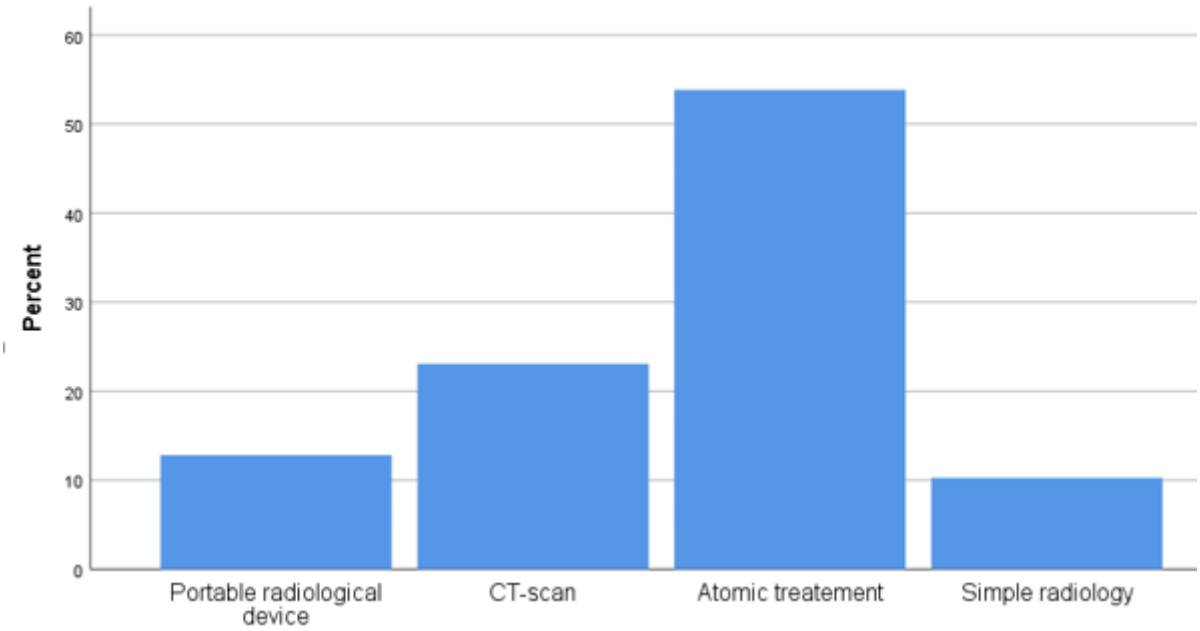

Figure 2. Bar chart demonstrates the count of participants if they know which instruments produces more radiations?

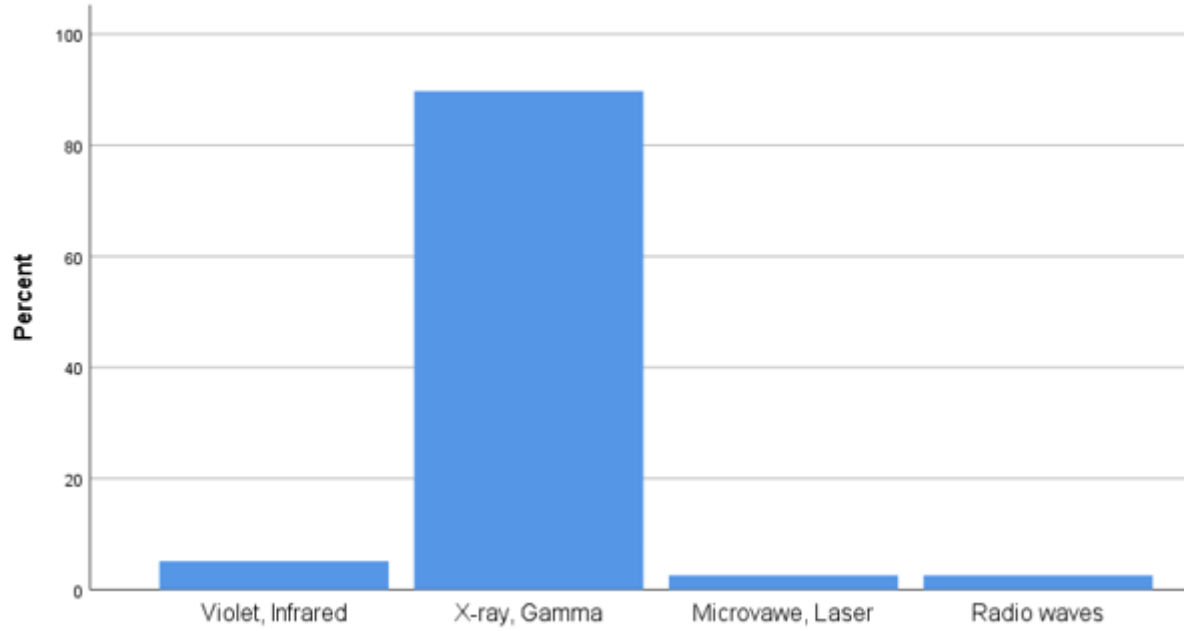

Figure 3. Bar chart demonstrates the count of participants if they know which radiations are ionic?

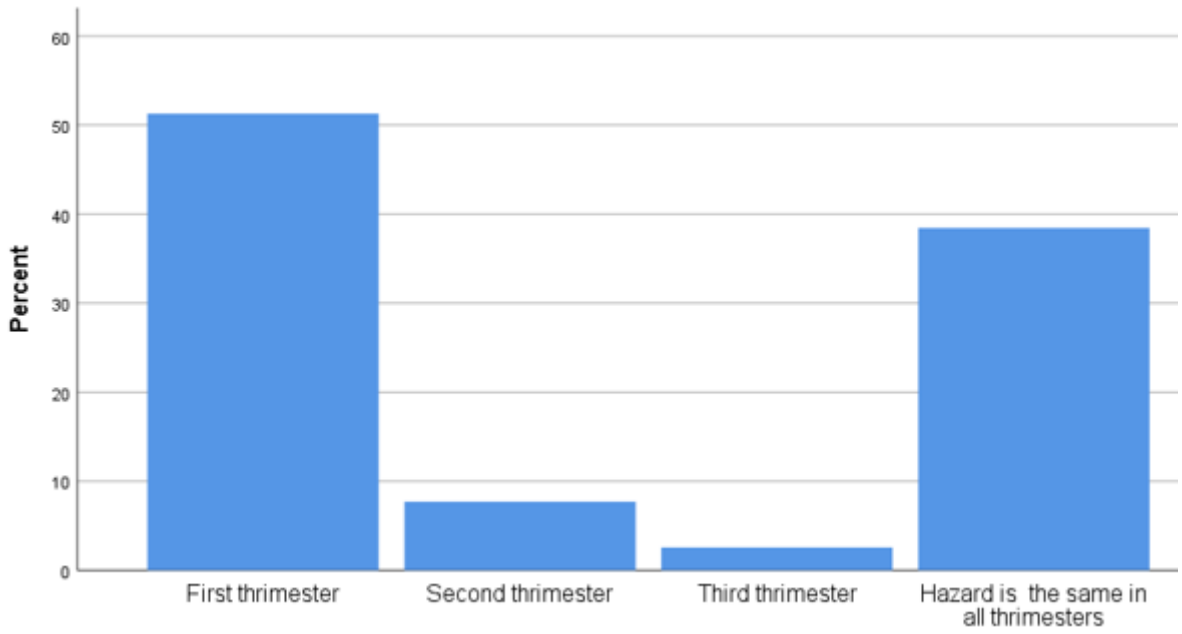

Figure 4. Bar chart demonstrates the count the participants sure about the sufficient awareness about ionizing radiations to pregnant patients?

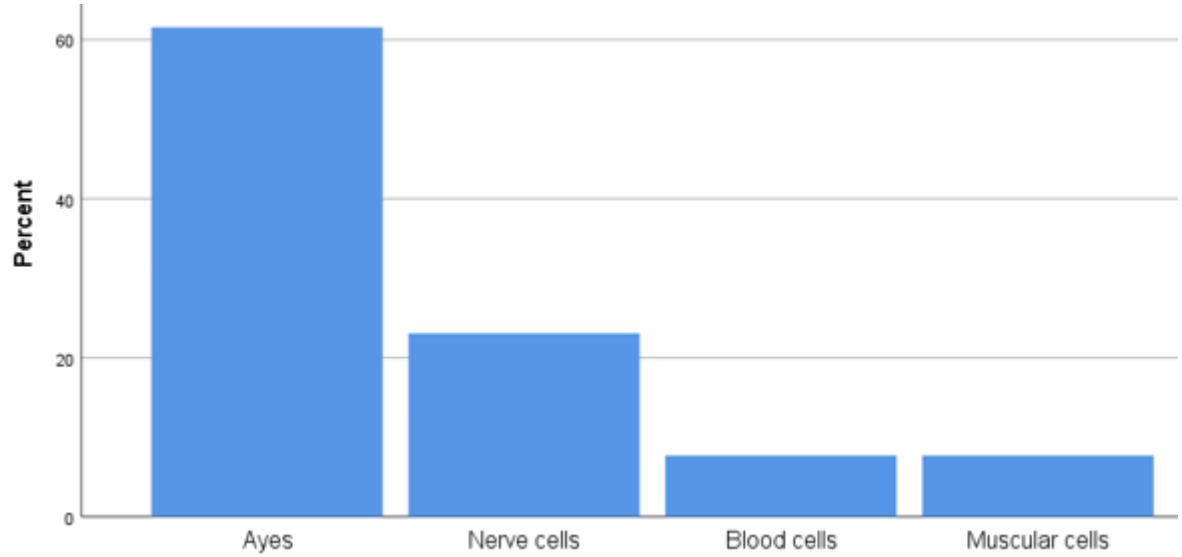

Figure 5. Bar chart demonstrates the count the participants sure which parts of the body are sensitive to radiations?

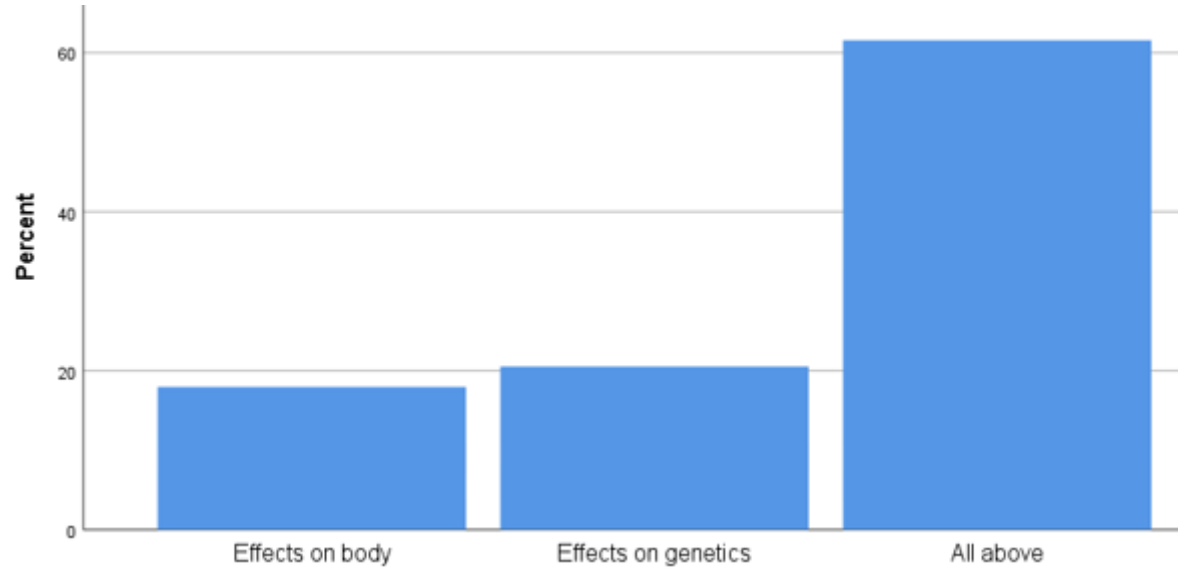

Figure 6. Bar chart demonstrates the count the participants understanding biological effects of radiations on human body?

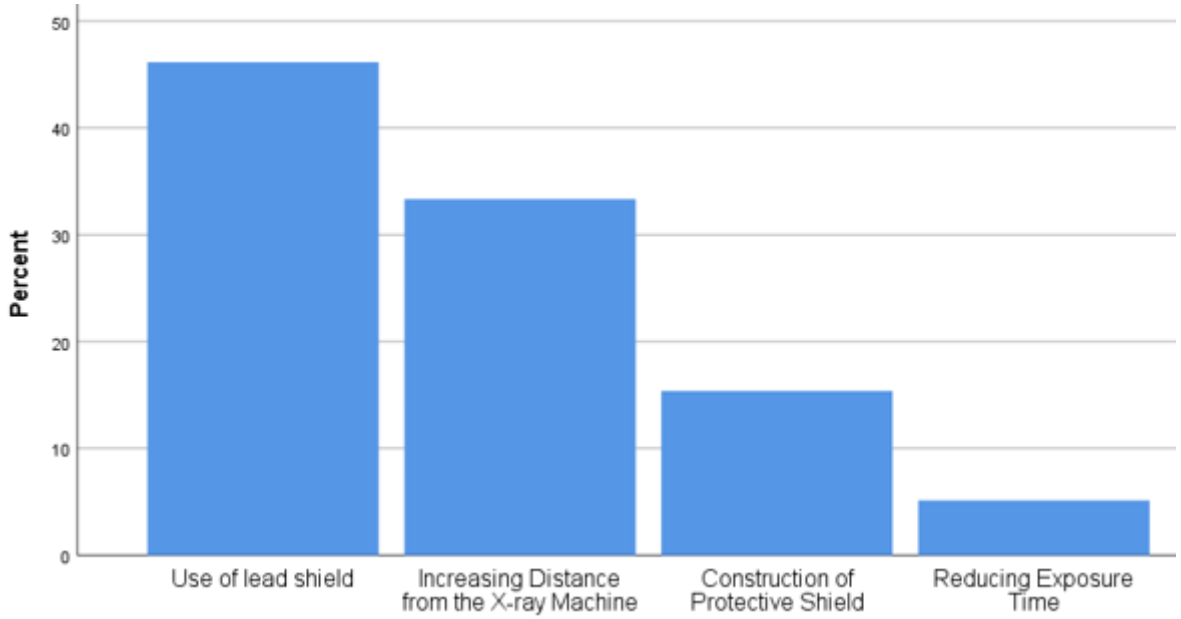

Figure 7. Bar chart demonstrates the count of awareness level of participants about the factors that reduces x-rays?

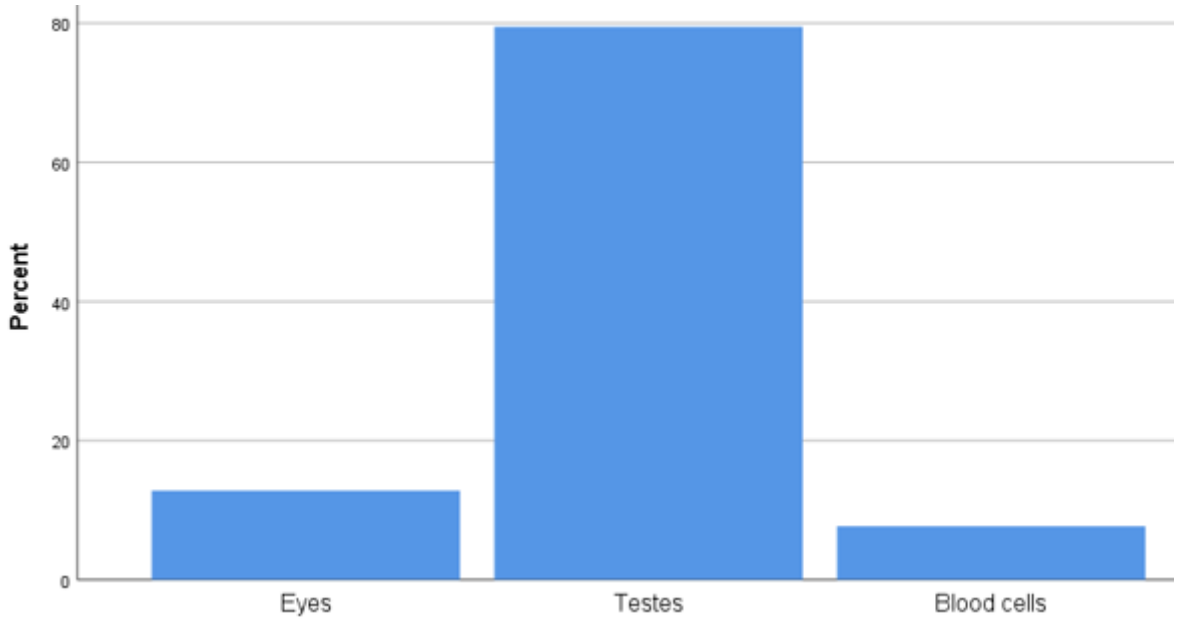

Figure 8. Pie chart demonstrates the count of participants if they know which parts of the body is more sensitive to ionizing radiations?

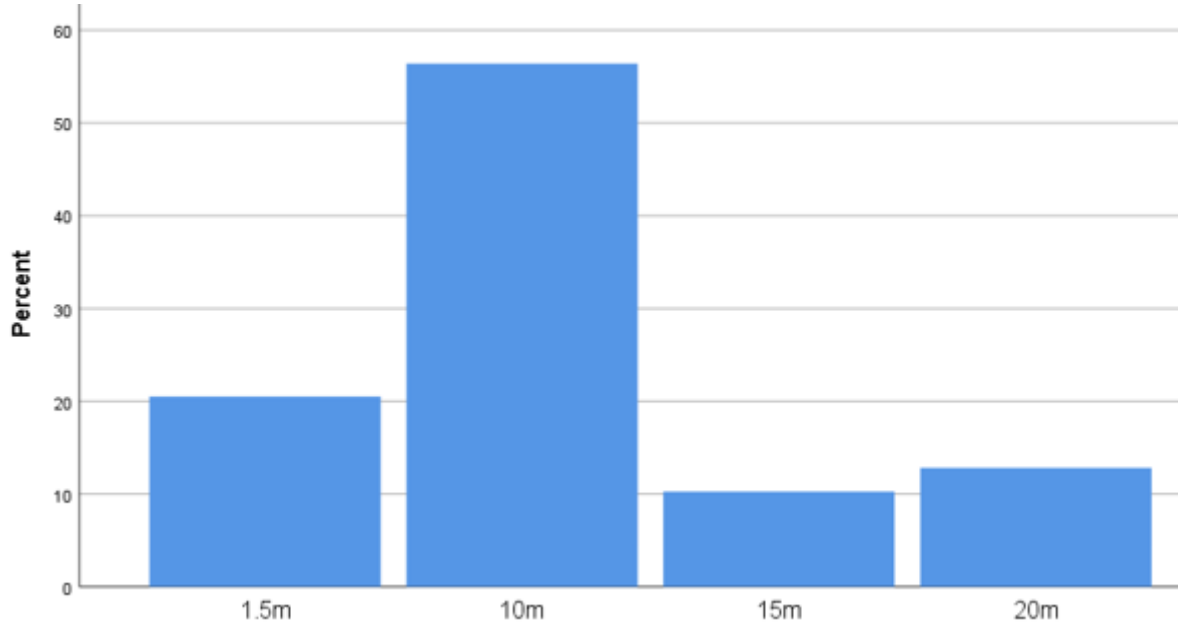

Figure 9. Pie chart demonstrates the count the participants know the portable distance of radiography machine and user?

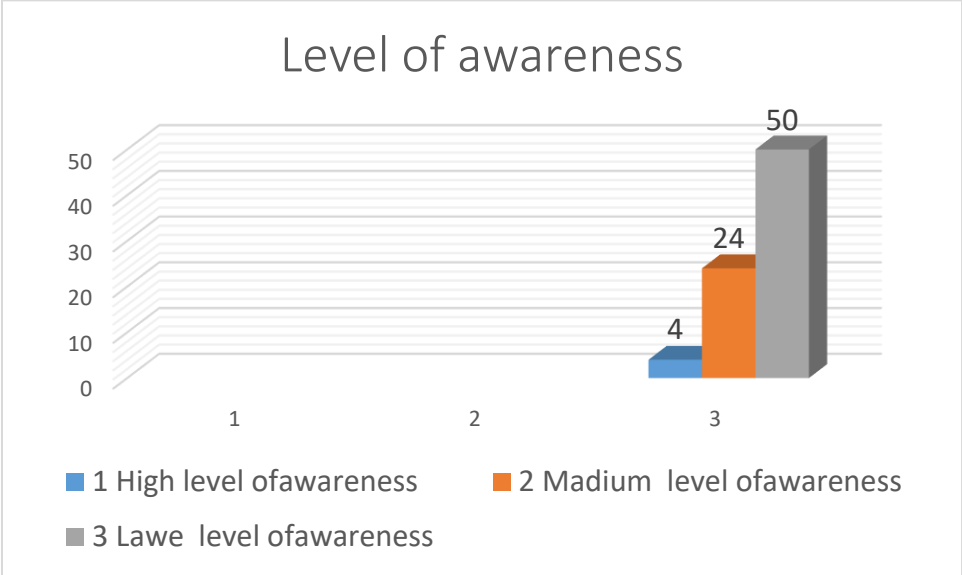

Figure 10. Evaluation of radiological staff awareness level

4. Discussion

This study represents a crucial effort to evaluate knowledge and awareness about radiation hazards and protective measures among doctors and radiographers in 6 hospitals in Helmand City, Afghanistan. The findings reveal significant insights into the understanding of radiation safety among healthcare professionals in this region.

The data indicates that a substantial majority of participants (53.8%) correctly identified atomic treatment as the procedures that produce the most radiation. However, only a minority recognized simple radiology. This suggests a need for enhanced educational initiatives regarding the various types of radiological procedures and their associated risks. The awareness level concerning ionizing radiation is noteworthy, with 89.7% of respondents correctly identifying X-rays and gamma rays. Nonetheless, 10.3% displayed a lack of understanding, indicating a gap in knowledge that could lead to unsafe practices. Furthermore, misconceptions surrounding non-ionizing radiation types, such as ultraviolet and infrared, highlight the necessity for comprehensive training. Regarding the risks of ionizing radiation during pregnancy, 51.3% of participants believed that risks are consistent across first trimester. This misunderstanding could have serious implications for patient safety, emphasizing the importance of targeted educational programs that clarify the varying sensitivities at different stages of pregnancy (Assiri et al., 2024).

Participants demonstrated awareness of the sensitivity of various body parts to radiation, with 61.5% identifying the eyes as particularly vulnerable. However, the lower recognition of other sensitive areas, such as blood cells and muscle cells, underscores the need for further education on the biological effects of radiation exposure.

In terms of protective measures, 46.2% of respondents recognized the importance of lead shielding, while only 33.3% understood the necessity of increasing distance from the X-ray machine. This indicates a gap in knowledge regarding other essential protective practices, such as creating barriers and reducing exposure time, which were noted by only a small percentage of participants.

The study found that only 4% of the staff had a high level of awareness regarding radiation hazards, with 50% categorized as having low awareness and 24% in the medium range. This aligns with findings from other studies, where significant percentages of healthcare professionals demonstrated similar gaps in knowledge.

Overall, the findings highlight the critical need for ongoing education and training to ensure that healthcare workers are well-informed about radiation hazards and protective measures, ultimately enhancing patient safety and care quality.

5. Conclusion

This study underscores the urgent need for improved awareness of radiation hazards among doctors and radiographers in Helmand City, Afghanistan. Although many participants recognized the risks associated with ionizing radiation, significant gaps in knowledge persist, particularly regarding non-ionizing radiation and protective measures.

The low levels of awareness about safety practices, such as lead shielding and appropriate distances from X-ray machines, highlight the necessity for targeted educational programs. By enhancing understanding of radiation safety, healthcare professionals can better protect themselves and their patients. Future efforts should focus on evaluating the effectiveness of these educational initiatives to ensure improved practices in radiographic settings.

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