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AWARENESS OF X-RAY RADIATION HAZARDS AND PERCEPTIONS OF RADIATION SAFETY MEASURES AMONG PATIENTS UNDERGOING X-RAY IMAGING IN PUBLIC SECTOR TERTIARY CARE HOSPITALS OF PESHAWAR, PAKISTAN

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Abstract

Background:

X-ray imaging is an extensively utilized diagnostic modality in clinical practice worldwide. Despite its considerable diagnostic value, exposure to ionizing radiation may pose potential health risks, particularly with repeated or unnecessary examinations. Adequate patient knowledge regarding radiation-related hazards and appropriate protective measures is therefore essential. This study aimed to assess patients' awareness of the potential hazards associated with X-ray imaging and evaluate their perceptions regarding radiation safety measures at a tertiary care hospital in Peshawar, Pakistan.

Materials and Methods:

*A cross-sectional study was conducted from March 2025 to November 2025 **at the** Lady Reading Hospital, Peshawar, Pakistan**.** A total of **200 patients** were recruited using a non-probability convenience sampling technique. Data were collected through a pretested questionnaire assessing participants' knowledge regarding radiation, awareness of the potential effects of X-ray exposure, and perceptions concerning appropriate safety measures during X-ray procedures. Data were analyzed using IBM Statistical Package for the Social Sciences (SPSS) version 26.0. Frequencies and percentages were calculated, while the chi-square test was applied to determine associations between categorical variables. A p-value of <0.05 was considered statistically significant.*

Results:

*Of the 200 participants, **116 (58%)** were aware of the term radiation, whereas **84 (42%)** had no awareness. A statistically significant association was observed between educational level and awareness of radiation (**p=0.003**). Television was identified as the most common source of information regarding radiation (**65.5%**).*

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*Although **161 participants** (80.5%) considered protective lead shielding important during X-ray examinations, **143 (71.5%)** reported that they had never been provided with a lead sheet. Furthermore, **142 participants** (71%) stated that they did not request protective shielding when it was not provided. Educational status was significantly associated with the practice of requesting a protective lead sheet (**p=0.012**).*

Conclusion:

The findings demonstrate insufficient patient awareness regarding ionizing radiation and the potential hazards associated with X-ray imaging. Although most participants recognized the importance of protective shielding, its provision and utilization remained inadequate. Strengthening patient education, improving communication between healthcare professionals and patients, and ensuring consistent implementation of radiation-safety practices may help reduce unnecessary radiation exposure and enhance patient safety.

INTRODUCTION

Ionizing radiation is an important component of modern medical practice and is widely utilized for diagnostic and therapeutic purposes. Among the various forms of ionizing radiation, X-rays are particularly important because of their extensive application in medical imaging. Since the introduction of X-ray technology into medicine, radiological examinations have become an essential part of patient assessment and diagnosis. The increasing availability and utilization of imaging services have consequently resulted in a growing number of patients being exposed to ionizing radiation.

Although X-ray examinations provide substantial diagnostic benefits, exposure to ionizing radiation is associated with potential biological effects. The degree of risk is influenced by the amount of radiation absorbed by body tissues and may increase with repeated or unnecessary exposure. Prolonged or excessive exposure has been associated with adverse outcomes, including tissue damage and an increased risk of malignancy. Therefore, radiation exposure should be carefully justified and optimized so that patients receive the minimum radiation dose required to obtain diagnostically adequate images.

The principle of **"As Low As Reasonably Achievable" (ALARA)** represents a fundamental approach to radiation protection. It emphasizes minimizing radiation exposure while maintaining sufficient image quality for accurate diagnosis. Appropriate radiation-safety practices are particularly important in healthcare facilities where diagnostic imaging is frequently performed. Protective measures may include appropriate radiation shielding, optimization of exposure parameters, avoidance of unnecessary repeat examinations, and adequate communication between healthcare professionals and patients.

Patient awareness is an important component of radiation protection. Individuals undergoing radiological examinations may have limited knowledge regarding the nature of X-ray radiation, its potential health effects, and the importance of protective measures. Inadequate understanding may prevent patients from actively participating in decisions related to their own safety. Conversely, appropriate patient education can encourage individuals to ask relevant questions, understand the rationale for an imaging examination, and recognize the importance of radiation-protection measures.

Previous research has demonstrated considerable variation in patients' understanding of radiation and its associated risks. A substantial proportion of patients may not recognize that X-ray imaging involves ionizing radiation or may have limited knowledge regarding the potential consequences of repeated exposure. Educational attainment has also been associated with differences in radiation awareness. Patients with limited educational

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backgrounds may be less likely to understand radiation-related risks or request appropriate protective measures.

Protective shielding is another important aspect of radiation safety. Although patients may recognize the value of protective devices such as lead shielding, their actual provision and use may not always be consistent. Lack of awareness among patients, inadequate communication, limited resources, and inconsistent implementation of safety protocols may contribute to insufficient protection during radiological examinations. Improving awareness among patients and healthcare workers is therefore important for promoting safer imaging practices.

Effective communication between healthcare providers and patients is also essential before an X-ray examination. Patients should receive appropriate information regarding the purpose of the examination, potential radiation exposure, and relevant safety precautions. Providing such information may improve informed participation and strengthen patient confidence in the healthcare system. It may also encourage the appropriate use of diagnostic imaging by ensuring that examinations are performed when their expected clinical benefits outweigh potential risks.

In Pakistan, particularly in busy tertiary care hospitals, X-ray examinations are routinely performed for the diagnosis and management of a wide range of conditions. However, limited information is available regarding patients' understanding of radiation hazards and their perceptions of radiation-safety practices. Assessing this knowledge is important because inadequate awareness may contribute to unnecessary anxiety, inappropriate expectations, or failure to seek available protective measures.

Lady Reading Hospital, Peshawar, is a major tertiary care healthcare facility serving a large and diverse patient population. Patients undergoing X-ray examinations at such a high-volume institution may have varying levels of education and previous exposure to radiological procedures. Evaluating their knowledge and perceptions can provide useful information regarding existing gaps in radiation awareness and safety practices.

Therefore, the present study was undertaken to assess the **awareness of X-ray radiation hazards and perceptions regarding radiation-safety measures among patients undergoing X-ray imaging at Lady Reading Hospital, Peshawar, Pakistan**. The findings may help identify deficiencies in patient knowledge and provide a basis for developing appropriate educational interventions and strengthening radiation-protection practices within the hospital.

MATERIAL AND METHOD

A cross-sectional study was conducted over a period of nine months, from March 2025 to November 2025, at the Department of Radiology, Lady Reading Hospital (LRH), Peshawar, Pakistan, after obtaining ethical approval from the relevant institutional research and ethics committee. A total of 200 participants were recruited using a non-probability convenience sampling technique. The study included patients who presented to the radiology department for X-ray imaging and were willing to participate in the study.

Patients were excluded if they refused to participate, had cognitive dysfunction or neurological disorders that could interfere with their ability to understand and respond to the questions, lacked the capacity to provide informed consent, or were unable to understand the communication languages used during the study.

A structured questionnaire comprising 15 questions was developed to assess participants' knowledge and experience regarding X-ray imaging, awareness of radiation-related hazards, and perceptions regarding the safety measures that should be adopted during X-ray procedures. Before commencement of the main study, a pilot study was conducted among 10 participants to identify any ambiguities, weaknesses, or difficulties in understanding the questionnaire. Necessary modifications were made accordingly.

After obtaining written informed consent, each participant was individually interviewed, and the questionnaire was completed by the researcher.

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Participants were informed about the purpose of the study and assured that their responses would remain confidential and would be used solely for research purposes. All possible measures were taken to maintain the privacy and confidentiality of the collected information.

The collected data were entered and analyzed using the Statistical Package for the Social Sciences (SPSS). Descriptive statistics were used to calculate frequencies and percentages for categorical variables, which were presented in tables and figures. The chi-square test was applied to assess the association between educational level and knowledge regarding radiation hazards, as well as between educational level and the participants' preference for requesting a lead protective sheet during X-ray imaging. A p-value of <0.05 was considered statistically significant.

Results

Characteristics of the Study Population

A total of 200 participants were included in the study. The mean age of the participants was 35.96 ± 13.62 years, with an age range of 12–80 years. The largest proportion of participants belonged to the 25–34-year age group (29.5%), followed by those aged 35–44 years (25.0%) and 15–24 years (19.5%). Participants aged 45–54 years constituted 12.0% of the study population, while 7.5% were aged 55–64 years. Participants aged 65 years and above represented 4.5%, and those younger than 15 years accounted for 2.0%.

Regarding educational status, 26.0% of participants had no formal education. Primary education was reported by 14.0%, while 15.0% had received secondary education. Participants with matriculation constituted the largest educated group (21.5%), followed by those with intermediate education (12.0%). Bachelor's degree holders represented 7.5% of the participants, whereas 1.5% had a diploma. A small proportion had postgraduate (0.5%) or master's-level education (2.0%).

Knowledge and Awareness Regarding X-ray Imaging

All participants reported having undergone X-ray imaging previously. Among the 200 participants, 164 (82.0%) had undergone fewer than three previous X-ray examinations, whereas 36 (18.0%) had undergone three or more examinations.

Overall, 116 participants (58.0%) reported that they were aware of the term "radiation," while 84 (42.0%) had no knowledge of the term. Awareness demonstrated a significant association with educational status. Among participants with no formal education, 59.61% were unaware of the term radiation, compared with 40.38% who reported awareness. The association between educational level and awareness of radiation was statistically significant (p=0.003).

Among the participants who had some knowledge regarding radiation, television was the most frequently reported source of information (65.5%), followed by books (25.0%), the internet (6.9%), and newspapers (2.6%).

When participants were asked about the effects of X-ray imaging, 166 (83.0%) considered X-ray imaging beneficial, whereas 18 (9.0%) perceived it as harmful. One participant (0.5%) considered it harmless, while 15 (7.5%) reported that they did not know. The majority of participants (78.5%) identified diagnosis as the principal benefit of X-ray imaging.

Knowledge regarding populations particularly susceptible to radiation exposure was limited. A total of 182 participants (91.0%) were unable to identify the population group most vulnerable to X-ray radiation. Thirteen participants (6.5%) correctly identified the susceptible group, while five (2.5%) provided an incorrect response.

Regarding repeated exposure to X-ray radiation, 117 participants (58.5%) believed that repeated exposure could increase the risk of harm. In contrast, 44 (22.0%) believed that repeated exposure did not increase harm, 24 (12.0%) were unsure, and 15 (7.5%) did not provide a response.

General Knowledge Regarding Radiation-Related Effects

Knowledge concerning radiation and its potential effects varied considerably among the participants. When asked whether the X-ray room continued to emit radiation after completion of an X-ray examination, 63 participants (31.5%)

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responded affirmatively, 50 (25.0%) responded negatively, and 84 (42.0%) were uncertain. Three participants (1.5%) did not provide a response.

When asked which imaging procedure was associated with a higher radiation dose, 59 participants (29.5%) identified CT scanning, 20 (10.0%) selected chest X-ray, and 36 (18.0%) selected skull X-ray. A substantial proportion, 84 participants (42.0%), were unable to provide an answer, while one participant (0.5%) did not respond.

Regarding adjustment of radiation dose according to patient age, 96 participants (48.0%) considered such adjustment necessary, while 11 (5.5%) did not. Eighty-four participants (42.0%) were unsure, and nine (4.5%) provided no response.

Awareness of specific potential adverse effects of X-ray exposure was generally limited. Only one participant (0.5%) believed that X-ray imaging could cause cancer, whereas 184 (92.0%) responded that it could not, and 15 (7.5%) did not respond. Similarly, 20 participants (10.0%) believed that X-ray exposure could cause anemia, while 165 (82.5%) disagreed and 15 (7.5%) did not respond.

With respect to burns, five participants (2.5%) believed that X-ray imaging could cause burns, whereas 180 (90.0%) did not, and 15 (7.5%) provided no response. Seven participants (3.5%) considered cataract a possible consequence of X-ray exposure, while 178 (89.0%) disagreed and 15 (7.5%) did not respond. Only one participant (0.5%) associated X-ray imaging with fertility problems, whereas 184 (92.0%) did not identify this potential effect and 15 (7.5%) provided no response.

Awareness and Practice of Radiation Safety Measures

The majority of participants demonstrated awareness of the importance of protective measures during X-ray imaging. A total of 161 participants (80.5%) considered the use of a protective lead sheet important for radiation protection. Twelve participants (6.0%) considered it unnecessary, while 27 (13.5%) were uncertain.

Despite this relatively high level of perceived importance, the actual provision of protective lead sheets was less consistent. Most participants (71.5%) reported that they had never been provided with a lead sheet during X-ray examinations. Forty-eight participants (24.0%) reported that they were always provided with a lead sheet, whereas nine (4.5%) stated that they received one occasionally.

When asked whether they requested a protective lead sheet when one was not provided, 142 participants (71.0%) reported that they did not request one, whereas only 58 (29.0%) stated that they requested a lead sheet.

The practice of requesting a protective lead sheet varied according to educational status. Participants without formal education were less likely to request a protective lead sheet compared with those who had received formal education. The association between educational level and the practice of requesting a protective lead sheet was statistically significant ($p=0.012$).

Among participants who requested a protective lead sheet, 39 (19.5%) reported that the sheet was provided upon request, while 10 (5.0%) stated that it was not provided. A further 151 participants (75.5%) reported that the protective sheet was provided only sometimes.

Overall, the findings demonstrate that although a considerable proportion of participants recognized the importance of radiation protection during X-ray imaging, their understanding of radiation-related risks and their active practice of requesting protective measures remained limited.

Discussion

The present study was conducted to assess patients' knowledge, awareness, and perceptions regarding radiation risks associated with X-ray imaging, as well as their awareness and practice of radiation safety measures. The findings demonstrated an overall inadequate level of understanding regarding radiation exposure and its potential health consequences. Although most participants had previous experience with X-ray imaging, a considerable proportion lacked basic

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knowledge about radiation and the associated risks.

In the present study, 42.0% of participants were unaware of the term "radiation." Furthermore, knowledge regarding the potential harmful effects of X-ray exposure was generally poor. These findings are comparable with observations reported in previous studies, which have demonstrated inadequate patient awareness regarding radiation exposure during diagnostic imaging. A study conducted among patients in Hong Kong reported that 87.9% were unaware that conventional X-ray examinations involve radiation exposure [8]. Similarly, another study found that approximately one-third of patients did not know that diagnostic imaging procedures could expose them to radiation [9]. In contrast, other research has demonstrated comparatively better awareness, with approximately 70.8% of participants showing an overall understanding of the imaging procedure they underwent [10]. These variations may reflect differences in educational background, access to health information, healthcare systems, and patient counseling practices.

The current findings also indicated limited awareness of the potential adverse effects associated with radiation exposure. Participants demonstrated poor recognition of possible radiation-related risks, including malignancy, cataract formation, burns, anemia, and reproductive effects. Similar observations have been reported in previous studies. For example, research conducted in Nigeria found that 86.7% of patients were unaware of the potential hazards associated with X-ray imaging [11]. Other studies have likewise reported that patients frequently underestimate the potential cancer risk associated with diagnostic radiation exposure [8,9,12].

Knowledge regarding radiation dose associated with different imaging modalities was also inadequate. In the present study, 42.0% of participants were unable to identify which imaging procedure was associated with a higher radiation dose. Previous studies have reported comparable findings, with patients frequently underestimating the radiation dose associated with computed tomography compared with conventional chest radiography [8,12]. This lack of awareness is important because patients may undergo multiple imaging examinations over time, and an inadequate understanding of cumulative radiation exposure may contribute to inappropriate expectations regarding repeated investigations.

The majority of participants were also unable to identify the population group most vulnerable to radiation exposure. In addition, many participants were uncertain about whether radiation remains present in the X-ray room after completion of the examination. These findings suggest substantial gaps in basic radiation knowledge among patients attending the radiology department. The relatively high proportion of participants with limited educational backgrounds may partly explain these findings. A significant association was observed between educational level and awareness of radiation ($p=0.003$), indicating that education may play an important role in improving patients' understanding of radiation-related issues. Similar findings have been reported by Sin et al., who identified a significant relationship between educational attainment and radiation knowledge [8]. However, their study population had a comparatively higher educational background, which may account for differences in overall awareness.

The study also assessed participants' perceptions and practices regarding radiation protection during X-ray examinations. Although 80.5% of participants considered the use of a protective lead sheet important, 71.5% reported that they had never been provided with such protection during previous X-ray examinations. This discrepancy between perceived importance and actual implementation indicates a potential gap between patients' expectations regarding radiation safety and the practices experienced during diagnostic imaging.

Furthermore, 71.0% of participants reported that they did not request a protective lead sheet when it was not provided. Similar observations have been reported in previous research, where a substantial proportion of patients stated that protective devices were not routinely provided

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during radiation-based procedures [11]. The limited use of protective measures may be related to inadequate awareness among patients, inconsistent implementation of radiation protection practices, and limitations in healthcare resources.

Educational status was significantly associated with the practice of requesting a protective lead sheet (p=0.012). Participants with lower educational attainment were less likely to request radiation protection compared with those who had received formal education. This finding emphasizes the importance of patient education and effective communication in promoting radiation safety. Patients should be informed about the purpose of the examination, potential risks associated with radiation exposure, and appropriate protective measures before undergoing imaging procedure

Among participants who reported having knowledge about radiation, television was identified as the most common source of information, followed by books, the internet, and newspapers. This finding differs from studies in which healthcare professionals were identified as the primary source of information regarding radiation and diagnostic imaging [9,13].

Healthcare professionals are potentially the most appropriate source of information because they can provide individualized explanations based on the patient's clinical condition, previous imaging history, and the expected benefits and risks of the proposed examination. Previous research has also shown that many patients expect their physicians to explain diagnostic procedures and their associated risks [8].

The limited role of healthcare professionals as a source of radiation-related information may indicate inadequate patient counseling before imaging procedures. It may also reflect gaps in radiation-related knowledge among healthcare providers, as reported in previous studies [12,13]. Strengthening radiation-safety education within healthcare professional training programs may therefore improve the ability of healthcare providers to communicate radiation risks effectively.

The prominent role of television and other forms of electronic media in providing information also presents an opportunity for public health education. Carefully designed awareness campaigns through television, social media, and other digital platforms could improve public understanding of radiation risks and appropriate safety practices.

Conclusion

The findings of this study indicate that patients attending the radiology department at a tertiary care hospital had limited knowledge and awareness regarding radiation exposure associated with X-ray imaging and its potential health risks. Although a considerable proportion of participants recognized the importance of radiation protection, actual awareness and practice of protective measures were inadequate.

Educational status was significantly associated with both awareness of radiation and the practice of requesting protective measures. These findings highlight the need for improved patient education, particularly among individuals with limited formal education.

Healthcare providers should provide patients with clear and understandable information regarding the purpose of X-ray examinations, radiation exposure, potential risks, and appropriate safety precautions. Radiation protection measures should be consistently implemented in radiology departments, and patients should be encouraged to ask questions and participate in decisions concerning their diagnostic investigations.

Regular public awareness programs should be developed to improve knowledge regarding radiation safety, with television, social media, and other electronic communication platforms potentially serving as effective methods of reaching the wider population. In addition, healthcare professionals should be adequately trained in radiation protection and patient counseling.

Diagnostic X-ray examinations should be requested only when clinically justified, with the expected diagnostic benefit outweighing the potential radiation risk. Maintaining an

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appropriate record of previous radiation exposure may also help reduce unnecessary repeat examinations. Effective communication, informed consent, appropriate justification of imaging requests, and consistent implementation of radiation-protection principles are essential for improving patient safety.

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