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AWARNESS AND ATTITUDE OF PATIENTS TOWARDS RADIATION EXPOSURE IN TERTIARY CARE HOSPITALS

Original Research

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ABSTRACT

Background: Radiation exposure, particularly ionizing radiation, is a significant concern in medical imaging. Understanding patient awareness of radiation risks is crucial for improving healthcare practices. Although previous studies have explored this area, knowledge gaps remain, especially in regions with limited educational outreach. This study aims to assess the level of awareness and attitudes toward radiological exposure among patients in Peshawar and Mardan.

Objective: The study aimed to assess patient knowledge and attitudes toward radiological exposure and to investigate how their knowledge influences their attitudes toward medical imaging procedures.

Methods: This descriptive cross-sectional study was conducted at Khyber Teaching Hospital, Peshawar, and Mardan Medical Complex, Mardan, from June to November 2022. A systemic random sampling technique was used to select 335 patients for data collection. A pre-designed questionnaire was administered to gather information on demographics, knowledge of ionizing radiation, and attitudes toward radiological tests. The collected data were analyzed using SPSS/Excel, and descriptive statistics, including percentages, frequencies, and graphical presentations, were used to analyze the data.

Results: Of the 335 participants, only 99 (29.6%) were aware of ionizing radiation, while 236 (70.4%) were unaware. The majority (50 participants, 14.9%) cited educational institutes as their primary source of knowledge. Awareness was positively correlated with education level, as participants with higher educational qualifications demonstrated better knowledge. A significant portion (58.2%) of participants lacked awareness of radiation hazards and were therefore not concerned about undergoing further radiological tests.

Conclusion: The study revealed a significant lack of awareness regarding the risks of radiation exposure among patients. Educational institutes and social media are key platforms to enhance patient education. This highlights the need for improved communication and educational programs to promote awareness of radiation safety in healthcare settings.

Keywords: ALARA, Deterministic Effects, Ionizing Radiation, Knowledge, Patient Awareness, Radiological Exposure, Stochastic Effects.

INTRODUCTION

Radiation is a form of energy in motion, which can be described as either a wave or energized particles emitted by a source. These radiations occur everywhere, with the majority originating from natural sources, and a smaller proportion stemming from artificial sources. Radiation that occurs naturally is commonly referred to as background radiation (1). Broadly, radiations are categorized into two primary types: ionizing and non-ionizing radiation (2). Ionizing radiation possesses sufficient energy to break molecular bonds and can displace electrons from atoms, which may lead to harmful effects on biological systems (3). Ionizing radiation is further subdivided into particulate radiation, which involves matter, and electromagnetic radiation, which does not (4). X-rays, a form of electromagnetic radiation, have frequencies ranging from 10^16 to 10^20 Hz and wavelengths between 10^-8 and 10^-12 meters (5). In medicine, X-rays are utilized in several procedures, including radiographic imaging, fluoroscopy, angiography, computed tomography (CT), and mammography (6). Mammography, in particular, is the most effective method for early breast cancer detection, relying on its ability to distinguish between different tissue densities without the need for contrast materials (7). While the benefits of ionizing radiation in medical imaging are undeniable, its negative impacts on living organisms have also been observed. Excessive radiation exposure has been linked to the development of dermatoses, hematological disorders, cataracts, and even cancers in early radiology practitioners (8). Radiation exposure can lead to two distinct types of harmful health effects: deterministic effects and stochastic effects. Deterministic effects occur rapidly after exposure and are typically associated with higher doses, whereas stochastic effects arise from low doses of radiation administered over extended periods, with the risks increasing over time (9).

The primary goal of radiological imaging is to produce high-quality images while minimizing radiation exposure. However, in some cases, international radiation dose guidelines may be exceeded due to the limitations inherent in certain diagnostic procedures (10). Concerns about radiation exposure have grown as the use of imaging technologies in medicine continues to increase, especially with modalities that utilize ionizing radiation (11). Though X-ray dosages in clinical settings are typically minimal, cumulative exposure over an individual's lifetime can potentially contribute to long-term health issues, making it crucial to limit unnecessary imaging procedures (11,12). However, the risks associated with radiation are often overstated or misinterpreted, which can result in undue concern among patients and the general public, potentially affecting patient perceptions and attitudes toward imaging procedures (13). The level of awareness that patients have regarding radiation exposure significantly influences their acceptance of diagnostic imaging. Patients' attitudes toward radiation are shaped by various factors, including their knowledge, perceptions, and understanding of the risks involved. Educational background, communication with healthcare providers, personal experiences, and cultural differences all play a role in shaping patient awareness (14). By providing patients with accurate information about the risks and benefits of medical imaging, healthcare providers can foster more ethical decision-making and better engage patients in their care (15). This knowledge not only empowers patients but also contributes to a more effective doctor-patient relationship, ultimately improving the safety and quality of the healthcare system (16).

Despite the importance of this issue, no study has yet been conducted in Khyber Pakhtunkhwa to assess patient awareness and attitudes regarding medical radiation exposure. The objective of this study, therefore, is to evaluate the level of awareness among patients regarding medical radiation exposure and their attitudes toward it. By addressing this gap, the research aims to enhance understanding of how patients perceive the risks and benefits of medical imaging and to inform strategies for improving patient education and care in the region.

METHODS

This descriptive cross-sectional study was conducted in the Radiology departments of Khyber Teaching Hospital, Peshawar, and Mardan Medical Complex, Mardan, from June 2022 to November 2022. Ethical approval for the study was obtained from the Clinical Research Ethics Committee of the Institute of Paramedical Sciences (KMU), Peshawar. Additionally, approval for data collection was granted by both Khyber Teaching Hospital, Peshawar, and Mardan Medical Complex, Mardan. The study aimed to evaluate the awareness and attitudes of patients regarding radiation exposure, with a total of 335 participants included after obtaining informed consent. The sample size was determined using the following formula: $N = Z^2p(1-p)/E^2$, where n represents the sample size, Z is the desired confidence level

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(95%), E is the standard sampling error (5%), and p is the estimated prevalence (71%) (1). Based on these calculations, the sample size was determined to be 335 participants. A systemic random sampling technique was employed to select participants, with every third patient visiting the radiology departments included in the study. The inclusion criteria encompassed all patients aged 15 years and older, regardless of gender, who visited the radiology departments. Patients undergoing ultrasound or MRI procedures were excluded from the study, as these imaging techniques do not involve ionizing radiation, which was the primary focus of the study. Additionally, patients with cognitive dysfunction or nervous disorders were excluded, as these conditions might have affected their ability to understand and respond to the survey questions. This exclusion criterion was implemented to ensure the sample was focused on individuals who had the capacity to respond accurately to the questions about radiation exposure and attitudes toward medical imaging procedures.

The study was designed to maintain participant confidentiality and privacy throughout the data collection process. Informed written consent was obtained from all participants. For those with no formal education or a primary education level, the questionnaire was administered with the help of an interviewer who explained the questions. Patients with a matriculation or higher level of education completed the questionnaire independently. The questionnaire was structured into three sections: demographic information, patient knowledge about radiation, and their attitudes toward radiation exposure. Data analysis was performed using SPSS V.20 and MS Excel. Descriptive statistics were applied to determine the frequency and percentage distribution of variables, and frequency tables were used to assess the relationships among the variables. In conclusion, the study aimed to assess patient awareness and attitudes toward radiation exposure while ensuring careful consideration of ethical standards and participant confidentiality. By using systemic random sampling and a structured questionnaire, the study aimed to gather accurate and relevant data to inform strategies for improving patient education and safety in radiological procedures.

RESULTS

The study included 335 participants, of which 170 (50.7%) were male and 165 (49.3%) were female. The participants were categorized into five age groups: 16-25 years, 26-35 years, 36-45 years, 46-55 years, and above 55 years. The largest group was the 16-25 years age group, which accounted for 55 males and 64 females. Regarding marital status, 235 (70.1%) participants were married, and 100 (29.9%) were single. In terms of educational background, 102 (30.4%) participants had no formal education, 86 (25.7%) had primary education, 51 (15.2%) had matriculation, and 96 (28.7%) had higher education. Most of the educated participants were in the 16-25 years age group, with no participants above the age of 55 having a higher level of education. The majority of participants in the age group of 16-25 years were unemployed, while those in the 26-35 years age group were mostly self-employed. The largest group of students also belonged to the 16-25 years age group. Regarding knowledge of ionizing radiation, 99 (29.6%) participants were aware of ionizing radiation, while 236 (70.4%) were unaware. Awareness of ionizing radiation increased with higher education levels, as 64 (66.6%) of the highly educated participants, 23 (45%) of those with matriculation, and 8 (9.3%) of those with primary education were aware. Among the uneducated participants, only 4 (3.9%) were aware of ionizing radiation.

The study identified the major sources of information about radiation knowledge. Educational institutions were the primary source, followed by electronic media, healthcare professionals in families, and radiographers. When asked about which modalities use ionizing radiation, 64 (19.1%) of the respondents identified X-rays, 28 (8.4%) identified CT scans, 4 (1.4%) identified fluoroscopy, and 19 (16.5%) correctly identified all options. Most participants, 225 (67.2%), visited the radiology department for an X-ray, followed by 97 (29%) for a CT scan, 9 (2.7%) for fluoroscopy, and 4 (1.2%) for mammography. Regarding perceptions of radiation harm, 123 (36.7%) respondents believed radiation was harmful, while 212 (63.3%) believed it was not harmful. Among those with higher education, 70 (73%) believed radiation was harmful.

Feelings of anxiety in the diagnostic room were recorded, with 229 (68.4%) respondents feeling normal and 98 (29.3%) feeling scared. It was noted that more females (67.3%) and individuals with primary education were fearful. The main reasons for fear included the sound produced by the machines (46 respondents), the absence of the radiographer during the procedure (19 respondents), and being a first-time visitor (19 respondents). The least common cause of fear was related to the radiographer's instructions (14 respondents). When asked about their understanding of the effects of radiation, 195 (58.2%) were unfamiliar with the effects, while 50 (14.9%) did not consider radiation harmful. Additionally, 45 (13.4%) believed radiation to be fatal, and another 45 (13.4%) thought it was carcinogenic. Regarding their willingness to undergo radiological tests, 173 (51.6%) respondents stated they would not prefer radiological tests if they could tolerate the disease, while 162 (48.7%) would prefer to have them. When asked about their feelings towards further radiological tests, 228 (68.1%) were pleased with the idea, while 107 (31.9%) were not.

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Upon further analysis of the data, a correlation between educational level and the perception of radiation's harmful effects was observed. Among the participants with higher education, 73% (70 out of 96) believed that radiation is harmful, suggesting that higher education is associated with a greater awareness of the potential risks of radiation exposure. In contrast, only 36.7% of the total sample believed radiation to be harmful, with a majority (63.3%) believing it was not harmful. Among those with no education, only 3.9% were aware of the harmful effects of radiation, further emphasizing the role of education in shaping awareness. This trend highlights that individual with higher academic qualifications are more likely to recognize the potential dangers of ionizing radiation. Therefore, education level appears to play a crucial role in the understanding of radiation's risks, reinforcing the importance of education and awareness campaigns regarding radiation safety. This insight into the relationship between educational level and radiation knowledge should be considered when designing future public health initiatives and patient education programs.

Table 1 Demographic distribution of patients

Category	16-25 Years	26-35 Years	36-45 Years	46-55 Years	Above 55	Total
Gender						
Male	55	53	43	15	4	170 (50.7%)
Female	64	51	26	16	8	165 (49.3%)
Marital Status						
Married	39	85	68	31	12	235 (70.1%)
Single	80	19	1	0	0	100 (29.9%)
Divorced	0	0	0	0	0	0 (0%)
Academic Qualification						
No Education	28	26	23	19	6	102 (30.4%)
Primary	29	28	20	6	3	86 (25.7%)
Matric	23	13	12	3	0	51 (15.2%)
Higher	39	37	14	3	3	96 (28.7%)
Employment						
Self-employed	63	53	33	16	8	82 (24.5%)
Unemployed	13	17	12	5	1	173 (51.6%)
Civil Servant	0	0	1	2	1	48 (14.3%)
Retired	26	2	0	0	0	4 (1.2%)
Student	0	0	1	2	0	28 (8.4%)

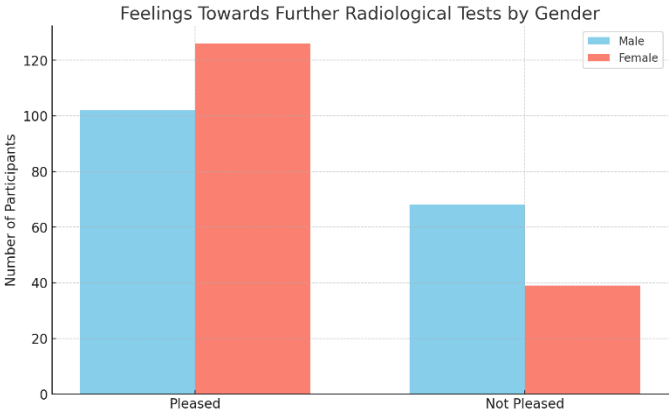

Figure 2 Feelings Towards Furthur Radiological Tests by Gender

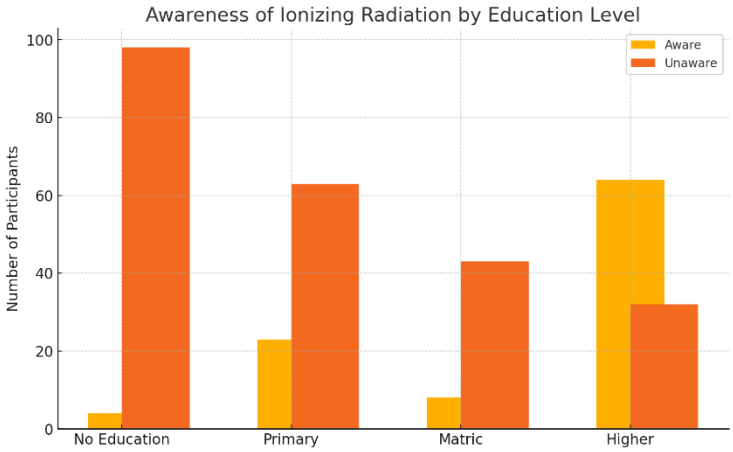

Figure 1 Awareness of Ionizing Radiation by Education Level

Table 2 Demographic Distribution of Patients' Knowledge Regarding Ionizing Radiation

Category	16-25 Years	26-35 Years	36-45 Years	46-55 Years	Above 55	Total
Gender						
Male	24	22	10	4	1	61
Female	31	31	33	11	3	109
Marital Status						
Married	18	12	3	2	3	38
Single	46	39	23	14	5	127
Qualification						
No Education	9	24	13	6	4	56
Primary	30	61	55	25	8	179
Matric	33	10	0	0	2	43
Higher	47	9	22	19	4	57
Total						
Yes	26	27	7	2	2	64
No	13	10	7	1	1	32
Total	61	109	38	127	56	335

Table 3 Perception of Radiation's Harmful Effects by Education Level

Education Level	Total Participants	Participants Believing Radiation is Harmful	Percentage Believing Radiation is Harmful (%)
No Education	102	4	3.9%
Primary Education	86	23	26.7%
Matriculation	51	8	15.7%
Higher Education	96	70	73%
Total	335	123	36.7%

Table 4 Gender and qualification-based analysis between radiology test willingness followed by disease tolerance

If you could tolerate the disease, would you do the radiological test?	Gender		Academic qualification			
	Male	Female	No education	Primary	Matric	Higher
Yes	85	77	39	40	28	55
No	85	88	63	46	23	41
Total	170	165	102	86	51	96

Table 5 Gender and qualification-based analysis of patients' feelings if the physician would prescribe them some more tests

How would you feel if there is a need for more tests?	Gender		Academic qualification			
	Male	Female	No education	Primary	Matric	Higher
Pleased to do more tests	102	126	64	63	36	65
Not be pleased to do more tests	68	39	38	23	15	31
Total	170	165	102	86	51	96

DISCUSSION

The aim of this study was to assess the knowledge and attitudes of patients toward radiation exposure. The findings revealed that 29.6% of the patients were aware of ionizing radiation, a figure lower than what has been reported in previous studies. For example, a study in Karachi found that 58% of participants were aware of radiation (5,17). This discrepancy may be attributed to the higher literacy levels in Karachi compared to the relatively lower literacy rates in Mardan and Peshawar, where the current study was conducted. Such differences in awareness may reflect the impact of regional literacy and educational outreach efforts on the public's understanding of medical radiation. Educational institutions were identified as the major source of information about ionizing radiation, which contrasts with findings from studies in other regions where television was reported as the primary source of information (18). This suggests that the sources of radiation-related education can vary significantly based on geographic and cultural differences. Moreover, this study demonstrated a clear correlation between education level and radiation awareness. Those with higher educational qualifications were more likely to be aware of ionizing radiation, underscoring the importance of educational programs in improving patient knowledge about the risks of medical imaging.

Regarding the participants' knowledge of the modalities using ionizing radiation, 71.3% were unaware of the types of imaging that involve radiation, a finding that contrasts with studies from other countries where fewer participants (16.2%) lacked this knowledge (12). In a similar study, only 50% of patients in Saudi Arabia could differentiate between various imaging modalities (19). The lack of awareness in the present study may be attributed to the low literacy levels of the participants, highlighting the need for more targeted educational interventions to raise awareness about medical imaging procedures and their associated risks. In terms of understanding the role of radiation in diagnosis, 79.1% of patients acknowledged the importance of radiology in medical diagnosis, which stands in contrast to a study in Nigeria where only 49.6% of participants understood the significance of radiations in diagnostic imaging (14). This discrepancy might indicate regional differences in the general public's knowledge about healthcare practices, potentially influenced by healthcare accessibility and public health education efforts.

The study further explored the attitudes of patients toward radiation exposure. A majority (68.4%) of participants reported feeling scared in the diagnostic room, which contrasts with a study in which most patients (64.4%) felt comfortable due to the explanation provided by the radiographers regarding the importance of radiation in their diagnosis (2). This suggests that patients' anxiety about radiation could be reduced with better communication from healthcare providers, highlighting the role of patient education and reassurance in reducing fear and improving the overall patient experience during radiological procedures. When asked about their willingness to undergo radiological tests if they could tolerate the disease, 51.6% of participants stated they would not choose to have the tests, a finding consistent with another study in which 66.1% of patients were reluctant to undergo such tests (3,16). The high unemployment rate among participants in the current study might have influenced this response, as patients may perceive the financial burden of unnecessary tests as a significant deterrent.

Interestingly, 68.1% of participants in this study expressed willingness to undergo further radiological tests for better diagnosis, which differs from the results of another study where only 33% of respondents were pleased with further radiological tests (8,9). This could be attributed to the lower awareness of radiation risks among the respondents in this study, which may have made them more accepting of additional testing without fear of potential harm. In contrast, other studies have shown that a higher level of awareness of radiation risks, such as in a study conducted in 2019, led more patients to resist further radiological tests due to concerns about radiation exposure (20). This study has several strengths, including the relatively large sample size and the focus on a region where limited research on this topic has been conducted. However, there are notable limitations, including the potential bias introduced by the exclusion of participants undergoing certain imaging procedures, such as ultrasound and MRI, which do not involve ionizing radiation. Additionally, the reliance on self-reported data could have introduced recall bias or inaccuracies in participants' understanding of radiation-related information. Future studies could benefit from using a more diverse sample from different regions and employing a mixed-methods approach to gather more in-depth insights into patients' attitudes and knowledge. Furthermore, incorporating direct assessments of radiation risk awareness, such as objective testing of participants' knowledge, could provide more accurate data on public awareness.

CONCLUSION

In conclusion, the study revealed a significant gap in knowledge and awareness about radiation and its associated risks among patients. The primary source of information for patients was educational institutions, highlighting the need for more comprehensive educational outreach. The study also identified that a lack of patient understanding plays a major role in their willingness to undergo further radiologic investigations. Additionally, very few patients were receiving information about radiation risks from radiographers, underscoring the importance of effective communication from healthcare professionals. Educating patients about the potential risks of radiation could play a crucial role in minimizing future health risks, including cancer and other radiation-related conditions, and is an essential step toward improving patient care and safety in diagnostic imaging.

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Author Contribution

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Shama Nayab Salam*	Substantial Contribution to study design, analysis, acquisition of Data Manuscript Writing Has given Final Approval of the version to be published
Nayab Mehsood	Substantial Contribution to study design, acquisition and interpretation of Data Critical Review and Manuscript Writing Has given Final Approval of the version to be published
Mohammad Azhar Uddin	Substantial Contribution to acquisition and interpretation of Data Has given Final Approval of the version to be published
Bilal Uddin	Contributed to Data Collection and Analysis Has given Final Approval of the version to be published
Shah Faisal Jamal	Contributed to Data Collection and Analysis Has given Final Approval of the version to be published
Rizwan Ullah	Substantial Contribution to study design and Data Analysis Has given Final Approval of the version to be published

REFERENCES

1. Ng CG, Manan HA, Mohd Zaki F, Zakaria R. Awareness of Medical Doctors in Pusat Perubatan Universiti Kebangsaan Malaysia on Diagnostic Radiological Examination Related Radiation Exposure in the Pediatric Population. Int J Environ Res Public Health. 2022;19(10).

2. Alyousef K, Assiri A, Almutairi S, Aldalham T, Felimban G. Awareness of Radiation Protection and Common Radiation Dose Levels Among Healthcare Workers. Glob J Qual Saf Healthc. 2023;6(1):1-5.

3. Campolo J, Annoni G, Vignati G, Peretti A, Papa M, Colombo PE, et al. The burden of radiation exposure in congenital heart disease: the Italian cohort profile and bioresource collection in HARMONIC project. Ital J Pediatr. 2024;50(1):100.

4. Abuelhia E, Alghamdi A, Tajaldeen A, Mabrouk O, Bakheet A, Alsaleem H, et al. Dental Undergraduates and Interns' Awareness, Attitudes, and Perception of Radiological Protection. Int J Dent. 2022;2022:5812627.

5. Sensakovic WF, Royall I, Hough M, Potrebko P, Grekoski V, Vicenti R. Fetal Dosimetry at CT: A Primer. Radiographics. 2020;40(4):1061-70.

6. Linet MS, Applegate KE, McCollough CH, Bailey JE, Bright C, Bushberg JT, et al. A Multimedia Strategy to Integrate Introductory Broad-Based Radiation Science Education in US Medical Schools. J Am Coll Radiol. 2023;20(2):251-64.

7. Bastiani L, Paolicchi F, Faggioni L, Martinelli M, Gerasia R, Martini C, et al. Patient Perceptions and Knowledge of Ionizing Radiation From Medical Imaging. JAMA Netw Open. 2021;4(10):e2128561.

8. Alashban Y, Alghamdi SA. Patient perspectives on ionising radiation exposure from computed tomography in Saudi Arabia: a knowledge and perception study. Radiat Prot Dosimetry. 2024;200(7):687-92.

9. Matković A, Ferenc T, Dimjašević L, Drinković M, Lovreković B, Popić J, et al. Patient's knowledge regarding radiation exposure from various imaging modalities: a pilot study. Radiat Prot Dosimetry. 2023;200(1):91-6.

10. Paulo G, Bartal G, Vano E. Radiation Dose of Patients in Fluoroscopically Guided Interventions: an Update. Cardiovasc Intervent Radiol. 2021;44(6):842-8.

11. Ribeiro ASF, Husson O, Drey N, Murray I, May K, Thurston J, et al. Radiation exposure awareness from patients undergoing nuclear medicine diagnostic 99mTc-MDP bone scans and 2-deoxy-2-(18F) fluoro-D-glucose PET/computed tomography scans. Nucl Med Commun. 2020;41(6):582-8.

12. Vinnikov VA, Belyakov O. Radiation Exposure Biomarkers in the Practice of Medical Radiology: Cooperative Research and the Role of the International Atomic Energy Agency (IAEA) Biodosimetry/Radiobiology Laboratory. Health Phys. 2020;119(1):83-94.

13. Bos D, Guberina N, Zensen S, Opitz M, Forsting M, Wetter A. Radiation Exposure in Computed Tomography. Dtsch Arztebl Int. 2023;120(9):135-41.

14. Wijma IN, Casal RF, Cheng GZ, Einsiedel PF, Fantin A, Hall DJ, et al. Radiation Principles, Protection, and Reporting for Interventional Pulmonology: A World Association of Bronchology and Interventional Pulmonology White Paper. Respiration. 2024;103(11):707-22.

15. Vassileva J, Holmberg O. Radiation protection perspective to recurrent medical imaging: what is known and what more is needed? Br J Radiol. 2021;94(1126):20210477.

16. Sawyer JR. Radiation Reduction Strategies in Pediatric Orthopaedics. J Pediatr Orthop. 2021;41(Suppl 1):S75-s9.

17. Provenzano DA, Florentino SA, Kilgore JS, De Andres J, Sitzman BT, Brancolini S, et al. Radiation safety and knowledge: an international survey of 708 interventional pain physicians. Reg Anesth Pain Med. 2021;46(6):469-76.

18. Almohiy HM, Hussein K, Alqahtani M, Elshiekh E, Loaz O, Alasmari A, et al. Radiologists' Knowledge and Attitudes towards CT Radiation Dose and Exposure in Saudi Arabia-A Survey Study. Med Sci (Basel). 2020;8(3).

19. Saleim AR. REFERRING PHYSICIANS' KNOWLEDGE OF THE RADIATION DOSES FOR COMMONLY RADIOLOGICAL INVESTIGATIONS IN NASIRIYA TURKISH HOSPITAL. Wiad Lek. 2023;76(9):2061-7.

20. Di Maria S, van Nijnatten TJA, Jeukens C, Vedantham S, Dietzel M, Vaz P. Understanding the risk of ionizing radiation in breast imaging: Concepts and quantities, clinical importance, and future directions. Eur J Radiol. 2024;181:111784.