

Artificial Intelligence in Healthcare: Exploring Knowledge, Attitudes, and Practices Among Healthcare Workers in a Tertiary Care Hospital in Mardan, Pakistan — Insights from a Low- and Middle-Income Country

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Abstract

Artificial Intelligence (AI) is revolutionizing healthcare worldwide by improving diagnostics, treatment planning, and patient management. However, its effective integration into healthcare systems in low- and middle-income countries (LMICs) like Pakistan remains limited. Successful implementation largely depends on the knowledge, attitudes, and practices of healthcare professionals. This study aims to assess these factors among healthcare workers at a tertiary care hospital in Mardan, Pakistan, offering valuable insights from an LMIC context. To evaluate the knowledge, attitudes, and practices of healthcare professionals regarding the use of Artificial Intelligence (AI) in healthcare settings. A cross-sectional study was conducted from July to December 2024. Healthcare workers were consecutively surveyed using a validated KAP questionnaire with strong reliability (Cronbach's alpha: 0.89 for KAP, 0.79 for awareness/behavior). Scores ranged from 0–12 for knowledge, 0–18 for attitude, and 0–16 for practice. Data were analyzed using descriptive statistics and group comparisons (t-tests, Chi-square, Mann–Whitney U) based on age, gender, occupation, and qualification; significance was set at $p < 0.05$. Among 250 participants (mean age 32.1 ± 6.1 years; 67% male), 58.3% were doctors, 30.9% paramedics, and 10.9% nurses. Mean scores were: knowledge 9.2 ± 2.9 , attitude 12.8 ± 3.6 , and practice 11.7 ± 3.6 . Good knowledge, positive attitudes, and adequate practice were observed in 60%, 54.8%, and 64.8% of participants, respectively. Female participants and paramedics had comparatively higher KAP scores than their counterparts. Attitude differed significantly by occupation and education ($p=0.01$), while practice varied among diploma holders and paramedics. Healthcare professionals in this LMIC setting demonstrate moderate knowledge, positive attitudes, and fair practices towards AI. Targeted education and policy initiatives are essential to improve AI readiness and integration in healthcare systems like Mardan.

Key Words: Artificial Intelligence, Healthcare Professionals, Knowledge, Attitude, LMICs

Introduction

The integration of artificial intelligence (AI) into healthcare systems is revolutionizing modern medicine by enhancing diagnostic precision, optimizing treatment strategies, and improving healthcare efficiency across various specialties, ultimately reshaping medical decision-making and redefining patient care (1). This technological paradigm shift continues to evolve rapidly, with AI applications extending from virtual health assistants and precision imaging to drug discovery and personalized medicine, establishing an increasingly interconnected framework for contemporary healthcare services (2). As healthcare organizations globally contend with escalating demands, resource constraints, and complex patient needs, AI technologies offer unprecedented opportunities to democratize specialized knowledge, standardize care protocols, and achieve what experts have termed the "quadruple aim" of healthcare: improved patient experience, better health outcomes, cost efficiency, and enhanced clinician well-being (3). Despite significant advancements, the successful integration of AI in clinical settings depends on multiple interconnected factors beyond technological capabilities. Research highlights several challenges, including ethical and privacy concerns, technological reliability, professional liability issues, and, most importantly, the readiness of healthcare professionals to adopt these innovations (4). The knowledge levels, attitudes, and practical readiness of clinicians represent critical determinants in the effective deployment of AI technologies, as these professionals ultimately serve as the primary interface between computational systems and patient care (5). Understanding these human factors is crucial, as healthcare professionals operate within diverse cultural, educational, and institutional contexts that significantly shape their perspectives on adopting new technologies (6). Current literature reveals a concerning knowledge gap regarding healthcare workers' understanding of and attitudes toward AI implementation, particularly in developing healthcare systems and non-Western contexts (7). While preliminary investigations have identified that younger healthcare professionals, those with full-time employment, and individuals with prior AI exposure through conferences or research tend to possess better knowledge and more positive attitudes toward AI integration, comprehensive research across diverse healthcare settings remains limited (8). This knowledge deficiency becomes particularly pronounced when examining specific regional contexts like Pakistan, where technological adoption patterns, healthcare infrastructure, and professional training paradigms may differ substantially from more extensively studied Western healthcare systems (9). Despite the global nature of technological advancement, the localized factors influencing AI adoption demand contextualized investigation to develop effective implementation strategies (10). This research addresses this critical gap by examining the knowledge, attitudes, and practices regarding artificial intelligence among healthcare workers at a tertiary care hospital in Mardan, Pakistan. The study aims to comprehensively assess healthcare professionals' current understanding of AI applications in medicine, evaluate their attitudinal dispositions toward technological integration, and document existing practices or readiness for AI within this specific institutional context.

Material and Methods

This descriptive cross-sectional study was conducted at Medical Teaching Institution Mardan Medical Complex which is a tertiary care hospital of Khyber Pakhtunkhwa, Pakistan over a six-month period from July to December 2024. The study population included doctors, nurses, and allied health professionals, while administrative and supporting staff were excluded. A convenient sampling technique was used and sample size was calculated using OpenEpi (www.openepi.com). Ethical approval was obtained from the Advanced Studies and Research Board (AS&RB) of Medical teaching institution Bacha Khan Medical College, Mardan (Reference No. 577/BKMC). Informed consent was obtained from all participants, ensuring confidentiality and voluntary participation. Data were collected using a structured, pre-validated questionnaire comprising four

sections: sociodemographic information, and items assessing knowledge, attitude, and practice regarding artificial intelligence (AI). Data were analyzed using IBM SPSS Statistics version 26. Continuous variables (age, and knowledge, attitude, and practice scores) were presented as means $\pm$ standard deviations, while categorical variables were summarized as frequencies and percentages. Independent t-tests were used to compare mean scores between groups. Categorical variables were analyzed using the Chi-square test. In cases where the expected cell counts were less than 5, the Monte Carlo exact test was applied to obtain accurate p-values. Statistical significance was set at $p < 0.05$ with a 95% confidence level.

Results

A total of 230 healthcare workers were included in the study. The mean age of the participants was 32.1 ± 6.1 years, ranging from 21 to 53 years. Among them, 154 (67%) were males and 76 (33%) were females. In terms of job designation, 134 (58.3%) were doctors, 25 (10.9%) were nurses, and 71 (30.9%) were technicians or technologists. Regarding educational background, 69 (30%) participants were FCPS graduates, 65 (28.3%) held MBBS or BDS degrees, 20 (8.7%) had BSN degrees, 30 (13%) were graduates of BS Allied Health Sciences, and 46 (20%) were diploma holders. The mean knowledge, attitude, and practice (KAP) scores are presented in Table 1.

Table 1: Comparison of Knowledge, Attitude, and Practice Scores Across Demographic Subgroups of Healthcare Professionals

Demographic	Knowledge (X $\pm$ SD)	Attitude (X $\pm$ SD)	Practice (X $\pm$ SD)
Age			
>45 years (n = 07)	9.2 $\pm$ 3.1	12.8 $\pm$ 3.6	11.8 $\pm$ 3.6
$\leq$ 45 years (n = 223)	9.7 $\pm$ 2.4	12.5 $\pm$ 4.8	12.6 $\pm$ 3.4
Gender			
Male (n = 154)	9.0 $\pm$ 3.1	12.6 $\pm$ 3.6	11.6 $\pm$ 3.7
Female (n = 76)	9.7 $\pm$ 2.8	13.3 $\pm$ 3.5	12.3 $\pm$ 3.3
Occupation			
Doctors (n = 115)	8.9 $\pm$ 3.2	12.6 $\pm$ 3.7	11.2 $\pm$ 3.8
Nurses (n = 30)	9.5 $\pm$ 2.6	12.1 $\pm$ 3.8	11.5 $\pm$ 3.1
Paramedics (n = 85)	9.5 $\pm$ 2.8	12.8 $\pm$ 3.6	12.7 $\pm$ 3.3
Education			
FCPS (n=69)	9.6 $\pm$ 2.9	13.1 $\pm$ 3.3	11.9 $\pm$ 3.7
MBBS/BDS (n= 65)	8.7 $\pm$ 3.1	12.1 $\pm$ 4.0	1.1 $\pm$ 3.6
BSN (n=20)	9.6 $\pm$ 2.6	12.5 $\pm$ 3.2	11.4 $\pm$ 3.6
BS Allied Health Sciences (n=30)	9.3 $\pm$ 2.7	12.2 $\pm$ 4.2	11.5 $\pm$ 3.7
Diploma (n=46)	9.2 $\pm$ 3.1	12.0 $\pm$ 2.9	12.9 $\pm$ 3.1

Knowledge Score out of 12; Attitude Score out of 18; Practice Score out of 16

Mean knowledge score of the participants regarding AI was 9.2 ± 2.9 . Regarding their knowledge about AI total 12.2% healthcare workers have poor knowledge about AI, 27.8% have intermediate knowledge and 60% have good knowledge regarding AI. The distribution of AI knowledge levels across various demographic and professional groups are shown in table 02.

Table 2: Distribution of Knowledge Levels About Artificial Intelligence Among Healthcare Professionals

Demographic	Poor Knowledge n (%)	Intermediate Knowledge n (%)	Good Knowledge n (%)	p-value
Age				
>45 years (n = 07)	0 (0)	03 (42.9)	04 (57.1)	0.54
≤45 years (n = 223)	28(12.6)	62.1 (27.4)	134 (60.1)	
Gender				
Male (n = 154)	21 (13.6)	46 (29.9)	87 (56.5)	0.29
Female (n = 76)	07 (9.2)	18 (23.7)	51 (67.1)	
Occupation				
Doctors (n =115)	19 (16.5)	34 (29.6)	62 (53.9)	0.24
Nurses (n =30)	02 (6.7)	07 (23.3)	21(70)	
Paramedics (n=85)	07 (8.2)	23 (27.1)	55 (64.7)	
Education				
FCPS (n= 69)	07(10.1)	19 (27.5)	43 (62.3)	0.65
MBBS/BDS (n= 65)	13 (20	17 (26.2)	35 (53.8)	
BSN (n=20)	01 (05)	05 (25)	14 (70)	
BS Allied Health Sciences (n=30)	03 (10)	09 (30)	18 (60)	
Diploma (n=46)	04 (8.7)	14 (30.4)	28 (60.9)	

Poor knowledge: Score 1-4, Intermediate knowledge: Score 5-8, Good knowledge: Score 9-12.

Mean Attitude score of the participant regarding AI was 12.8 ± 3.6 , 7.4% have poor attitude, 37.8% have intermediate attitude and 54.8% have good attitude regarding AI as shown in table 03.

Table 3: Distribution of Attitude Levels Toward AI Among Healthcare Professionals

Demographic	Poor Attitude n (%)	Intermediate Attitude n (%)	Good Attitude n (%)	p-value
Age				
>45 years (n = 07)	01(14.3)	02 (28.6)	04(57.1)	0.82
≤45 years (n = 223)	16 (7.2)	85 (38.1)	122 (54.7)	
Gender				
Male (n = 154)	13 (8.4)	63 (40.9)	78 (50.6)	0.21
Female (n = 76)	04 (5.3)	24 (31.6)	48 (63.2)	
Occupation				
Doctors (n = 115)	08 (07)	53 (46.1)	54 (47)	0.01
Nurses (n = 30)	04 (13.3)	12 (40)	14 (46.7)	
Paramedics (n = 85)	05 (5.9)	22(25.9)	58 (68.2)	
Education				
FCPS (n = 69)	01 (1.4)	31 (44.9)	37 (53.6)	0.01
MBBS/BDS (n = 65)	09 (13.8)	25 (38.5)	31 (47.7)	
BSN (n = 20)	01 (5.0)	10 (50.0)	09 (45.0)	
BS Allied Health Sciences (n = 30)	04 (13.3)	11 (36.7)	15 (50.0)	
Diploma (n = 46)	02 (4.3)	10 (21.7)	34 (73.9)	

Poor attitude: Score 1-6, Intermediate attitude: Score 7-12, Good attitude: Score 13-18.

The mean practice score of participants regarding artificial intelligence (AI) was 11.7 ± 3.6 . When categorized into levels, 5.8% of participants demonstrated poor practice, 30.0% exhibited intermediate practice, and 64.8% showed good practice related to AI. Detailed stratification of practice score across demographic and professional variables are presented in Table 4.

Table 4: Distribution of Practice Levels Related to Artificial Intelligence in healthcare Among Healthcare Professionals

Demographics	Poor Practice n (%)	Intermediate Practice n (%)	Good Practice n (%)	p-value
Age				
>45 years (n = 07)	0 (0.0)	02 (28.6)	05 (71.4)	0.11
≤45 years (n = 223)	12 (5.4)	67 (30.0)	144 (64.6)	
Gender				
Male (n = 154)	10 (6.5)	50 (32.5)	94 (61.0)	0.20
Female (n = 76)	02 (2.6)	19 (25.0)	55 (72.4)	
Occupation				
Doctor (n = 115)	07(6.1)	42(36.5)	66(57.4)	0.11
Nurse (n = 30)	01 (3.3)	10 (33.3)	19 (63.3)	
Paramedics (85)	04 (4.7)	17 (20.0)	64 (75.3)	
Education				
FCPS	3 (4.3)	21(30.4)	45(65.2)	0.23
MBBS/BDS	04 (6.2)	24 (36.9)	37 (56.9)	
BSN	01 (5.0)	06 (30.0)	13 (65.0)	
BS Allied Health Sciences	02 (6.7)	12 (40.0)	16 (53.3)	
Diploma	02 (4.3)	06 (13.0)	38 (82.6)	

Poor practice: Score 1-5, Intermediate practice: Score 6-10, Good practice: Score 11-16

Discussion

Artificial intelligence (AI) involves developing systems that perform tasks requiring human intelligence and has the potential to significantly enhance healthcare delivery (11). This study assessed the knowledge, attitudes, and practices (KAP) regarding artificial intelligence (AI) among healthcare professionals in a tertiary care hospital in Mardan, Pakistan. Findings revealed that a majority of participants demonstrated good knowledge (60%), positive attitudes (54.8%), and favorable practices (64.8%) towards AI. The mean knowledge score was 9.2 ± 2.9 , which aligns with a study by Butt et al. (2024), where 80.3% of healthcare workers acknowledged the importance of AI, though only a minority had formal training (12). Similarly, a mean attitude score of 12.8 ± 3.6 reflects a generally positive perception, corroborated by Yousif et al. (2024), who reported healthcare professionals in Southern Punjab expressing willingness to adopt AI in clinical settings (13). The mean practice score of 11.7 ± 3.6 in this study surpasses figures from Butt et al, where only 24.4% reported active use of AI in healthcare practice(12). A cross-sectional study by Kalaimani et al. in India assessed the knowledge, attitude, and practice (KAP) of artificial intelligence among dentists and healthcare students found that 63.5% of participants were familiar with AI, and 60% supported its inclusion in dental curricula. Similarly, our study demonstrated that 60% of healthcare professionals had good knowledge of AI.(14) Differences in attitudes were statistically significant across occupations and education levels ($p=0.01$), with paramedics and diploma holders showing more favorable attitudes—findings consistent with the results of Habib et al. (2024), who found that younger and less experienced professionals held more optimistic

views about AI (15). Despite the promising attitude of medical medical professionals across these studies, a recent systematic review highlighted the importance of including relevant AI education in medical curricula to raise understanding and application (14).

Conclusion

This study demonstrates a generally favorable level of knowledge, attitudes, and practices regarding Artificial Intelligence (AI) among healthcare professionals in a tertiary care setting in Mardan, Pakistan. The findings suggest that while most participants exhibit awareness and a willingness to embrace AI in clinical practice, disparities exist across different professional roles and educational levels. These variations underscore the need for targeted training programs and institutional support to bridge knowledge gaps and enhance preparedness for AI integration. As AI continues to transform healthcare delivery, especially in low- and middle-income countries, equipping healthcare professionals with the necessary competencies and fostering a culture of ethical and informed adoption will be critical for maximizing its benefits.

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Author contributions

Paghunda Nobat: Conceptualization, writing – review & editing, Writing – original draft, Visualization, Validation, Methodology, Investigation, Data curation. **Khalid Khan:** Methodology, Data curation, review & editing. **Jafar Iqbal:** Concept, Methodology, Data curation, Supervision. **Muhammad Shahab:** Methodology, Data curation, Visualization, Validation. **Shabir Ahmad:** Methodology, Data curation, Visualization, Validation. **Syed Arshad Ullah:** Conceptualization, Visualization, Validation, Writing – review & editing.

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Data availability

The data will be available upon reasonable request from the corresponding author.

Declarations

Conflict of interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Ethical approval and informed consent

The institutional review board at Medical Teaching Institution Bacha Khan Medical College, Mardan (Reference No. 577/BKMC) provided ethical approval for the study. Informed written consent obtained from study participants following explanation of the study aims and objectives.

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