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KNOWLEDGE ATTITUDE AND PRACTICE OF RADIOLOGY PROFESSIONALS REGARDING ARTIFICIAL INTELLIGENCE AT HMC, KTH AND PIC HOSPITAL.

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Abstract
Over the past few decades, artificial intelligence (AI) has gained substantial momentum, with its applications in medical imaging growing worldwide. However, countries like Pakistan face challenges in integrating AI-based solutions within healthcare. Using AI in medical imaging can help find diseases faster and make better use of resources.

INTRODUCTION

Radiology plays a crucial role in diagnosing and treating many medical conditions, providing physicians with images of the body's internal structures to aid in diagnosis and treatment planning. However, interpreting medical images is a complex and time-consuming process, often requiring specialized expertise and extensive

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training. In recent years, artificial intelligence (AI) has emerged as a powerful tool in radiology, offering new possibilities for improving accuracy, efficiency, and patient outcomes (1).

Radiology, which focuses on using imaging techniques to identify and cure disorders, is an important area of modern medicine. It helps direct treatment and control illnesses throughout time, so it's not just about identifying issues. With the use of devices like CT scans, MRIs, PET scans, ultrasounds, and X-rays, radiography gives medical professionals precise images that help them make choices quickly, monitor patient progress, and build a comprehensive picture of their health. These imaging methods help physicians better understand the architecture, function, and disease processes of the body, which facilitates treatment customization, enhances results, and lessens adverse effects (2).

Artificial Intelligence:

Over the past few decades, artificial intelligence (AI) has advanced quickly and had a big impact on a number of industries, including healthcare. A group of technologies known as artificial intelligence (AI) give computers the ability to carry out a variety of sophisticated tasks, including comprehending and translating language, evaluating information, resolving issues, and formulating recommendations. These qualities have become AI essential, especially in the field of medical imaging, where its uses are revolutionizing diagnostic procedures (3).

The application of artificial intelligence (AI) methods, specifically machine learning (ML) and deep learning (DL), to the analysis of medical pictures is known as AI in medical imaging. These methods enable computers to use medical imaging data to find patterns, spot anomalies, and help diagnose illnesses. AI has improved radiology's diagnosis efficiency and accuracy by utilizing these capabilities.

Machine learning:

Without explicit programming, computers may learn from data and gradually get better at what they do thanks to machine learning, a subfield of artificial intelligence. In order to find patterns and make decisions based on incoming data, algorithms are used.

An ML model's primary characteristic is its capacity for autonomous adaptation, learning from past computations and generating trustworthy outcomes while new datasets are continuously fed into the model.

Healthcare is evolving as a result of machine learning (ML), which speeds up and improves the analysis of big datasets. When compared to conventional methods, advanced techniques like logistic regression, support vector machines, and clustering offer superior diagnostic capabilities, assisting medical practitioners in more effectively managing patient care.

Ensemble learning, which integrates several models to increase prediction accuracy, is one of the most effective strategies. These developments demonstrate machine learning's increasing potential to enhance conventional cancer detection and prevention techniques, opening up new avenues for better, more precise treatment (4).

Deep learning:

Deep learning is a branch of machine learning that models intricate patterns in massive datasets by using multi-layered neural networks, or deep neural networks. By automatically extracting high-level characteristics from unprocessed data, deep learning performs very well in tasks like speech recognition, image recognition, and natural language understanding.

Deep learning-based techniques have demonstrated remarkable efficacy in enhancing the precision and effectiveness of image registration over the last ten years. In contrast to conventional techniques, deep learning uses a training dataset to optimize a global objective function in order to train a general network. During the testing phase, the network is applied straight to every image pair after it has been trained, using preset network weights and requiring no additional optimization. This strategy has a number of benefits. By averaging out noisy or deceptive gradients that might result in less-than-ideal solutions, the variety in the training

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dataset serves as an implicit regularization, smoothing the loss landscape.

Additionally, pre-trained weights (often referred to as transfer learning) in conjunction with sophisticated optimization algorithms improve deep learning's capacity to optimize intricate, non-convex problems. This enhances the performance of deep learning models by enabling them to find the global minima more efficiently. Additionally, deep learning techniques do not require iterative optimization stages because they process image pairings in a single forward pass. This results in a notable speed advantage over conventional optimization-based techniques, making deep learning significantly faster in addition to being more accurate. Because of these advantages, deep learning has emerged as a viable method for picture registration, providing better performance and efficiency than conventional methods (5).

Lastly, AI-assisted medical imaging is attracting the attention of major tech firms like Google, Apple, IBM, and Microsoft. However, the majority are currently endorsing the AI solutions of others. For instance, Google has collaborated with businesses that use AI in medical imaging, such as Zebra Medical Imaging, Change Healthcare, and Kanteron Systems (6),(7).

Additionally, Google provides numerous partners with Google Cloud, a platform for data storage and machine learning development. Amazon currently provides an AI-based service that quickly de-identifies medical images, while Microsoft has invested in its artificial intelligence platform for developers in an effort to enhance medical imaging diagnostics 14, 15. Additionally, despite the fact that none of the big IT firms have yet to produce a medical imaging solution, their collaborations show a strong desire to get involved in this market (8).

AI in medical imaging has enormous potential to revolutionize processes for diagnosis and treatment in the future. AI models will improve diagnostic speed, accuracy, and decision making as they develop, minimizing human error and allocating resources as efficiently as possible. More advanced picture analysis, such as early disease detection, disease progression prediction, and treatment plan personalization, will be made possible by the anticipated advancement of machine learning algorithms, especially deep learning. AI will make it easier to analyze imaging results in real time as the amount of medical data increases, assisting doctors in making accurate and fast diagnoses. Additionally, combining AI with other medical technologies like telemedicine and electronic health records (EHR) may spur more advancements in tailored care and remote diagnostics (9).

However, there are still obstacles to the broad use of AI, especially in environments with limited resources. It will be essential to guarantee fair access to AI technologies and get beyond obstacles like the requirement for specialized infrastructure, training, and ethical issues. Future studies must concentrate on developing standardized AI models that can be easily incorporated into clinical processes in a variety of healthcare settings as the technology advances. To solve issues with data privacy, algorithm transparency, and clinical validation, cooperation between physicians, data scientists, and regulatory agencies will be essential. AI has the potential to transform medical imaging with continued development and appropriate application techniques, enhancing patient outcomes and the general effectiveness of healthcare systems (10).

AI integration in radiology has shown significant benefits globally, allowing radiologists to quickly and accurately identify anomalies. However, there are wide variations in how AI is being incorporated into healthcare systems, especially in poorer nations like Pakistan. AI has the ability to significantly change radiological practices in Peshawar, Pakistan, but obstacles such a lack of knowledge, insufficient training, and infrastructure are preventing this from happening. (3)

For AI to be adopted in medical imaging, radiology professionals' knowledge, attitudes, and practices (KAP) are crucial. Comprehending these elements aids in locating training deficiencies, resolving ethical dilemmas, and creating plans to facilitate AI adoption (11). The situation in places like Peshawar necessitates targeted research to

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evaluate the present level of radiology experts' readiness for this technological change, even though affluent countries are making strides in integrating AI.

METHODOLOGY

Study Design

The study adopted a cross-sectional, quantitative design to investigate the knowledge, attitudes, and practices (KAPs) of radiology professionals regarding Artificial Intelligence (AI) in medical imaging. This design facilitated the collection of data from a specific point in time, making it suitable for assessing the current awareness and perceptions of AI among radiology professionals in Peshawar.

Study Settings

The study was conducted in multiple hospitals across Peshawar, including Hayatabad Medical Complex (HMC), Peshawar Institute of Cardiology (PIC), and Khyber Teaching Hospital (KTH).

Study Duration

Study duration for this research work was 6 months w.e.f March 2024 to August 2024.

Sample Size

The sample size was determined using Slovin's formula, which calculates an appropriate sample size based on a known population size and a specified margin of error. Slovin's formula is used to determine an appropriate sample size when the population size is known and the margin of error is specified. It is particularly useful for researchers when conducting surveys or studies with a known population size. (8)

Formula: n=N/1+N(e^2) Where:

n = Sample size N = Population size e = Margin of error (expressed as a decimal)

Steps to Calculate Sample Size for Population of 178 For a population size (N) of 178 and a margin of error (e) of 5% (e=0.05): n = 178/1+178 (0.05) ^2 n = 123

In the case of a population of 178 and a margin of error of 5%, the calculated sample size is 123, meaning that 123 respondents or observations are needed to achieve the desired accuracy in the results.

Sampling Technique

A convenience sampling technique was used to ensure the sample accurately represented different professional categories (radiologists, TMOs, and technologists) and encompassed diverse experience levels and hospital affiliations.

Inclusion Criteria:

Radiology professionals working in hospitals and medical centers in Peshawar were included in the study. These participants comprised radiologists, radiology technologists, and radiology TMOs.

Exclusion criteria:

However, the study excluded radiology technicians, radiographers, and radiology students to maintain a focused scope on specific professional categories.

In this study we excluded, students and trainees who are not proper staff of the operation theater.

Data Collection Procedure

The data collection method will involve the development of a structured questionnaire comprising several focused sections. The first section will gather demographic information, including age, gender, qualification, designation, years of experience, and current workplace. The second section will assess knowledge of AI, exploring participants' awareness and understanding of AI technologies and their applications in medical imaging. The third section will examine attitudes towards AI, delving into general perceptions, openness to adoption, and the perceived benefits or drawbacks of AI in radiology. Lastly, the fourth section will address practices related to AI, investigating current usage, the integration of AI tools in daily practice, and participants' training or exposure to AI technologies.

The questionnaire included both closed-ended and open-ended questions to capture a combination of quantitative and qualitative data. Closed-ended questions facilitated the

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quantification of KAPs, while open-ended questions provided deeper insights into participants' experiences and concerns.

Data Analysis Procedure:

The study utilized SPSS Version 22.0 software for data analysis to ensure accurate and efficient examination of the collected data. Frequency tables were employed to analyze demographic variables, providing a clear summary of participant characteristics. Additionally, cross-tabulation and chi-squared tests were applied to explore statistical associations between variables. The level of statistical significance was set at 5%, with a p-value of less than 0.05 considered statistically significant, ensuring rigorous evaluation of the data.

Ethical Consideration:

Ethical approval for the study was obtained from the institutional review boards of Hayatabad Medical Complex (HMC), Peshawar Institute of Cardiology (PIC), Khyber Teaching Hospital (KTH), and the Institute of Kidney Diseases (IKD). All participants provided informed consent prior to their involvement in the study. Participation was entirely voluntary, and confidentiality of the responses was maintained throughout the research process.

RESULTS

A total of 123 questionnaires were initially collected, with 105 valid responses (%) included in the final analysis. This exclusion was necessary due to 18 questionnaires containing duplicate responses and incorrect data entries within the KAP dimensions. The demographic data of the participants in this study provides a comprehensive overview of the radiology professionals surveyed in Peshawar, Pakistan. A total of 105 participants were included, with 62 males (59%) and 43 females (41%), highlighting a slight male predominance in the sample.

In terms of age distribution, the majority of participants (69, 65.7%) were between 20–29 years, followed by 22 participants (21%) aged 30–39 years, 13 participants (12.4%) aged 40–49 years, and 1 participant (1%) aged 50–59 years. This indicates that most of the respondents were early-career professionals. Regarding educational qualifications, nearly half (50 participants, 47.6%) held a specialization in radiology, while 46 participants (43.9%) had a bachelor's degree in radiology. A smaller proportion of respondents (9 participants, 8.6%) had a master's degree in radiology as their qualification, indicating a diverse range of educational backgrounds among the respondents. The distribution of participants by professional designation shows that 16 participants (15.2%) were Radiologists, 34 participants (32.4%) were Radiology TMOs, and 55 participants (52.4%) were Radiology Technologists. This reflects a balanced representation of different professional roles within the radiology field.

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Table 1 - Demographic Data

Variables			Number	(%)
Gender		Male	62	59
		Female	43	41
Age		20-29	69	65.7
		30-39	22	21.0
		40-49	13	12.4
		50-59	1	1.0
Education Qualification		Specialization in Radiology	50	47.6
		BS in Radiology	46	43.9
		Master's Degree in Radiology	9	8.6
Designation		Radiologist	16	15.2
		Radiology TMO	34	32.4
Years of		Radiology Technologist	55	52.4
Experience		0-5 Years	73	69.5
		6-10 Years	18	17.1
		11-15 Years	5	4.8
Current		16 Years and Above	9	8.6
Workplace		Public Hospital	85	81.0
		Private Hospital	11	10.5
		Academic Institution	9	8.6

Years of professional experience varied, with the majority (73 participants, 69.5%) having 0–5 years of experience, followed by 18 participants (17.1%) with 6–10 years of experience. A smaller proportion had 11–15 years (5 participants, 4.8%) and 16 years or more (9 participants, 8.6%) of experience, indicating that most participants were relatively new to the field. In terms of workplace, 85 participants (81%) were employed in public hospitals, 11 participants (10.5%) worked in private hospitals, and 9 participants (8.6%) were affiliated with academic institutions. This distribution suggests that the majority of radiology professionals in the study were working in public sector healthcare facilities. [Table 1].

Gender and Knowledge

Among participants, 47 males (44.8%) and 35 females (33%) were familiar with the concept of AI in medical imaging, while 15 males (14.3%) and 8 females (7.6%) were not (p = 0.496). Regarding understanding of AI applications in radiology, 15 males (24.2%) and 10 females (23.3%) rated their understanding as "Excellent," while "Good" ratings were reported by 27 males (43.5%) and 15 females (34.9%). "Fair" understanding was noted by 15 males (24.2%) and 12 females (27.9%), and "Poor" by 5 males (8.1%) and 6 females (14%) (p = 0.691).

The presence of AI tools in radiology departments was more commonly reported by females (26, 24.8%) than males (20, 19%), while the absence of AI tools was higher among males (41, 39%) than females (17, 16.2%) (p = 0.014). Participation in AI-related training or workshops was low, with only 5 males (4.8%) and 7 females (6.7%) attending, and most reporting no participation (p = 0.13).

Knowledge of Machine Learning and Deep Learning was stronger among females, with 10 (9.5%) reporting a strong understanding compared to 4 males (3.8%). Basic understanding was reported by 22 males (21%) and 13 females (12.4%), while familiarity with one field was minimal (p = 0.052). [Table 2]

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Table 2 - Cross Tab and Chi-square between Gender and Knowledge

Factors	Answers	Male n(%)	Female n(%)	p-value
Are you familiar with the concept of Artificial Intelligence (AI) in				
medical imaging?	Yes	47 (44.80)	35 (33)	0.496
How would you rate your understanding of AI	No	15 (14.30)	8 (7.6)	
applications in radiology?	Excellent	15 (24.2)	10 (23.3)	0.691
	Good	27 (43.5)	15 (34.9)	
	Fair	15 (24.2)	12 (27.9)	
Is there any use of AI in radiology in your	Poor	5 (8.1)	6 (14)	
department?	Yes	20 (19)	26(24.8)	0.014
	No	41 (39)	17 (16.2)	
Have you participated in any AI training or workshop on AI in				
radiology?	Yes	5 (4.8)	7 (6.7)	0.13
Do you have any	No	57 (54.3)	36 (34.3)	
knowledge about Machine Learning and Deep Learning, fields of AI?	Strong understanding of both	4 (3.8)	10 (9.5)	0.052
	Basic understanding of both	22 (21)	13(12.4)	
	Familiar with one	6 (5.7)	1 (1)	
	Not familiar with either	30 (28.6)	19 (18.1)	

Gender and Attitude

Regarding AI enhancing radiological diagnoses, 13 males (12.4%) and 9 females (8.6%) strongly agreed, while 23 males (21.9%) and 16 females (15.2%) agreed. Neutral responses were noted from 15 males (14.3%) and 12 females (11.4%) (p = 0.984). Concern over AI potentially replacing radiology professionals was higher among females, with 11 (10.5%) agreeing compared to 6 males (5.7%). Strong agreement was reported by 9 males (8.6%) and 2 females (1.9%) (p = 0.031).

When asked about integrating AI into daily radiology practice, 6 males (5.7%) and 8 females (7.6%) felt "Very Positive," while "Positive" responses were reported by 26 males (24.8%) and 13 females (12.4%) (p = 0.268). On AI reducing workload, 6 males (5.7%) and 6 females (7.6%) strongly agreed, with 22 males (21%) and 20 females (19%) agreeing. Neutral responses included 15 males (14.3%) and 11 females (10.5%) (p = 0.209). Regarding willingness for further training on AI, 56 males (53.3%) and 41 females (39%) responded positively, while a minority declined (p = 0.34). [Table 3]

Table 3 – Cross Tab and Chi-square between Gender and Attitude

Factors	Answers	Male n(%)	Female n(%)	p-value
Do you believe AI can enhance the accuracy of				
radiological diagnoses?	Strongly Agree	13 (12.4)	9 (8.6)	0.984
	Agree	23 (21.9)	16 (15.2)	
	Neutral	15 (14.3)	12 (11.4)	

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	Disagree	4 (3.8)	2 (1.9)		
Are you concerned that AI might replace radiology professionals	Strongly Disagree	7 (6.7)	4 (3.8)		
in the future?	Strongly Agree	9 (8.6)	2 (1.9)		0.031
	Agree	6 (5.7)	11 (10.5)		
	Neutral	17 (16.2)	6 (5.7)		
	Disagree	20 (19)	20 (19)		
How do you feel about integrating AI into your	Strongly Disagree	10 (9.5)	4 (3.8)		
daily radiology practice?	Very Positive	6 (5.7)	8 (7.6)		0.268
	Positive	26 (24.8)	13 (12.4)		
	Neutral	18 (17.1)	15 (14.3)		
	Negative	6 (5.7)	1 (1)		
Do you think AI will reduce the workload of	Very Negative	6 (5.7)	6 (5.7)		
radiology professionals?	Strongly Agree	6 (5.7)	7 (6.7)		0.209
	Agree	22 (21)	20 (19)		
	Neutral	15 (14.3)	11 (10.5)		
	Disagree	10 (9.5)	2 (1.9)		
Would you be willing to undergo further training on AI to enhance your	Strongly Disagree	9 (8.6)	3 (2.9)		
skills?	Yes	56 (53.3)	41 (39)		0.34
	No	6 (5.7)	8 (7.6)		

Gender and Practice

The use of AI tools in radiology practice was reported by 10 males (9.5%) and 11 females (10.5%), while 52 males (49.5%) and 32 females (30.5%) reported not using AI tools (p = 0.234). Frequency of AI use in daily practice varied, with 12 males (11.4%) and 8 females (7.6%) using AI daily, while most participants rarely or never used AI (p = 0.648).

Regarding the accuracy of AI in radiological diagnosis, 5 males (4.8%) and 3 females (2.9%) rated it as "Very Accurate," while 19 females (18.1%) and 17 males (16.2%) rated it as "Accurate" (p = 0.013). Confidence in interpreting AI-generated medical imaging results was low overall, with only 2 males (1.9%) and 1 female (1%) being "Very Confident," and most participants expressing moderate or no confidence (p = 0.087).

Barriers to AI adoption included a lack of resources, reported by 25 males (23.8%) and 9 females (9.5%), and knowledge/training gaps reported by 13 males (12.4%) and 6 females (5.7%) (p = 0.009). [Table 4]

Table 4 - Cross Tab and Chi-square between Gender and Practice

Factors	**Answers**	**Male n(%)**	**Female n(%)**	**p-value**
Do you currently use any AI tools in your radiology practice?	Yes	10 (9.5)	11 (10.5)	0.234
How frequently do you use AI in your	No	52 (49.5)	32 (30.5)	
daily practice?	Daily	12 (11.4)	8 (7.6)	0.648
	Weekly	4 (3.8)	1 (1)	

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	Monthly	4 (3.8)	6 (5.7)	
	Rarely	16 (15.2)	10 (9.5)	
How would you rate the accuracy of AI in radiological	Never	26 (24.88)	18 (17.1)	
diagnosis?	Very Accurate	5 (4.8)	3 (2.9)	0.013
	Accurate	17 (16.2)	19 (18.1)	
	Slightly Accurate	18 (17.1)	6 (5.7)	
	Not Accurate	9 (8.6)	0 (0)	
How confident are you in interpreting AI-generated medical imaging	No Comments	13 (12.4)	15 (14.3)	
results?	Very Confident	2 (1.9)	1 (1)	0.087
	Confident	16 (15.2)	18 (17.1)	
	Slightly Confident	17 (16.2)	6 (5.7)	
	Not Confident	14 (13.3)	4 (3.8)	
What are the	No Comments	13 (12.4)	14 (13.3)	
barriers to adopting AI in your practice?	Lack of Knowledge/Training	13 (12.4)	6 (5.7)	0.009
	Lack of Resources	25 (23.8)	10 (9.5)	
	Resistance to change	3 (2.9)	1 (1)	
	Lack of Infrastructure	10 (9.5)	3 (2.9)	
	Other	1 (1)	1 (1)	
	Multiple Reasons	10 (9.5)	22 (21)	

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Designation and Knowledge

Familiarity with the concept of AI in medical imaging was highest among Radiologists, with 15 (93%) reporting familiarity compared to 29 Radiology TMOs (85%) and 38 Radiology Technologists (69.2%) (p = 0.052). For understanding AI applications in radiology, 6 Radiologists (37.5%), 6 Radiology TMOs (17.6%), and 13 Radiology Technologists (23.6%) rated their understanding as "Excellent." "Good" responses were noted from 4 Radiologists (25%), 11 TMOs (32.4%), and 27 Technologists (49.1%) (p = 0.211).

The presence of AI tools in radiology departments was reported by 7 Radiologists (43.8%), 10 TMOs (29.4%), and 29 Technologists (55.8%). Among these, AI use was mostly reported in multiple modalities by Radiologists (25%) and TMOs (41.2%), while 7 Technologists (12.7%) used it across multiple modalities (p = 0.205). Participation in AI-related training or workshops was highest among Radiology Technologists (7, 13%), followed by 3 Radiologists (18.8%) and 5 TMOs (14.7%) (p = 0.342).

Knowledge of Machine Learning and Deep Learning showed that 5 Radiologists (31.3%), 9 TMOs (26.5%), and 21 Technologists (38.2%) had a basic understanding. A strong understanding was noted in 5 Radiologists (31.3%), 4 TMOs (11.8%), and 5 Technologists (9.1%) (p = 0.279). [Table 5]

Table 5 - Cross Tab and Chi-square between Designation and Knowledge

Factors Are you familiar with the concept of Artificial Intelligence (AI) in medical	**Answers**	**Radiologist n (%)**	**Radiology TMO n (%)**	**Radiology Technologist n (%)**	**p-value**
imaging?	Yes	15 (93)	29 (85)	38 (69.2)	0.052
How would you rate your understanding of AI	No	1 (6.3)	5 (14.7)	17 (16.2)	
applications in radiology?	Excellent	6 (37.5)	6 (17.6)	13 (23.6)	0.211
	Good	4 (25)	11 (32.4)	27 (49.1)	
	Fair	4 (25)	11 (32.4)	12 (21.8)	
Is there any use of AI in	Poor	2 (12.5)	6 (17.6)	3 (5.5)	
radiology in your department?	Yes	7(43.80)	10(29.40)	29(55.80)	0.205
If Yes, which modality is AI is	No	9(56.30)	24(70.60)	26(44.20)	
being used for?	CT	0(0)	3(8.80)	7(12.70)	
	MRI	2(12.50)	2(5.905)	6(10.90)	0.468
	U/S	2(12.50)	1(2.90)	4(7.30)	
	X-RAY	0(0)	0(0)	4(7.30)	
	IR	0(0)	0(0)	1(1.80)	
	Nuclear Radiology	0(0)	2(5.90)	1(1.80)	
	NO	8(50.00)	22(64.70)	25(45.50)	
Have you participated in training or workshop on AI	Multiple	4(25.00)	4(11.80)	7(12.70)	
related radiology?	Yes	3(18.8)	5(14.7)	4(7.3)	
	No	13(81.3)	29(85.3)	51(92.7)	0.342

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Do you have any knowledge about Machine Learning and Deep learning?	Strong understanding of both 5(31.3)	4(11.8)	5(9.1)	
	Basic understanding of both 5(31.3)	9(26.5)	21(38.2)	0.279
	Familiar with one 0(0)	3(8.8)	4(7.3)	
	Not familiar with either 6(37.5)	18(52.9)	25(45.5)	

Designation and Attitude

The belief that AI enhances radiological diagnosis was strongly agreed upon by 7 Radiologists (43.8%), 7 TMOs (20.6%), and 8 Technologists (14.5%), with significant differences between groups (p = 0.009). Fig. 2. Agreement was also higher among TMOs (17, 50%) and Technologists (16, 29.1%) compared to Radiologists (6, 37.5%). Concerns about AI replacing radiology professionals showed 3 Radiologists (18.8%) and 8 Technologists (14.5%) strongly agreed, while disagreement was most common among Radiologists (7, 43.8%) and TMOs (16, 47.1%) (p = 0.088).

Positive attitudes toward integrating AI into daily practice were noted among 6 Radiologists (37.5%), 5 TMOs (14.7%), and 3 Technologists (5.5%) as "Very Positive." Most participants expressed "Positive" attitudes, including 3 Radiologists (18.8%), 16 TMOs (47.1%), and 20 Technologists (36.4%) (p = 0.005).

The perception that AI reduces workload was agreed upon by 3 Radiologists (18.8%), 22 TMOs (64.7%), and 13 Technologists (23.6%). Significant differences were observed (p = 0.000).Willingness to undergo AI training was high across groups, with 13 Radiologists (81.3%), 31 TMOs (91.2%), and 53 Technologists (96.4%) expressing agreement (p = 0.127). [Table 6]

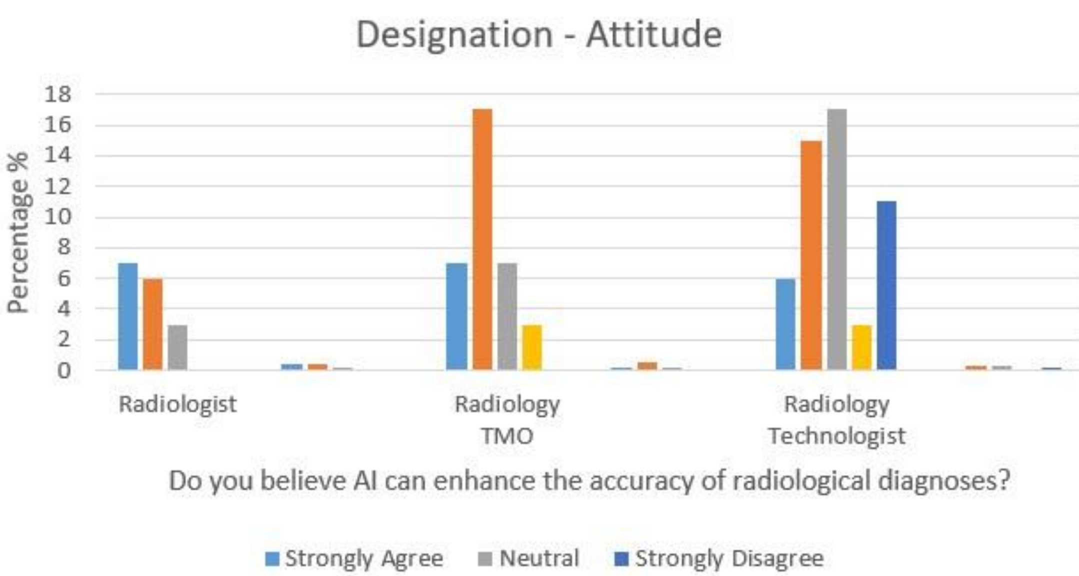

Fig 1.

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Table 6 - Cross Tab and Chi-square between Designation and Attitude

Factors	Answers	Radiologist n (%)	Radiology TMO n (%)	Radiology Technologist n (%)	p-value
Do you believe AI can enhance the accuracy of radiological diagnosis?	Strongly Agree	7(43.8)	7(20.6)	8(14.5)	0.009
	Agree	6(37.5)	17(50.0)	16(29.1)	
	Neutral	3(18.8)	7(20.6)	17(30.9)	
	Disagree	0(0)	3(8.8)	3(5.8)	
	Strongly Disagree	0(0)	0(0)	11(25)	
Are you concerned that AI might replace radiology professionals in future?	Strongly Agree	3(18.8)	0(0)	8(14.5)	0.088
	Agree	2(12.5)	9(26.5)	6(10.9)	
	Neutral	2(12.5)	7(20.6)	14(25.0)	
	Disagree	7(43.8)	16(47.1)	17(32.7)	
	Strongly Disagree	2(12.5)	2(5.9)	10(19.2)	
How do you feel about integrating AI into your daily radiology practice?	Very positive	6(37.5)	5(14.7)	3(5.5)	0.005
	Positive	3(18.8)	16(47.1)	20(36.4)	
	Neutral	7(43.8)	9(26.5)	17(30.9)	
	Negative	0(0)	3(8.8)	4(7.3)	
	Very Negative	0(0)	1(2.9)	11(20)	
Do you think AI will reduce work load of radiology professionals?	Strongly Agree	3(18.8)	4(11.8)	6(10.9)	0.000
	Agree	7(43.8)	22(64.7)	13(23.6)	
	Neutral	5(31.3)	8(23.5)	13(23.6)	
	Disagree	0(0)	0(0)	12(21.8)	
	Strongly disagree	1(6.3)	0(0)	11(20)	
Would you be willing to undergo further training on AI to enhance your skills?	YES	13(81.3)	31(91.2)	53(96.4)	0.127
	NO	3(18.8)	3(8.8)	2(3.6)	

Designation and Practice

According to Table 7, the use of AI tools in radiology practice was reported by 4 Radiologists (25%), 8 TMOs (23.5%), and 9 Technologists (16.4%), while the majority reported no use of AI tools (p = 0.616). AI-based image reconstruction and automated reporting systems were the most common tools, used by a small proportion across all designations (p = 0.715).

Frequency of AI use in daily practice varied, with daily usage highest among

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Technologists (13, 23.6%) compared to Radiologists (3, 18.8%) and TMOs (4, 11.8%) (p = 0.249).Accuracy of AI in radiology was rated as "Very Accurate" by Technologists only (8, 14.5%), with "Accurate" ratings highest among TMOs (14, 41.2%) and Technologists (16, 29.1%) (p = 0.006). Confidence in interpreting AI-generated medical imaging was low, with no Radiologists or TMOs reporting "Very Confident." Only 3 Technologists (5.5%) reported high confidence, while most participants expressed slight or no confidence (p = 0.016). Barriers to AI adoption included lack of resources, reported by 4 Radiologists (25%), 2 TMOs (5.9%), and 29 Technologists (52.7%), as well as knowledge gaps, cited by 4 Radiologists (25%), 5 TMOs (14.7%), and 10 Technologists (18.2%) (p = 0.0). [Table 7]

Table 7 - Cross Tab and Chi-square between Designation and Practice

Factors Do you currently use any AI tools in your radiology	**Radiologist Answers**	**n (%)**	**Radiology TM n (%)**	**Radiology Technologist n(%)**	**p-value**
Practice?	Yes	4(25.0)	8(23.5)	9(16.4)	0.616
	No	12(75.0)	26(76.5)	46(83.6)	
If yes which AI tools do you used?	AI based image reconstruction	2(12.5)	3(8.8)	6(10.9)	0.715
	Automated report system	2(12.5)	2(5.9)	6(10.9)	
	Other	0(0.0)	3(8.8)	7(12.7)	
	No tools	12(75)	25(73.5)	36(65.5)	
How frequently do you used AI in your daily	Auto detection system	0(0)	1(2.9)	0(0)	
Practice?	Daily	3(18.8)	4(11.8)	13(23.6)	0.249
	Weekly	1(6.3)	1(2.9)	3(5.5)	
	Monthly	4(25.0)	3(8.8)	3(5.5)	
	Rarely	3(18.8)	7(20.6)	16(29.1)	
How would you rate the accuracy of AI in	Never	5(31.3)	19(55.9)	20(36.4)	
Radiology?	Very Accurate	0(0)	0(0)	8(14.5)	0.006
	Accurate	6(37.5)	14(41.2)	16(29.1)	
	Strongly Accurate	5(31.3)	2(5.9)	17(30.9)	
	Not Accurate	0(0)	4(11.8)	5(9.1)	
How confident are you interpreting medical	No comments	5(31.3)	14(41.2)	9(16.4)	
imaging result?	Very confident	0(0)	0(0)	3(5.5)	0.016
	confident	4(25.0)	12(35.3)	18(32.7)	
	Slightly confident	5(31.3)	3(8.8)	15(27.3)	
	Not confident	3(18.8)	3(8.8)	12(21.8)	
What are the barriers	No comments	4(25.0)	16(47.1)	7(12.7)	
adopting adapting AI in your practice?	Lack of knowledge/ Training	4(25.0)	5(14.7)	10(18.2)	0.000
	Lack of Resources	4(25.0)	2(5.9)	29(52.7)	
	Resistance to change	0(0)	0(0)	4(7.3)	

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	Lack of infrastructure	0(0)	7(20.6)	6(10.9)	
	Other	0(0)	0(0)	2(3.6)	
	Multiple reasons	0(0)	20(58.8)	4(7.3)	

DISCUSSION

Demographic Data

The demographic profile of radiology professionals in this study provides critical insights into the workforce dynamics in Peshawar, Pakistan [Table 1]. The study revealed a male predominance (59%), consistent with trends observed in radiology professions globally, where male professionals often outnumber females in specialized roles. However, the female representation (41%) in this study is relatively higher compared to studies in Saudi Arabia and China, where the proportion of females in radiology remains lower due to cultural and institutional factors(13). This higher representation in Pakistan could indicate a positive shift toward gender diversity within the profession. Fig. 1

The age distribution highlights that the majority (65.7%) of participants were aged 20–29 years, indicating that the workforce is predominantly young and at the early stages of their careers. This trend aligns with studies in China, where younger radiologists are the primary adopters of emerging technologies like Artificial Intelligence (AI) (13). In contrast, studies in Saudi Arabia reported a more balanced age distribution, reflecting a mature workforce with more experience in radiology practices.

Fig 2.

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In terms of educational qualifications, 47.6% of participants had a specialization in radiology, and 42.9% held a bachelor's degree. A smaller percentage (8.6%) had a master's degree, and 1% reported "Other" qualifications [Table 1]. These findings reflect a diverse academic background among radiology professionals in Pakistan, similar to trends observed in China, where most professionals have basic radiology qualifications but lack advanced specialization (13). However, the limited number of participants with master's degrees highlights the need for more advanced training programs in Pakistan to align with global standards.

The distribution of professional designations shows that nearly half (52%) of the respondents were Radiology Technologists, followed by Radiology TMOs (33%) and Radiologists (15.2%). This trend is similar to findings in Saudi Arabia, where technologists represent the largest segment of the radiology workforce (5). However, the smaller proportion of Radiologists in this study underscores the need to address workforce shortages in specialized roles, a challenge faced globally in radiology. Fig. 4.

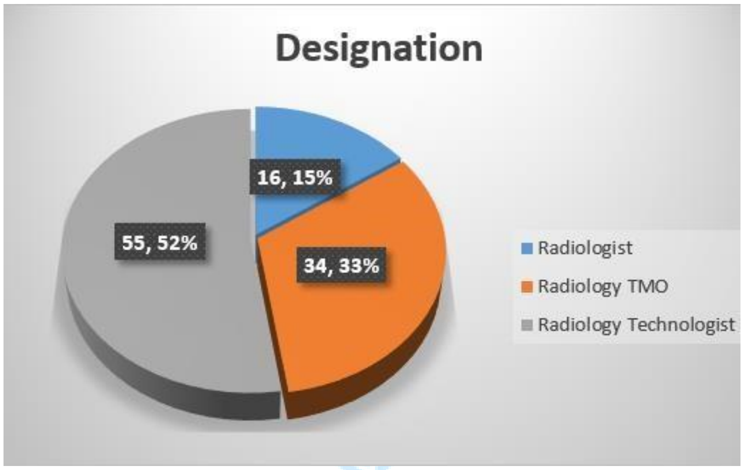

Fig 3

The analysis of years of experience revealed that 69.5% of participants had 0–5 years of experience, indicating a predominantly early-career workforce. This finding mirrors observations in China, where younger radiology professionals dominate the field, particularly in urban centers [(5), (13)]. However, the small proportion of participants with more than 15 years of experience (8.6%) suggests a lack of senior professionals, which could impact mentorship and skill development opportunities for early-career radiologists. In terms of workplace, 81% of participants were employed in public hospitals, 10.5% in private hospitals, and 8.6% in academic institutions (Table 1). This distribution highlights the dominance of public sector healthcare in Pakistan, consistent with studies in Saudi Arabia, where public hospitals employ the majority of radiology professionals (5). In contrast, China shows a more balanced distribution across public and private sectors due to significant investments in private healthcare (13). The smaller representation from academic institutions in Peshawar points to limited research and training opportunities, which may hinder the integration of advanced technologies like

AI. Fig. 1

The demographic data from this study underscores the youthful and early-career composition of the radiology workforce in Peshawar, Pakistan, with a slight male predominance and a significant representation from public hospitals. These trends align with findings from Saudi Arabia and China, while also highlighting local challenges such as a shortage of senior professionals and advanced educational qualifications. Addressing these gaps through targeted policies, enhanced training programs, and investments in both public and private

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healthcare sectors will be crucial to strengthening the radiology profession and enabling the adoption of AI technologies.

Gender and Knowledge

The findings of our study in Peshawar, Pakistan, reveal notable gender disparities in knowledge of Artificial Intelligence (AI) in radiology. Males demonstrated a slightly higher familiarity with AI concepts (44.8%) compared to females (33%), though this difference was not statistically significant ($p = 0.496$) [Table 2]. These results align with findings from Saudi Arabia, where male radiologists also exhibited greater familiarity with AI concepts, potentially reflecting a global trend of higher male exposure to technological advancements in healthcare settings. Conversely, in a study conducted in southeastern China, female radiologists demonstrated comparable or higher engagement in understanding AI applications, possibly reflecting cultural or workplace dynamics that prioritize equal access to training opportunities.

Interestingly, our study found that females in Peshawar reported higher access to AI tools in their radiology departments (24.8% vs. 19% for males), a disparity that was statistically significant ($p = 0.014$) [Table 2]. This observation diverges from findings in Saudi Arabia, where males were more likely to report exposure to AI technologies in clinical practice. Such differences may be attributable to organizational and departmental variations in the implementation of AI technologies. These findings emphasize the need for equitable access to AI
tools across genders, an issue that resonates across studies in both developed and developing countries.

Furthermore, participation in AI training workshops was low among both genders, with only 4.8% of males and 6.7% of females reporting participation. This gap highlights a global trend observed in similar studies, such as in China, where less than half of radiologists received any formal AI training despite widespread enthusiasm for integrating AI into clinical practice [(5), (13)]. Addressing these gaps in training will be critical for empowering radiology professionals in Pakistan and beyond.

Gender and Attitude

Attitudes towards AI in radiology in Peshawar were largely positive across both genders. Most participants agreed on AI's potential to enhance diagnostic accuracy, with minimal gender differences. These findings are consistent with studies in Saudi Arabia and China, where radiologists expressed optimism about the ability of AI to improve diagnostic precision and reduce workloads. However, males in our study were more concerned about AI replacing radiologists in the future (8.6% strongly agreed, compared to 1.9% of females; $p = 0.031$) [Table 3]. This trend aligns with findings from China, where male radiologists reported greater concerns about job security due to AI compared to their female counterparts.

Regarding the integration of AI into daily radiology practice, females in Peshawar exhibited slightly more enthusiasm, with 7.6% reporting a "Very Positive" attitude compared to 5.7% of males [Table 3]. Similar findings were observed in Saudi Arabia, where female radiologists showed greater openness to adopting AI tools, potentially due to a higher focus on collaborative work environments. Both genders in Peshawar demonstrated a high willingness to undergo further AI training (53.3% for males and 39% for females), comparable to results from China, where 78% of radiology residents expressed a desire to embrace AI training opportunities (13).

Gender and Practice

The practical application of AI in radiology in Peshawar remains limited, with only 9.5% of males and 10.5% of females reporting active use of AI tools in their daily practice. This trend reflects global findings, particularly in Saudi Arabia and China, where the adoption of AI tools has also been slow due to infrastructural and training barriers. However, females in Peshawar rated the accuracy of AI tools more favorably, with none reporting AI as "Not Accurate," while 8.6% of males held this view ($p = 0.013$) [Table 4]. This perception may influence how genders approach AI adoption in clinical workflows.

Confidence in interpreting AI-generated medical imaging results was moderate across both genders, with males slightly more likely to report being

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"Very Confident" (1.9% vs. 1% for females) [Table 4]. These findings mirror those from China, where radiologists expressed moderate confidence in utilizing AI, highlighting the need for hands-on training to build expertise and trust in AI technologies.
Barriers to AI adoption in Peshawar were multifaceted and echoed challenges faced globally. Males predominantly cited a lack of resources (23.8%), while females pointed to multiple reasons, including insufficient training and infrastructure. This observation is consistent with studies from Saudi Arabia and China, which identified resource limitations,

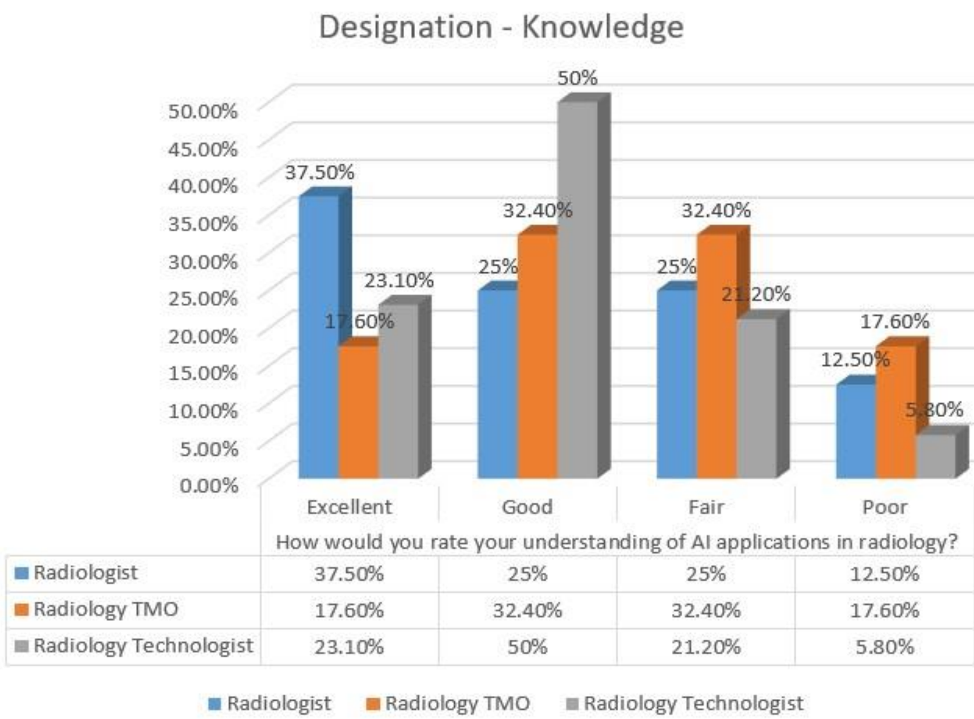

Fig 4

However, the lower levels of AI familiarity among Radiology Technologists in Peshawar highlight a disparity in access to information and training opportunities. These findings emphasize the need to design targeted training programs that cater to the specific needs of each designation, as seen in China, where AI-related workshops and continuing education programs have been shown to enhance knowledge across different professional tiers.

Designation and Attitude

The study also revealed differences in attitudes toward AI based on professional designation. Radiologists were the most optimistic, with 37.5% reporting a "Very Positive" attitude toward integrating AI into their daily practice, followed by Radiology TMOs (14.7%) and Radiology Technologists (5.8%) [Table 6]. These findings are consistent with studies from China and Saudi Arabia, where radiologists expressed a more proactive and positive stance toward AI integration, likely due to their confidence in leveraging AI as a complementary tool rather than a threat.
Interestingly, concerns about AI replacing radiology professionals in Peshawar varied significantly by designation. Radiology Technologists showed the highest level of concern AI replacing their jobs, with 21.2% strongly agreeing that AI might replace radiology personals,

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compared to only 8.6% of Radiologists and 0% of TMOs. Fig. 6.

These findings are similar to observations in Saudi Arabia, where technologists expressed more apprehension about job displacement, likely due to their lower involvement in decision-making roles (5). In contrast, radiologists in China exhibited relatively lower concerns, reflecting their belief that AI serves as an assistive rather than a replacement tool.

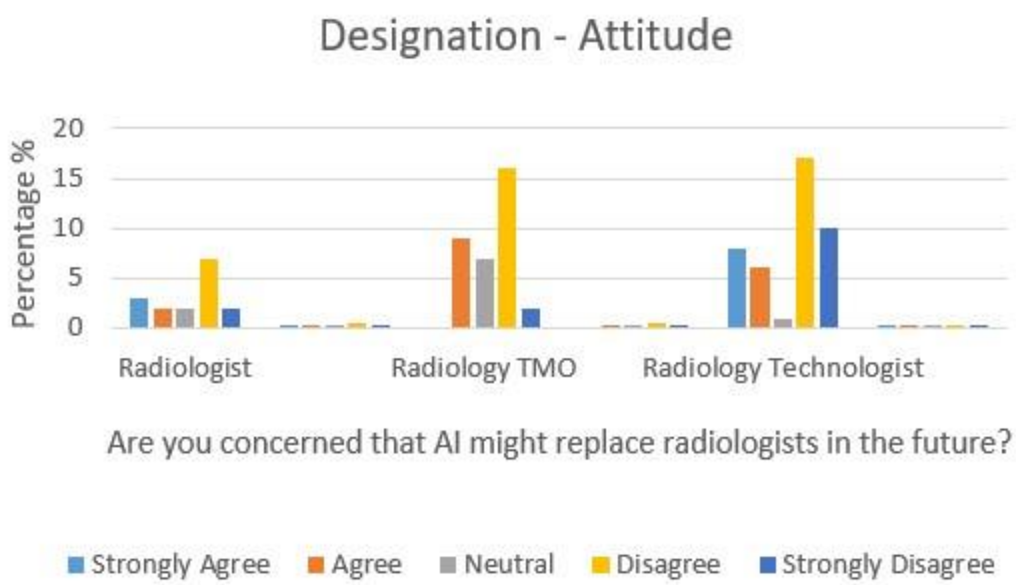

Fig. 5

Willingness to undergo AI training was high across all designations in Peshawar, with Radiology Technologists reporting the highest willingness (96.2%), followed by TMOs (91.2%) and Radiologists (81.3%) [Table 6]. This enthusiasm parallels findings from China, where most professionals expressed a strong desire for training despite existing disparities in access (13).

Designation and Practice

The practical use of AI in radiology varied significantly by designation. Radiologists in Peshawar reported the highest levels of AI usage in their departments (43.8%), followed by Radiology Technologists (55.8%) and TMOs (29.4%) [Table 7]. These findings are comparable to trends observed in Saudi Arabia, where radiologists were the primary adopters of AI tools due to their leadership roles in clinical workflows. However, in China, Radiology Technologists demonstrated higher involvement in day-to-day AI applications, reflecting their growing integration into imaging tasks [(5), (13)].

Confidence in interpreting AI-generated results also differed by designation. Radiologists in Peshawar reported higher confidence levels (25% "Confident"), while Technologists were less confident, with 28.8% reporting being "Slightly Confident" and 21.2% "Not Confident." [Table 7] Similar trends have been documented in Saudi Arabia and China, where radiologists' confidence stems from their familiarity with the theoretical and practical applications of AI. These findings highlight the need for targeted training programs to enhance confidence levels, particularly among Radiology Technologists and TMOs.

Barriers to AI adoption also varied. In Peshawar, Radiologists identified multiple barriers, including a lack of training (50%) and limited resources. Radiology Technologists cited resistance to change and inadequate infrastructure as primary obstacles. These challenges align with studies in China and Saudi Arabia, which identified similar barriers to AI adoption, such as insufficient training opportunities, limited

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institutional support, and resource constraints [(5), (13)]. Fig. 7.

Fig 6

Designation-based differences in knowledge, attitudes, and practices regarding AI in radiology are evident in Peshawar, aligning with global trends observed in Saudi Arabia and China. Radiologists demonstrate higher familiarity, confidence, and optimism, while Radiology Technologists face significant barriers to AI adoption. Addressing these gaps through targeted training and resource allocation will be essential to fostering equitable AI integration across all professional tiers in radiology. Collaborative efforts and lessons learned from countries like Saudi Arabia and China could provide valuable guidance for developing effective strategies in Pakistan.

CONCLUSION

This study provides critical insights into the knowledge, attitudes, and practices of radiology professionals in Peshawar, Pakistan, regarding Artificial Intelligence (AI) in medical imaging. The findings reveal notable disparities across gender and professional designations. Males demonstrated slightly higher familiarity with AI concepts, while females exhibited greater access to AI tools and higher confidence in the perceived accuracy of these technologies. Despite the overall positive attitudes toward AI, concerns about its potential to replace radiologists were more pronounced among certain groups, particularly Radiology Technologists. Participation in AI-related training remained low across all demographics, highlighting a significant gap in professional development.

The practical application of AI in radiology was limited, with only a minority of professionals actively using AI tools in their daily workflows. Radiologists reported higher levels of usage and confidence compared to Radiology TMOs and Technologists, reflecting their advanced training and leadership roles. Barriers to AI adoption, such as insufficient resources, limited training opportunities, and inadequate infrastructure, were prominent, particularly in public hospitals. These findings underscore the need to address systemic challenges to facilitate the integration of AI into radiology practice in Pakistan.

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