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KNOWLEDGE, ATTITUDE, AND PRACTICE REGARDING RADIATION PROTECTION AMONG HEALTHCARE WORKERS AT A TERTIARY CARE HOSPITAL IN D.I. KHAN, PAKISTAN: A CROSS-SECTIONAL STUDY

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Abstract

Background: Ionizing radiation is used extensively in medical diagnosis and therapy but is a hazard to healthcare workers (HCWs) who are routinely exposed during radiological procedures. To reduce this risk, adequate knowledge coupled with a positive attitude and safe practice with regards to radiation protection is essential.This study aimed to evaluate the Knowledge, Attitude and Practice (KAP) of health care workers on the issue of radiation protection in a tertiary hospital at D. I. Khan, Pakistan. **Methods**: A descriptive cross sectional study was carried out during 4 months (March – July 2026) in three health care settings in D.I. Khan BIO MED, DHQ Hospital and MMMH. Sample size was determined from the WHO sample size calculator (95% confidence level, 5% margin of error) and a sample of 218 HCWs occupationally exposed to ionizing radiation was selected by convenience sampling. A self-administered structured questionnaire with three sections: Demographic, Knowledge, and Attitude/Practice was used to collect data, which was analyzed in SPSS version 26, descriptive statistics (frequency and percent). **Results:** The majority of respondents held a diploma level qualification (65.6%) and had less than 5 years of experience (64.2%) with the majority being male (71.1%). Most of the personnel worked in X-ray departments (45.9%). 140 (64.2%) of the participants reported to know about the ALARA principle and 148 (67.8%) knew about the cardinal principles of radiation protection, while only 81 (37.1%) knew about TLD badges/pocket dosimeters and only 60 (27.5%) about annual radiation dose limits. Of the respondents, 156 (71.5%) reported using a regular lead apron and 183 (83.9%) reported using a personal dosimeter, while only a small fraction of respondents reported using lead gloves (14.6%), thyroid collars (19.2%) or goggles (5.9%). In total, 130 (59.6%) used the cardinal principles of radiation protection consistently throughout procedures. **Conclusion:** HCWs in this setting had moderate knowledge of fundamental radiation safety principles and decent adherence to the use of lead apron and dosimeters but significant lack of knowledge or use of S.P.E. and knowledge of annual dose limits. These gaps are recommended to be addressed through structured training, incorporation of radiation safety content into allied health curricula, and frequent oversight and monitoring of the work.

Keywords: Radiation protection; Healthcare personnel; Health knowledge, attitudes, practice; ALARA principle; Occupational exposure; Personal protective equipment.

INTRODUCTION

Energy that can liberate an orbital electron from an atom to which it is interacting is called ionizing radiation. The annual dose received due to natural background radiation is ~3 mSv per year, which is about the same as the dose received due to man-made radiation sources (1). The use of ionizing radiation in diagnostic and therapeutic procedures has grown significantly in the past few decades as imaging technology in medicine has made progress (2).

In the context of their work, healthcare workers (HCWs) are routinely exposed to ionizing radiation. This frequent exposure to work can cause changes in the normal function of the cells DNA, with immediate (acute) effects such as dermatitis, hair loss, etc., and delayed (long term) effects such as cataracts, genetic damage, malignancy, etc. The relative risk of cancer for occupationally exposed HCWs is estimated to be 40% higher than that for patients and the general population (3). International organizations, including the International Radiation Protection Association have as a consequence introduced dose-limitation procedures, and the International Commission on Radiological Protection (ICRP) has expressed three principles for radiation protection, which underpin the ALARA principle (As Low As Reasonably Achievable) (4). In the world, there is estimated to be 2.3 million HCWs working in radiation related modalities, of which 50% is man-made ionizing radiation (5).

The dose limits for an occupationally exposed worker may differ from those set for the general public. The effective dose limit is 20 mSv/year for occupational exposure and higher dose limits are allowed for the eye lens (150 mSv/year), skin (500 mSv/year) and extremities (500 mSv/year) (6,7). Such national registries (in South Korea, for example, the national radiation dose register) can demonstrate the importance of systematic monitoring: In 2014, the average radiation dose for radiation workers who were tracked was 0.04 mSv per year, and the average dose per year was continuously decreasing over 5 years (8).

Radiation shielding is the main principle of safe practice and HCWs need to be aware of the risks associated with exposure to ionising radiation and the techniques that can be used to reduce these risks (9,10). Institutional radiation safety procedures are based on the principles of justification, optimization, and limitation of the ICRP, and the principle of ALARA is used to reduce the personal and collective radiation doses of individuals (11). Practical safeguards are established, such as distance from the primary beam, consistent use of the apron, wearing of a dosimeter, and wearing the thyroid shielding and gonadal shielding during procedures, as well as avoiding unnecessary repeat exposures and mechanical immobilization instead of manual immobilization of the patient during procedures (12). Although enormous patient benefit is derived from the use of ionizing radiation, the use of this radiation is a double-edged sword: An estimated 7 million HCWs worldwide are exposed to radiation doses yearly due to their occupational activity (13).

A number of studies in a variety of contexts have found knowledge gaps regarding radiation protection among non-radiology personnel, variable attitudes towards use of protective equipment, and suboptimal use of safe practice, despite training that is often inadequate, and equipment availability and complacency (14). But the evidence from tertiary care settings in the southern region of Khyber Pakhtunkhwa, Pakistan is limited and local generated evidence is required to guide institutional policies and training priorities.

1.1 Problem Statement

Although radiation is widely used in the medical diagnosis and treatment of patients, HCWs still exhibit poor knowledge, poor attitudes and unsafe practices related to radiation protection. There is an equal need to systematically evaluate KAP among HCWs as a basis for targeted intervention and building institutional radiation safety culture.

1.2 Aim and Objectives

The objective of this study was to assess the knowledge, attitude, and practice about radiation protection among healthcare workers who are at risk of exposure to ionizing radiation while working in a tertiary care hospital in D.I. Khan. Specifically, the objectives were to:

- Determine HCWs' awareness of radiation hazards and precautions.

Assess HCW attitudes to radiation protection and radiation safety procedures.

- Identify practices of HCWs to reduce occupational exposure to ionizing radiation.

Discuss awareness and application of ALARA principle in HCWs.

MATERIALS AND METHODS

The current study was a descriptive cross-sectional study that aimed to evaluate the knowledge, attitudes and practices about radiation protection among the healthcare workers who are occupied with ionizing radiation. The cross-sectional design gave a snapshot of the awareness and safety practices in place and allowed the identification of gaps in the selected health care facilities. The study was carried out from three health care facilities (HCFs - BIO MED, DHQ Hospital, Mufti Mehmood Memorial Teaching Hospital (MMMH)) which were selected to represent a broad spectrum of HCWs involved in the diagnostic and therapeutic radiological services provided in the hospitals.

Study Duration

The data collection, analysis and reporting period was from March to July 2026 for four months.

Analyze the sample size and sampling technique. Discuss the sample size and sampling technique.

A minimum of 218 respondents was determined with the use of WHO sample size calculator for descriptive studies with 95% confidence level, a 5% margin of error, and an estimated prevalence from similar preceding KAP studies. A convenience sampling technique was used, and HCWs who were available and included in the study during the data collection period were approached and enrolled.

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Inclusion and Exclusion Criteria

Inclusion criteria: any healthcare worker occupationally exposed to ionizing radiation in the X-ray, CT scan, fluoroscopy, mammography or operating theatre (OT) departments, including radiographers, radiology technicians and radiologists and other allied health professionals who perform radiological procedures.

Exclusion criteria: Healthcare workers not occupationally exposed to sources of ionizing radiation and those who refused to join the study.

Data Collection Procedure

After getting the ethical approval and No Objection Certificate (NOC) a formal application was made to the department of Medical Imaging, Faculty of Allied Health Sciences, Gomal University, D.I. Khan. Official letters were sent to the administration of DHQ Hospital, BIO MED, and MMMH for permission to collect data at their premises on their approval. A self-administered, structured questionnaire was then constructed based upon existing literature and radiation-safety guidelines and administered to gather data. The instrument consisted of three sections: Section A (Demographic characteristics) and Section B (Knowledge) and Section C (Attitude and safe practices) both Sections B and C had dichotomous (Yes/No) responses and the questionnaire was completed individually to ensure honest and unbiased responses.

Statistical Analysis

Data were coded, entered and analyzed using the SPSS version 26. Descriptive statistics such as means, standard deviations, frequencies, and percentages were used for quantitative variables (e.g., age and years of experience). The answers to the items on knowledge, attitude and practice were categorized and presented as frequencies, percentages and tabulated.

Ethical Considerations

The study was carried out on the basis of the Declaration of Helsinki ethical principles. The ethical approval was received from the Department of Medical Imaging, Faculty of Allied Health Sciences, Gomal University, D.I. Khan. The purpose of the study was explained to all participants and informed written consent was obtained before the participants took part. Respondents' confidentiality and anonymity was ensured during data collection, analysis and reporting.

RESULTS

A total of 218 questionnaires were self-administered and were included in the final analysis and were 100% complete of all approached and eligible questionnaires. The results below are presented based on the three sections of the questionnaire: demographic characteristics, knowledge, and attitude/practice.

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Demographic Characteristics

Of the 218 participants, 155 (71.1%) were male and 63 (28.9%) were female (Table 1, Figure 1). As far as educational attainment, 143 (65.6%) had a diploma, 55 (25.2%) a bachelor's degree and 20 (9.2%) higher (postgraduate) education (Table 2, Figure 2). With respect to department of work, 100 (45.9%) participants worked in X-ray, 55 (25.2%) in CT scan, 29 (13.3%) in fluoroscopy, 18 (8.3%) in the operating theatre, and 16 (7.3%) in mammography (Table 3, Figure 3). By years of experience, 140 (64.2%) had less than 5 years, 60 (27.5%) had 5–10 years, and 18 (8.3%) had more than 10 years of service (Table 4, Figure 4).

Table 1: *Gender Distribution of Participants (N = 218)*

Gender	Frequency	Percent (%)
Male	155	71.1
Female	63	28.9
Total	218	100.0

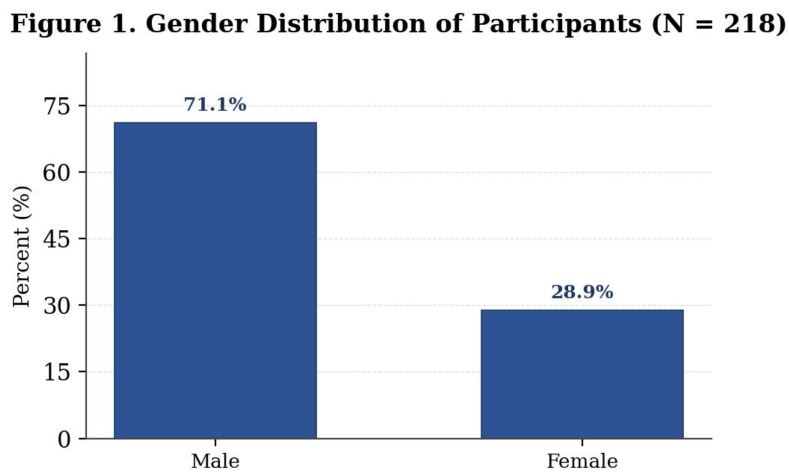

Figure 1. Gender distribution of participants (N = 218).

Table 2: *Educational Level of Participants (N = 218)*

Education Level	Frequency	Percent (%)
Diploma	143	65.6
Bachelor's Degree	55	25.2
Higher Education	20	9.2

Education Level	Frequency	Percent (%)
Total	218	100.0

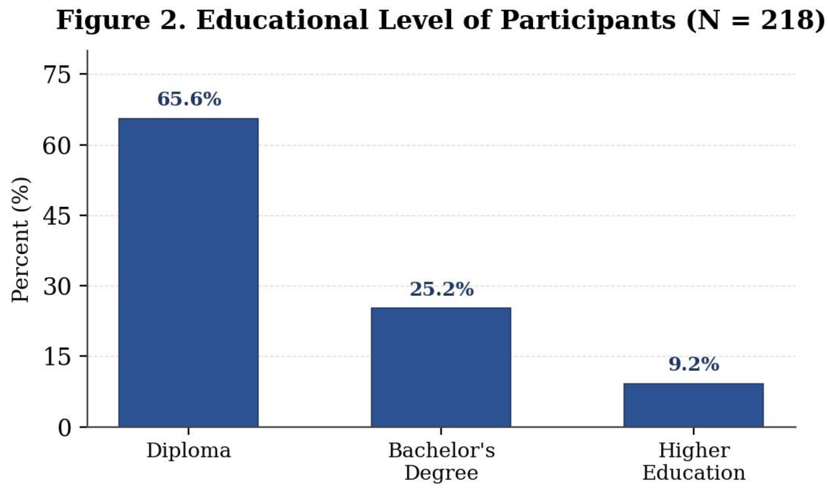

Figure 2. Educational level of participants (N = 218).

Table 3: *Department-wise Distribution of Participants (N = 218)*

Department	Frequency	Percent (%)
X-Ray	100	45.9
CT Scan	55	25.2
Fluoroscopy	29	13.3
Operating Theatre (OT)	18	8.3
Mammography	16	7.3
Total	218	100.0

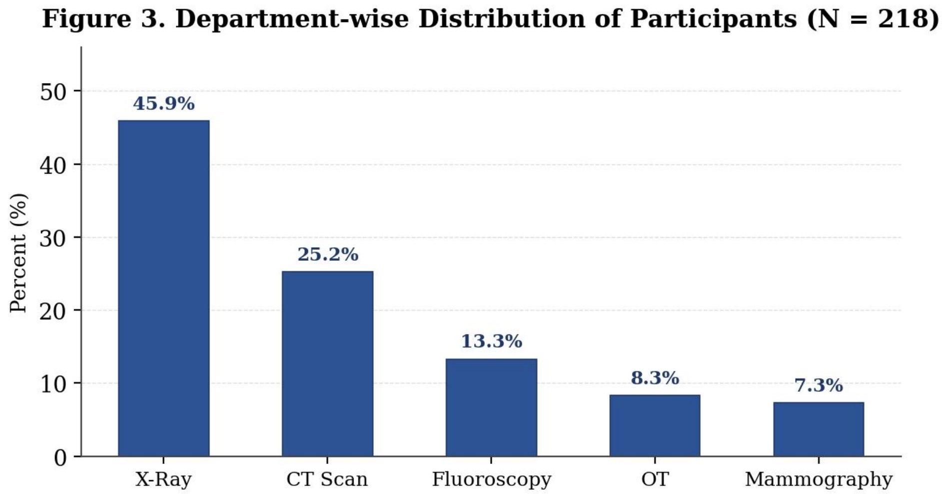

Figure 3. Department-wise distribution of participants (N = 218).

Table 4: *Years of Professional Experience (N = 218)*

Experience	Frequency	Percent (%)
Less than 5 years	140	64.2
5–10 years	60	27.5
More than 10 years	18	8.3
Total	218	100.0

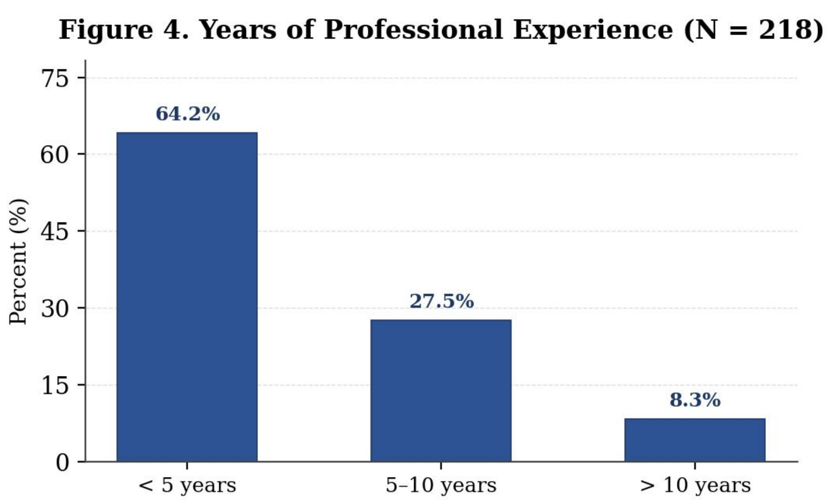

Figure 4. Years of professional experience among participants (N = 218).

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Knowledge Regarding Radiation Protection

Knowledge of the ALARA principle was reported by 140 (64.2%) participants, while 78 (35.8%) lacked this knowledge. Awareness of TLD badges or pocket dosimeters was limited, with only 81 (37.2%) participants reporting familiarity, compared with 137 (62.8%) who did not. Knowledge of ionizing radiation and its associated risks was reported by 105 (48.2%) participants, while 113 (51.8%) lacked this awareness. Knowledge of the cardinal principles of radiation protection was relatively high, reported by 148 (67.9%) participants. In contrast, awareness of annual radiation dose limits was markedly low, reported by only 60 (27.5%) participants, while 158 (72.5%) had no such knowledge. Knowledge of radiation protection equipment was reported by 123 (56.4%) participants (Table 5, Figure 5).

Table 5: *Knowledge of Healthcare Workers Regarding Radiation Protection (N = 218)*

Knowledge Item	Yes, n (%)	No, n (%)
Awareness of the ALARA principle	140 (64.2)	78 (35.8)
Awareness of TLD badge / pocket dosimeter	81 (37.2)	137 (62.8)
Knowledge of ionizing radiation and related risks	105 (48.2)	113 (51.8)
Knowledge of cardinal principles of radiation protection	148 (67.9)	70 (32.1)
Awareness of annual radiation dose limits	60 (27.5)	158 (72.5)
Knowledge of radiation protection equipment	123 (56.4)	95 (43.6)

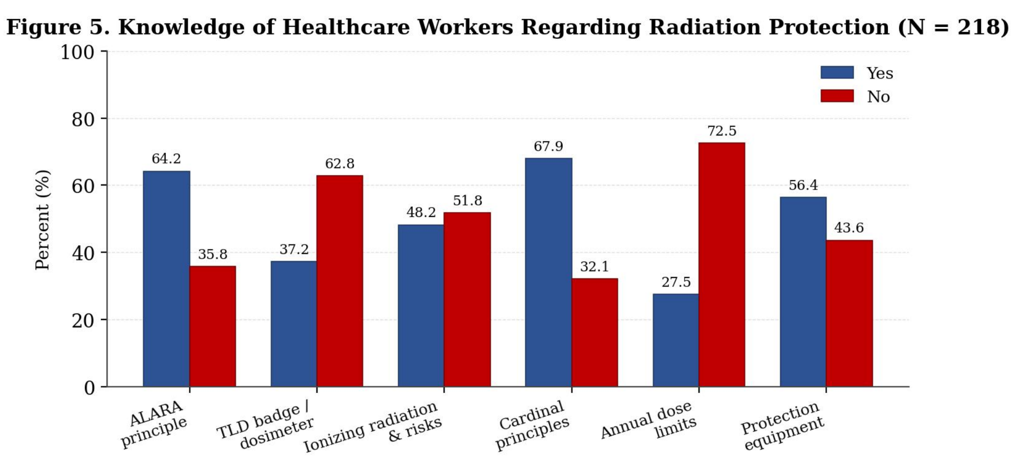

Figure 5. Knowledge of healthcare workers regarding radiation protection (N = 218).

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Attitude and Safety Practices

Regarding protective practices, 156 (71.6%) participants reported regular use of a lead apron, while 62 (28.4%) did not. Use of lead gloves was reported by only 32 (14.7%) participants, with the large majority (186, 85.3%) not using them. Thyroid collar use during radiographic procedures was reported by 42 (19.3%) participants, compared with 176 (80.7%) who did not use this protection. Eye goggle use was the least common protective behavior, reported by only 13 (6.0%) participants, while 205 (94.0%) did not use them. Adherence to the cardinal principles of radiation protection during procedures was reported by 130 (59.6%) participants. Consistent use of a personal dosimeter while working was the most widely reported safe practice, observed in 183 (83.9%) participants (Table 6, Figure 6).

Table 6; ***Attitude and Practice of Healthcare Workers Regarding Radiation Protection (N = 218)***

Attitude/Practice Item	Yes, n (%)	No, n (%)
Regular use of lead apron	156 (71.6)	62 (28.4)
Use of lead gloves	32 (14.7)	186 (85.3)
Use of thyroid collar during radiography	42 (19.3)	176 (80.7)
Use of eye goggles	13 (6.0)	205 (94.0)
Adherence to cardinal principles during procedures	130 (59.6)	88 (40.4)
Consistent use of personal dosimeter while working	183 (83.9)	35 (16.1)

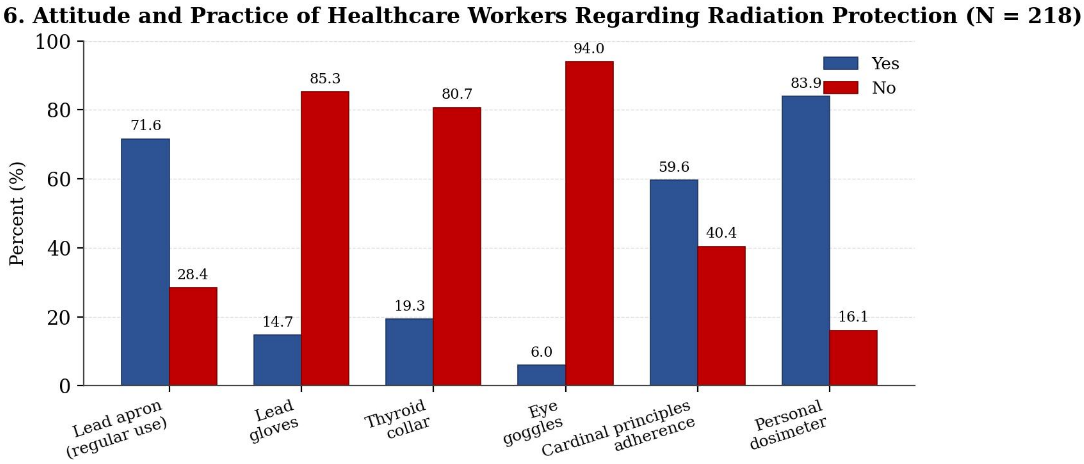

Figure 6. Attitude and practice of healthcare workers regarding radiation protection (N = 218).

Summary of Key Findings

Table 7: *Summary of Highest and Lowest Reported KAP Indicators (N = 218)*

Indicator	Category	n (%)
Highest reported practice	Personal dosimeter use	183 (83.9)
Lowest reported practice	Eye goggle use	13 (6.0)
Highest reported knowledge	Cardinal principles of radiation protection	148 (67.9)
Lowest reported knowledge	Annual radiation dose limits	60 (27.5)
Adherence to cardinal principles during procedures	Composite practice indicator	130 (59.6)

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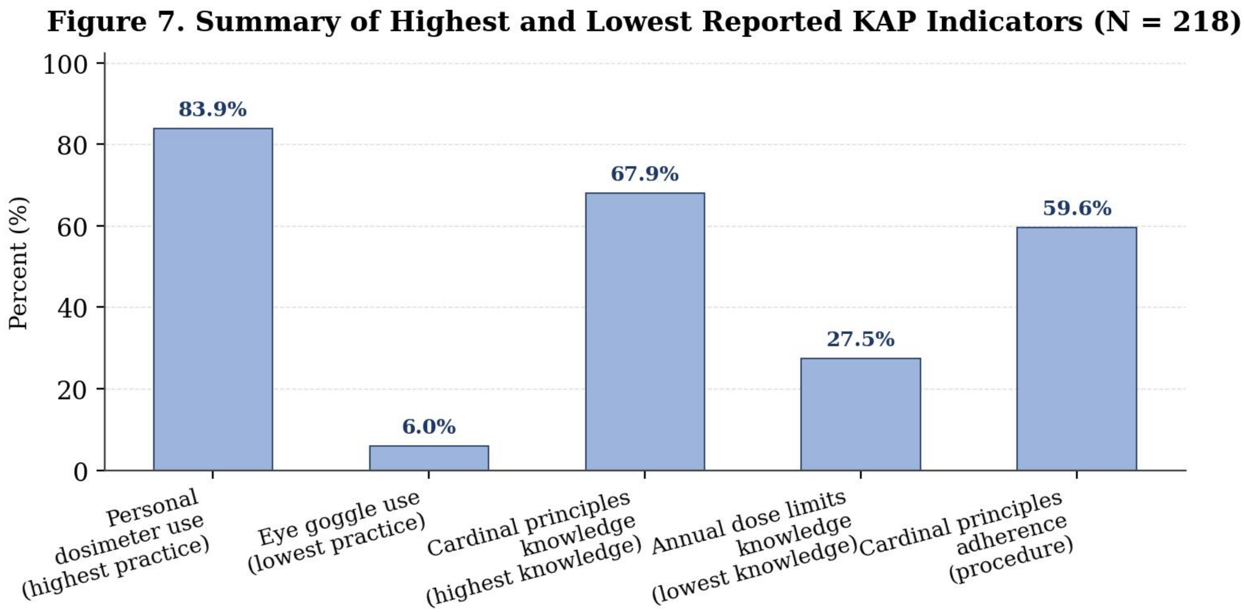

Figure 7. Summary of highest and lowest reported KAP indicators (N = 218).

DISCUSSION

The present cross-sectional study aimed to evaluate knowledge, attitude and practice of 218 health care workers about radiation protection in a tertiary care hospital in D.I. Khan. The findings showed that although HCWs had reasonably good knowledge of basics like ALARA and cardinal principles of radiation protection, there was huge deficiency in the knowledge of specific dosimetric concepts and a lack of uniformity in the use of supplementary protective equipment.

In the current sample, 64.2% of the participants used the term ALARA, which is similar to the percentages obtained in other tertiary-care KAP studies, reporting awareness of the ALARA principle but a lack of understanding of technical aspects related to the dose (13,14). It is interesting to note that only 37.2% of participants were familiar with the TLD badges or pocket dosimeters, and only 27.5% knew about annual radiation dose limits, which are fundamental aspects of personal dose monitoring. This has also been observed previously, where non-radiology, allied health professionals often do not have a comprehensive and technically detailed understanding of dose monitoring and regulatory limits, even when general hazard-awareness is sufficient (14).

With regard to practice, the high personal dosimeter use (83.9%) and lead apron use (71.6%) rates indicate that fundamental protective practices are fairly entrenched in the day-to-day routine in the study locations. The low adoption rates of eye goggles (6.0%), thyroid collars (19.3%) and lead gloves (14.7%) are typical of the low uptake reported of supplementary protective equipment even when adopting fundamental practices, and are likely due to discomfort, limited availability, or lack of targeted training or perceived low personal risk (14). Such a selective pattern of adherence (more visible/ institutionalized equipment versus less essential/more cumbersome) suggests that there is an important area to be targeted for institutional interventions.

Encouraging, that 59.6% of participants said they follow the cardinal principles of radiation protection during procedures, but there was a large minority (40.4%) that do not consistently apply them. The results could be partly attributed to the limited exposure to structured and continuous radiation-safety training during training and early career practice, as the majority of the study population was diploma holders (65.6%) and with less than five years of professional experience (64.2%). This is in line with literature which has highlighted that the implementation of targeted, recurrent training programmes, rather than one-off orientation programmes, have been correlated with enhanced compliance and retention of knowledge among radiology and allied health professionals (14).

Overall these results confirm the need to integrate radiation protection into allied health sciences programs, provide frequent in-service training, and reinforce supervision, to encourage the effective use of all types of protective equipment, not just the most obvious or easily obtained.

Strengths and Limitations

This study has a calculated sample size based on a well-known statistical method, that is the WHO Sample Size Calculator and data collection from three different health care facilities which made it more representative in D.I. Khan. However, some caveats must be noted. Firstly, convenience sampling may lead to selection bias and reduce the ability to generalize results to other settings beyond the study sites. Second, it is a cross-sectional design, which limits the ability to make causal inferences between the demographic factors and the KAP outcomes. Third, data were gathered using a self-administered questionnaire, thus the results may be influenced by social desirability and recall bias, especially for the self-reports of practice items. Finally, the dichotomous (Yes/No) response format used in the questionnaire for rapid assessment is not able to provide details about how many times, consistently, and in what context individuals engage in protective behaviors, as well as statistical testing of relationships between demographic variables (e.g., experience, education) and KAP scores.

Recommendations

Conduct regular training and/or workshops for all healthcare workers who are occupationally exposed to radiation on the principles of radiation protection and the use of radiation protection equipment.

Enhance institutional access of dosimeters, thyroid collars, eye goggles and a full range of personal protective equipment.

Improve awareness on patient protection and medical exposure and occupational safety messages.

Carry out frequent supervisory checks for compliance with radiation protection procedures.

Include radiation protection concepts institutionally into the curriculum of all allied health sciences disciplines.

Conduct larger multi-center surveys with inferential statistical analysis to evaluate the KAP related to radiation protection among healthcare workers in the country.

CONCLUSION

The study revealed that only about 60% of the healthcare workers in the study sites knew about the rules related to radiation protection, had positive attitudes and good practices, whereas a significant number knew little or not at all and were not adherent to the rules for radiation protection, especially those concerning supplementary protective equipment and annual dose limits. To enhance radiation safety culture among healthcare professionals, structured radiation-protection education, more equipment, and regular monitoring of the working processes are suggested. There is a need to systematically address these gaps through incorporating radiation protection content into the allied health sciences curriculum and running larger surveys of the nation.

Author Contributions

Fatima Nasir: Conceptualization, questionnaire development, data collection, investigation, literature review, and original manuscript drafting.

Hammad Mustafa: Data collection, data curation, statistical analysis, interpretation of results, and manuscript review.

Muhammad Abubakar Khan: Literature search, data acquisition, validation, data management, and manuscript editing.

Asad Ullah: Data curation, formal analysis, visualization, interpretation of findings, and manuscript review.

Anzalna Javed: Methodology development, supervision, critical review of the manuscript, and guidance throughout the research process.

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Aliza Shameen: Investigation, data collection, literature review, validation, and manuscript editing.
Maryam Atta: Questionnaire administration, participant coordination, data entry, data verification, and proofreading.
Sharifullah (Corresponding Author): Conceptualization, study design, supervision, methodology, formal analysis, project administration, manuscript review and editing, correspondence management, and final approval of the manuscript.
All authors contributed substantially to the research, reviewed and approved the final manuscript, and agreed to be accountable for all aspects of the work.

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