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ASSESSMENT OF KNOWLEDGE AND AWARENESS ABOUT BASICS OF RADIATION SAFETY MEASURES AMONG HEALTH CARE PROFESSIONALS, INCLUDING RADIOGRAPHERS AND STUDENTS OF MEDICAL IMAGING TECHNOLOGY AT TERTIARY CARE SETUP IN PAKISTAN

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Abstract

Objectives: *To determine knowledge and awareness about basic radiation safety measures among health care professionals.*

Study Design:
Cross-Sectional Study

Place and Duration of Study:
AFIRI Rawalpindi, Pakistan, for a duration of six months from April 2023 to September 2023.

Methodology:
The Study included 385 health care professionals, including radiographers and students of medical imaging technology. Convenience sampling was performed after consent. A World Health Organization modified questionnaire was used regarding questions related to knowledge and awareness of basic radiation safety, which included 8 questions regarding knowledge categories into good, satisfactory, and unsatisfactory knowledge, and 9 questions regarding attitude categories into very good, good, satisfactory, and unsatisfactory awareness. Respondents were asked to them.

Results:
Out of 385 respondents, 129 (33.5%) were male, and 256 (66.5%) were female. The consultant radiologist had good knowledge of 90% and good awareness of 90% and radiographers had unsatisfactory knowledge of 45.4% and unsatisfactory awareness of 36.3%.

Conclusion:
Consultant radiologists and trainee radiologists showed good knowledge and awareness. But the knowledge and understanding are unsatisfactory or below satisfactory in radiographers.

INTRODUCTION

Radiation plays a vital role in the modern healthcare system, particularly in diagnostic imaging. World Health Organization (WHO) reports that advances in medical technology have led to increased public exposure to radiation from artificial sources, especially

within healthcare settings.[1] Radiological examinations are indispensable for the diagnosis and management of numerous medical and dental conditions. However, the widespread availability and superior diagnostic yield of advanced imaging modalities such as computed tomography (CT) and cone beam computed tomography (CBCT), compared with conventional radiography, have resulted in their frequent use even in situations where such investigations may not be clinically justified. [2]

Technological advancements in diagnostic radiology have significantly increased patient exposure to ionizing radiation, with CT accounting for approximately 50% of total medical radiation exposure.[3] Epidemiological estimates suggest that radiation exposure from CT imaging may contribute to up to 15% of future cancer cases in the United States.[3] Ionizing radiation (IR), routinely used in diagnostic radiography, can exert both beneficial and harmful biological effects. These effects are broadly categorized into deterministic and stochastic effects.[4] Deterministic effects are dose-dependent and occur beyond a threshold level, whereas stochastic effects arise from sublethal radiation-induced DNA damage and may occur without a defined threshold.

Radiation protection encompasses measures designed to protect individuals and the environment from the harmful effects of exposure to ionizing radiation. [5] the fundamental principles of radiation protection include reducing exposure time, maximizing distance from the radiation source, utilizing the proper shielding are all examples of protection. Additionally, radiation protection is guided by three core principles: justification of exposure, optimization in accordance with the ALARA (As Low as Reasonably Achievable) principle, and dose limitation. [6] A sound understanding of radiation sources, biological effects, and protective strategies is therefore essential. Although radiation-based procedures are considered safe when appropriately used, failure to adhere to safety protocols and the ALARA principle may result in adverse biological effects. Insufficient knowledge regarding radiation protection and dose limitations among healthcare professionals has been identified as a major contributor to radiation-related risks.[7] In response, recent initiatives involving equipment manufacturers, educational institutions, and radiation protection organizations have focused on reducing radiation exposure and improving awareness among healthcare workers and patients.[8] Despite these efforts, radiation protection issues persist, largely due to inadequate knowledge and misconceptions among radiology practitioners regarding radiation hazards and permissible dose limits.[9]

Referring physicians play a critical role in radiation safety, as they are responsible for requesting radiological investigations and balancing their diagnostic benefits against potential risks. Radiology professionals, including radiologists and technologists, also bear significant responsibility in selecting appropriate imaging modalities, optimizing exposure parameters, and communicating effectively with patients and referring clinicians when necessary. [10]

Therefore, the present study aims to assess the knowledge and awareness regarding the basics of radiation safety measures among healthcare professionals, including radiographers and students of medical imaging technology, at a tertiary care hospital in Pakistan.

Methodology:

This cross-sectional study was carried out on 385 health care professionals, including radiographers and students of medical imaging technology. Since there was no data available, we used the World Health Organization (WHO) calculator to determine the sample size and assumed a 50% prevalence of knowledge due to lack of prior local data, with a 95% confidence level and 5% margin of error. Based on these parameters, the calculated sample size was 385. Convenience sampling was performed to recruit participants for a duration of six months from April 2023 to September 2023.Althogh convenience sampling does not provide generalization selection, it allowed inclusion of wide range of healthcare professional workers within the available time frame and institution setting. Before the study began, all participants were given comprehensive study material, including goals, objectives, and explanations, and a written informed consent was obtained in accordance with the ethical research practices.

Inclusion Criteria: All healthcare professionals with professionals including consultant radiologists, trainee radiologists, house officers, radiographers, and students at medical colleges, including allied health sciences program. The ages of the respondents ranged from 18 to 50 years. All the respondents had experience of 1-5 years in their specific area.

Exclusion Criteria: All respondents who refused to provide informed consent and those with a psychological disorder or mental illness, as these could impair the ability to comprehend and respond to the questionnaire accurately.

Ethical approval was obtained from the Institutional Review Board of the Armed Forces Institute of Radiology and Imaging, Rawalpindi, Pakistan (IREB Reference No. AFIRI-RWP-ERB-APRVL-016). A WHO-modified questionnaire was used to collect data regarding both knowledge and awareness of radiation safety. The knowledge and behavior of study participants regarding radiation safety characteristics were evaluated; a score of 1 indicated a correct response, and 0 indicated a wrong response. Points were awarded accordingly and total scores were calculated for each respondent. Variable marks were added for the individual group. For knowledge assessment, 8 questions/ variables were asked, as whether x is harmful or not, the ALARA principle, the thickness of the lead apron, what thermoluminescent dosimeter TLD, the purpose of collimators, and the average effective dose of abdominal x-ray in diagnostic radiography.

Regarding awareness, 9 questions were asked covering practical and procedural aspects, including the use of fluoroscopes, lead aprons, thyroid collars, lead glasses, radiation dosimeters, the type of fluoroscope units, how much radiation dose you are exposed to after endoscopic fluoroscopy, have you attended any program or lecture on radiation exposure, and the last was the three principles of radiation protection. Knowledge and awareness were divided into 3 categories: scores 1-3 had unsatisfactory knowledge, scores 4-6 had satisfactory knowledge, and scores 7-8 had good knowledge. Similarly, for the awareness score, 1-3 had unsatisfactory awareness, scores 4-6 had satisfactory awareness, scores 7-8 had good awareness, and scores 9 had very good awareness. To ensure the reliability and validity of the questionnaire and earlier pilot study was carried out on 30 participants. Using kappa statistics, the result was 0.85, indicating a high reliability of questionnaire.

SPSS version 27.0 was used to record, enter, and analyze the data. For quantitative data such as knowledge and awareness were expressed as mean ± standard deviation (SD), and for qualitative data including gender, and other demographic variables were calculated and expressed as frequency and percentages. The association between professional category (consultants, trainee radiologists, radiographers, and MIT students) and radiation safety knowledge and awareness levels was evaluated using the Chi-square test. A statistically significant p-value was defined as ≤0.05 indicating a meaningful association between professional role and study outcomes.

Results:

This study was carried out on 385 respondents, out of which 129 (33.5%) were male and 256 (66.5%) were female. Gender distribution can be seen in Table I.

Table-I: Gender Distribution of Respondents

Serial No	Variable	Percentage
1	Male	129(33.5%)
2	Female	256 (66.5%)
3	Total	385 (100%)

Regarding age distribution out of 385 participants, 322 (83.6%) had an age between 18-30 years, 54 (14.02%) had an age between 31-40 years, and 9 (2.3%) had an age between 41-50 years. Age distribution can be seen in Table II.

Table-II: Age Distribution of Respondents

AGE GROUP (Years)	FREQUENCY (n)	PERCENTAGE (%)
18-30	322	83.6
31-40	54	14.02
41-50	9	2.3

Regarding professional distribution, most participants were Medical Imaging Technology (MIT) students, accounting for 211 (54.9%) of the study population, followed by trainee radiologists with 117 (30.5%) participants. Radiographers constituted 33 (8.5%) of the respondents, while medical doctors and consultant radiologists represented 14 (3.6%) and 10 (2.6%) of the respondents, respectively. This distribution reflects the greater availability and accessibility of students and trainees during the study period. Assessment using the WHO-modified questionnaire revealed varying levels of radiation safety knowledge and awareness across professional categories. Detailed comparisons of knowledge and awareness of basic radiation safety scores among these groups are presented in Table III.

Table-III: Knowledge and Awareness of Basic Radiation Safety Among Healthcare Professionals

Variables	Consultant Radiologist (10)	Medical Doctors (14)	Trainee Radiology (117)	Radiographers (33)	MIT Students (211)
Knowledge Related to Basic Radiation Safety					
Good	9 (90%)	4 (28.5%)	74 (63.2%)	8 (24.2%)	41 (19.4%)
Satisfactory	1 (10%)	7 (50%)	35 (29.9%)	10 (30.3%)	108(51.18%)
Unsatisfactory	0	3 (21.4%)	8 (6.8%)	15 (45.4%)	62(29.38%)
Attitude Related to Basic Radiation safety					
Very Good Awareness	6 (60%)	3 (21.4%)	54 (46.2%)	12 (36.4%)	57 (27.01%)
Good Awareness	3(30%)	5 (35.7%)	29 (24.8%)	4 (12.1%)	46(21.80%)
Satisfactory	1(10%)	4 (28.5%)	32 (27.4%)	5 (15.2%)	67 (31.75%)
Unsatisfactory	0 (0%)	2(14.3%)	2(1.7%)	12(36.4%)	41 (19.4%)

- MIT = Medical Imaging Technology

The results here show that amongst all the healthcare professionals, consultant radiologists exhibited highest level of both good knowledge and awareness regarding basic radiation safety, followed by trainee radiology. The medical doctors and MIT students had satisfactory or good knowledge and awareness. However, the knowledge and awareness of radiation safety is unsatisfactory or below satisfactory among the radiographers.

Discussion:

This cross-sectional study involving 385 healthcare workers represents one of the few recent investigations from Pakistan assessing both knowledge and awareness of basic radiation safety measures. The findings reveal substantial variation across professional groups, reflecting differences in training, clinical exposure, and institutional emphasis on radiation protection.

This study showed that radiographers (36.4%) had lower awareness compared to radiologists. These findings are consistent with previous studies conducted by Dogar et al. which also reported suboptimal awareness of radiation protection principles among non-radiology healthcare professionals.[3] This gap highlights the need for structured educational interventions,

inclusion of radiation safety modules in medical education, and regular refresher training programs to enhance awareness and promote safe clinical practices among non-radiology doctors. Improving these measures is essential not only for occupational safety but also to ensure patient protection during diagnostic imaging procedures.

In our study consultant radiologists demonstrated highest levels of knowledge and awareness, consistent with studies by Bukra et al., which reported better compliance with radiation safety principles among senior radiology staff. [4]This likely reflects structured postgraduate training and greater professional experience.

Studies from Saudi Arabia, Egypt, and Europe generally report higher awareness levels for radiation safety than observed in this study. [4,5,7,8] the comparatively lower awareness among Pakistani healthcare professionals' highlights lacks in training resources and institutional radiation safety programs. These findings emphasise the need to strengthen radiation safety infrastructure and reinforce institutional commitment to radiation protection practices.

According to the findings of this study, medical imaging technology (MIT) students demonstrated a high level of satisfactory knowledge (51.1%), while the proportion exhibiting very good awareness remained relatively low (27%). This disparity suggests that although students possess adequate theoretical understanding of radiation protection, their practical awareness and application may be limited. Similar observations have been reported by Fatima et al. and Khalilia, who emphasized that medical imaging students often receive sufficient classroom-based instruction but lack sufficient practical exposure to radiation protection. [9,10]

Like our findings where consultant (90%) and trainee radiologists (63.2%) showed higher knowledge and awareness, Alyousef et al. also reported that professionals directly involved in radiological procedures had better understanding of radiation safety principles.[11]

This study showed radiographers had lower awareness and knowledge levels as compared to radiologists, which aligns with the findings of Elghareeb Allam et al., who reported gaps in radiation safety compliance among healthcare workers exposed to ionizing radiation.[12] These results are also supported by the study findings of Benjelloun et al. where limited understanding of radiation safety practices were seen among operating room personnel who are non-radiology specialists.[13]

In our study radiographers demonstrated the poorest performance, with unsatisfactory knowledge (45.5%) and awareness (36.4%). Comparable findings were reported by Ageeli et al. and Safina et al., who observed poor adherence to radiation safety protocols among radiographers and allied health professionals.[6,14] These results also align with the findings by Karimov et al.[15], who reported limited knowledge about radiation safety and awareness of cancer risks from ionizing radiation among radiographers. Given their central role in imaging procedures, this gap poses a significant occupational and patient safety concern.

This study shows, MIT students had satisfactory knowledge (51.1%) but lower levels of very good awareness, which is consistent with the findings of Hassan et al. where medical imaging students generally demonstrate satisfactory theoretical knowledge but comparatively lower practical awareness of radiation safety. This highlights the need to integrate more practical radiation safety training into medical imaging education programs.[16]

We found that different professional groups had differing opinions about radiation safety. In a scoping assessment, McLean et al. [17] noted that although medical radiation specialists frequently comprehend radiation protection principles, there are still gaps in consistent application and safety culture, highlighting the significance of institutional support and ongoing training programs.

When compared with the results of the study of Partap et al., notable differences emerge in radiation safety knowledge among healthcare professionals. Partap and colleagues found that overall knowledge and practice of radiation safety were generally low in their cohort of 118 health professionals across various specialties, with a particularly poor understanding of basic safety practices such as correct positioning of the image intensifier and safe distances from ionizing radiation equipment.[18]In contrast, our

study showed higher overall knowledge and awareness scores, particularly among consultant and trainee radiologists, medical doctors, and MIT students.

Conclusion:

Consultants and trainee radiologists demonstrated good knowledge and awareness of radiation safety measures, whereas radiographers showed inadequate knowledge and awareness regarding basic radiation safety. These findings emphasize the need for structured, interdisciplinary radiation safety programs, particularly targeting radiographers and non-radiological healthcare professionals to overcome the gaps in practical understanding and radiation safety among patients.

Limitations:

This study was limited by being single-centre design and the use of convenience sampling, which may impact on generalizability. Bias may be introduced using self-reported surveys and unequal representation of groups. Practical radiation safety practices were not assessed, and associations with risk factors such as experience or prior training could not be evaluated.

Conflict of Interest:

There is no conflict of interest.

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