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BARRIERS TO THE IMPLEMENTATION OF ARTIFICIAL INTELLIGENCE IN REHABILITATION: A CROSS-SECTIONAL SURVEY AMONG PHYSICAL THERAPISTS IN PESHAWAR, PAKISTAN

Original Research

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ABSTRACT

Background: Artificial intelligence (AI) has emerged as a transformative tool in healthcare, offering significant opportunities for enhancing diagnosis, treatment planning, and patient monitoring in rehabilitation. By enabling predictive analytics, clinical decision support, and improved efficiency, AI holds promise in addressing rehabilitation challenges. However, despite these advantages, its adoption among physiotherapists remains minimal, particularly in low- and middle-income countries where infrastructure, education, and organizational readiness are limited. Understanding the current level of awareness, readiness, and barriers is essential to guide future implementation strategies.

Objective: The study aimed to assess physiotherapists' knowledge, attitudes, and perceived barriers toward AI adoption in rehabilitation in Peshawar, Pakistan.

Methods: A descriptive cross-sectional survey was conducted between January and March 2025 among 200 practicing physiotherapists working in hospitals, clinics, and academic institutions in Peshawar. Eligibility criteria included at least one year of clinical experience. Data were collected using a structured, self-administered questionnaire distributed electronically through emails and WhatsApp groups. The instrument captured demographics, knowledge and awareness of AI, perceived barriers across five domains (educational, organizational, technical, ethical, and financial), and readiness to adopt AI. Data were analyzed using SPSS version 27, applying descriptive statistics including means, standard deviations, frequencies, and percentages. Chi-square and Fisher's exact tests were performed to explore associations between barriers and demographics, with a significance threshold of $p < 0.05$.

Results: Out of 200 participants, 120 (60%) were male and 80 (40%) female. Clinical experience ranged from 1–5 years (35%), 6–10 years (40%), and >10 years (25%). Regarding awareness, 48 (24%) had no knowledge of AI in rehabilitation, 74 (37%) reported theoretical knowledge only, 66 (33%) demonstrated basic awareness, and just 12 (6%) had hands-on use in practice. Barriers reported included limited clinician knowledge (156; 78%), lack of institutional support (130; 65%), data privacy concerns (120; 60%), high implementation costs (110; 55%), and insufficient training programs (85; 42.5%). Experience level was significantly associated with educational and organizational barriers ($p=0.03$), and private sector clinicians reported higher technical barriers compared with public sector counterparts ($p=0.04$).

Conclusion: The findings demonstrate that while awareness of AI exists among physiotherapists in Peshawar, practical application is severely constrained by multidimensional barriers. These include inadequate training, insufficient institutional support, technical limitations, ethical concerns, and high costs. Targeted strategies such as integrating AI literacy into curricula, strengthening institutional frameworks, investing in infrastructure, and developing cost-effective, context-appropriate solutions are vital to promote adoption. Enhancing clinician readiness through structured training and organizational policies could bridge the gap between awareness and effective utilization in rehabilitation practice.

Keywords: Artificial Intelligence; Awareness; Barriers; Cross-Sectional Studies; Physical Therapists; Rehabilitation; Surveys and Questionnaires.

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INTRODUCTION

Computers and digital technologies have transformed nearly every aspect of human life, becoming indispensable in homes, schools, and workplaces. In recent years, research and development has shifted toward creating advanced machines and automated systems capable of performing tasks with minimal human intervention. Within this context, Artificial Intelligence (AI)—defined as the ability of computer systems or computer-controlled machines to perform functions typically requiring human intelligence—has emerged as a crucial component of modern society (1). The COVID-19 pandemic further accelerated reliance on AI-driven systems in healthcare, highlighting their potential to improve accuracy, efficiency, and accessibility of care (1,2). As in other medical fields, AI is increasingly integrated into physical therapy and rehabilitation, where its applications are rapidly expanding (2). Advanced tools such as machine learning algorithms, predictive analytics, and robotic-assisted technologies are being designed to support diagnosis, optimize treatment planning, and enhance patient monitoring (2,3). AI systems leverage medical literature, evidence-based guidelines, and patient-specific data to reduce human errors and support clinical decision-making. These capabilities extend from administrative processes—such as scheduling, billing, and record management—to core clinical tasks like diagnostic support, outcome prediction, and individualized treatment planning (4,5). Importantly, AI learns through supervised models, where structured data guide predictions, and unsupervised models, where hidden patterns are identified within large, unstructured datasets. These learning mechanisms enable physiotherapists to address clinical questions more comprehensively, such as the prevalence of conditions like low back pain or early osteoarthritis in specific populations (6). A key strength of AI lies in predictive analytics, where vast datasets are harnessed to forecast patient trajectories, anticipate treatment responses, and identify risk factors for poor outcomes. Such insights support personalized rehabilitation programs and early interventions, ultimately improving quality of care (7).

Evidence demonstrating AI's clinical utility in physiotherapy continues to grow. For instance, wearable devices combined with machine learning have enabled remote monitoring of rotator cuff rehabilitation, simplifying the tracking of home exercise adherence (8). Similarly, digital AI-based rehabilitation sessions for knee osteoarthritis following total knee replacement have shown superior short- and medium-term outcomes compared to conventional home-based rehabilitation, while simultaneously reducing therapist workload (3–5). In another example, convolutional neural networks (CNN) successfully predicted fall timing in patients with Alzheimer's disease, paving the way for tailored fall-prevention strategies (4,9). Furthermore, machine learning models have accurately predicted functional recovery in stroke patients, with high discriminatory power (AUC = 0.94), demonstrating AI's promise in outcome forecasting and long-term patient monitoring (8,10). Beyond prediction, AI applications include robotic-assisted therapy, gait analysis, virtual reality interventions, and real-time decision support tools for physiotherapists (11,12). Despite these advancements, adoption of AI in physiotherapy remains limited in developing countries such as Pakistan. Barriers include inadequate clinician awareness, technical challenges, ethical and legal considerations, organizational resistance, and financial constraints. These challenges highlight the importance of exploring the current state of knowledge, attitudes, and perceived barriers among physiotherapists practicing in resource-limited settings, where infrastructure and training opportunities differ significantly from those in high-income countries. Against this backdrop, the present study aims to assess the knowledge, attitudes, and perceived barriers to AI adoption in rehabilitation among physiotherapists in Peshawar, Pakistan. By identifying existing gaps and challenges, the findings of this study can inform policy development, guide targeted training initiatives, and support the strategic integration of AI into physiotherapy practice in the local context.

METHODS

A descriptive cross-sectional survey was carried out to assess the knowledge, attitudes, and perceived barriers regarding artificial intelligence (AI) adoption among physiotherapists working in rehabilitation settings in Peshawar, Pakistan. The target population consisted of practicing physiotherapists employed in hospitals, clinics, and home healthcare services. Only licensed physiotherapists who were currently practicing in Peshawar, regardless of subspecialty (musculoskeletal, neurology, cardiopulmonary, pediatrics, etc.), were considered eligible. Additional inclusion criteria required at least one year of clinical experience and voluntary willingness to participate. Exclusion criteria comprised non-clinical and administrative physiotherapists, interns or students who had not yet graduated, and retired professionals. The sample size was calculated using a prevalence estimate of 50% for perceived barriers, assuming a 95%

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confidence interval and a 5% margin of error. This calculation yielded a minimum requirement of 196 participants, which was rounded to 200 for feasibility (13). A non-probability convenience sampling technique was applied, which, although practical, may introduce limitations in terms of representativeness. Data were collected using a structured, self-administered questionnaire that was developed based on prior literature and refined through expert input to ensure face and content validity. The instrument consisted of four sections: (i) demographic data including age, gender, qualifications, and years of clinical experience; (ii) knowledge and awareness of AI, including prior exposure and understanding of its applications in rehabilitation; (iii) perceived barriers, which were categorized into five domains—technical (infrastructure gaps, interoperability, software usability, insufficient validation), organizational (institutional resistance, workflow disruption, inadequate support), educational (low AI literacy, lack of formal training opportunities), ethical (data privacy, accountability, regulatory concerns), and financial (high purchase and maintenance costs); and (iv) readiness and attitudes, measured using Likert-scale items to assess willingness to adopt AI, perceived usefulness, and interest in training opportunities. The survey was distributed electronically via email and WhatsApp, and completion of the questionnaire was considered as provision of informed consent. Responses were anonymous, and participant identifiers were not collected. Data were analyzed using SPSS version 27. Descriptive statistics, including means, standard deviations, frequencies, and percentages, were used to summarize responses. Inferential statistics were applied to examine associations between participant demographics and perceived barriers using chi-square and Fisher's exact tests where appropriate, with statistical significance set at $p < 0.05$. A multiple response analysis was also performed to capture the frequency of reported barriers across different domains. Ethical approval was obtained from the appropriate institutional review board prior to the initiation of the study. All responses were treated confidentially, and results were reported in aggregate to ensure anonymity and protect individual identities.

RESULTS

A total of 200 physiotherapists completed the survey. The majority of participants were male, comprising 60% (n=120), while females accounted for 40% (n=80). In terms of clinical experience, 40% (n=80) had between 6 and 10 years of practice, 35% (n=70) had 1 to 5 years, and 25% (n=50) reported more than 10 years of professional experience. Regarding knowledge and awareness of artificial intelligence in rehabilitation, 24% (n=48) stated they had never heard of AI in this context. A further 37% (n=74) reported having heard of it but with no practical exposure, 33% (n=66) demonstrated only basic awareness, while just 6% (n=12) indicated hands-on use in their practice. Analysis of perceived barriers revealed that limited clinician knowledge was the most frequently reported issue, cited by 78% (n=156). Educational challenges also included a lack of training programs, identified by 42.5% (n=85). Organizational barriers were prominent, with 65% (n=130) highlighting inadequate institutional support and 45% (n=90) reporting resistance to change. Technical barriers included poor workflow integration, acknowledged by 50% (n=100). Ethical concerns were also significant, with 60% (n=120) citing data privacy issues and 35% (n=70) mentioning regulatory uncertainties. Financial barriers were frequently reported, with 55% (n=110) identifying high implementation and maintenance costs. Statistical associations demonstrated that years of clinical experience were significantly related to the perception of educational and organizational barriers ($p=0.03$). Additionally, clinicians working in private hospitals reported higher levels of technical barriers compared to those in public institutions ($p=0.04$). No significant gender-based differences in perceived barriers were observed ($p>0.05$).

Table 1: Demographic characteristics of participants (n=200)

Characteristic	(n=200)	Percentage (%)
Gender		
Male	120	60
Female	80	40
Years of Experience		
1-5	70	35
6-10	80	40
>10	50	25

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Table 2: Reported barriers to AI adoption in rehabilitation

Barrier Category	Frequency (n)	Percentage (%)
Educational		
Limited clinician knowledge	156	78
Lack of training programs	85	42.5
Organizational		
Lack of institutional support	130	65
Resistance to change	90	45
Technical		
Poor workflow integration	100	50
Ethical		
Data privacy concerns	120	60
Regulatory uncertainties	70	35
Financial		
High implementation/maintenance costs	110	55

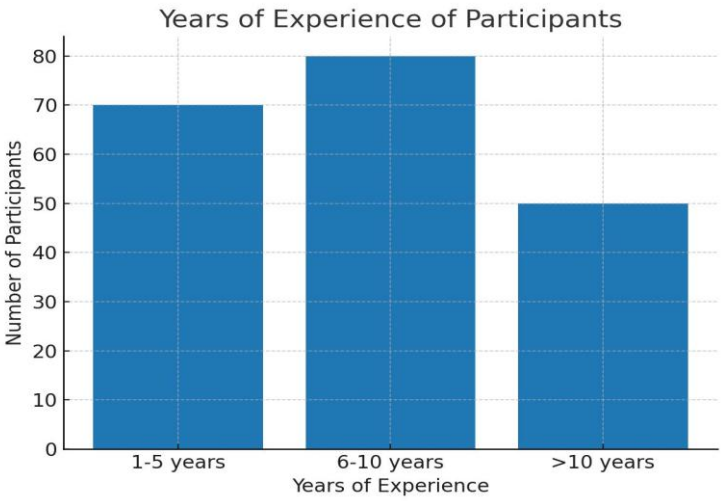

Figure 1 Years of Experience of Participants

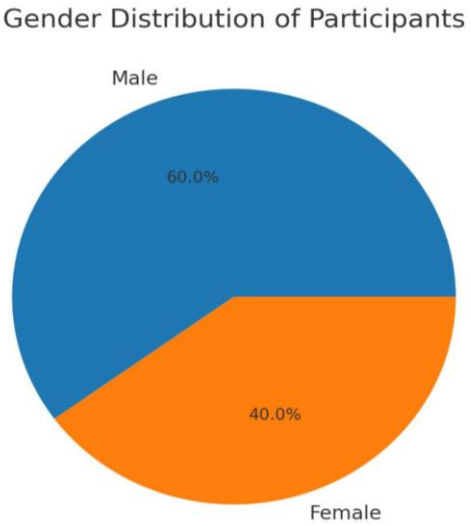

Figure 2 Gender Distribution of Participants

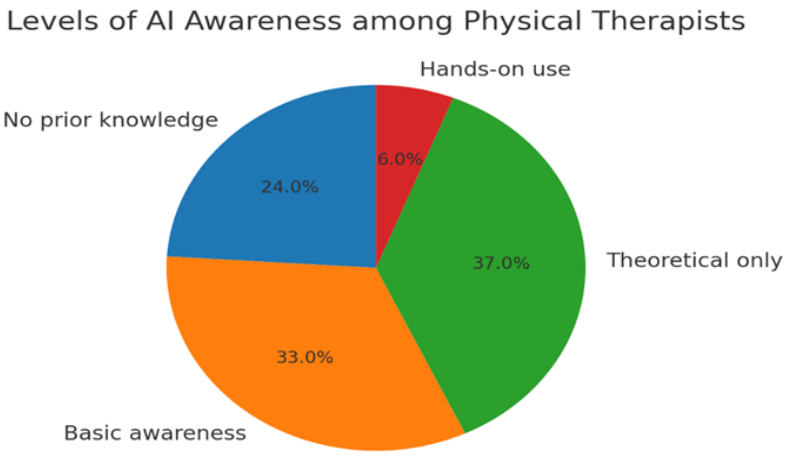

Figure 1 Levels of AI Awareness among Physical Therapists

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DISCUSSION

This study explored the levels of awareness and perceived barriers to artificial intelligence (AI) adoption among physiotherapists in rehabilitation practice in Peshawar, Pakistan. The findings provide important insights into both the opportunities and challenges that shape the integration of AI into clinical settings. Awareness levels were found to be relatively low, with more than one-third of participants reporting only theoretical knowledge and nearly one-quarter having no prior awareness. Only a small proportion indicated direct hands-on use, highlighting the considerable gap between conceptual familiarity and practical application. These results are consistent with global research, which demonstrates that healthcare professionals often demonstrate awareness of AI concepts but lack the practical exposure necessary to apply them effectively in clinical care (14,15). Educational and knowledge barriers emerged as the most substantial challenges, with limited clinician training and expertise being the most frequently cited issues. This pattern has been consistently reported across healthcare disciplines. Previous studies have demonstrated that professional experience, educational level, and workplace exposure strongly predict AI literacy among rehabilitation clinicians (16). Evidence from allied health professionals in high-income countries has shown that insufficient technical knowledge and the "black box" nature of AI limit trust and willingness to engage with AI systems (17). These findings underscore the necessity of embedding structured AI training and literacy programs into both undergraduate education and continuing professional development, ensuring that clinicians are adequately prepared to use these tools in practice.

Organizational and institutional barriers also accounted for a significant proportion of responses. Many participants indicated that institutional resistance and lack of support hinder adoption, findings that mirror international experiences. Research from healthcare organizations in various regions, including the Middle East, has highlighted that insufficient strategic planning, lack of standardized frameworks, and the absence of dedicated leadership roles contribute to clinician hesitancy toward AI integration (18). Evidence further suggests that organizational leadership plays a pivotal role in fostering innovation. Appointment of AI champions and the creation of supportive policies encourage clinician engagement, streamline workflow, and enhance acceptance. Without such leadership, resistance to change, resource constraints, and lack of communication undermine adoption efforts (19). Technical and infrastructural challenges further contributed to the reported barriers. Concerns related to poor workflow integration, interoperability, and weak technical support are consistent with global patterns in digital health technology adoption. Physiotherapists in other countries, including Norway, have similarly cited unreliable internet connectivity and insufficient technical support as major obstacles (20). Additional studies have identified that fragmented health information systems and lack of interoperability reduce care efficiency and hinder integration of new technologies (14,15). These barriers not only compromise the clinical utility of AI but also lead to wasted resources and duplication of effort. Investment in interoperable systems, user-friendly platforms, and reliable infrastructure is therefore essential for effective implementation.

Ethical and privacy concerns were also widely expressed by participants, with more than half indicating worries regarding data confidentiality. This aligns with global evidence, which emphasizes that data protection, accountability, and transparency are critical determinants of trust in AI (16,17). Clinicians and patients alike are cautious of systems that may compromise the human aspects of care, such as empathy and trust. Literature has warned that while AI can optimize decision-making, overreliance on automated systems risks eroding the therapeutic alliance between patient and therapist (18). To address these concerns, ethical guidelines grounded in principles of equity, inclusiveness, and accountability are vital. International bodies such as the World Health Organization have stressed the need for robust regulatory and governance frameworks to ensure that AI remains a complement to, rather than a replacement for, human judgment (19). Financial constraints were also highlighted as a major limitation, with more than half of respondents citing high implementation and maintenance costs as barriers. Similar findings have been observed in other low- and middle-income countries, where the high costs of infrastructure and limited funding hinder the sustainable adoption of AI systems (20). Without dedicated funding mechanisms and scalable low-cost models, such as mobile applications or wearable technologies, the disparity between AI's potential and its real-world application is likely to persist. Comparative evidence from other regions of Pakistan supports these findings. Studies have reported that while awareness and willingness to adopt AI are present among physiotherapists, actual usage remains limited due to lack of training, infrastructure, and policy support (21,22). These results indicate that while adoption remains in its infancy, there is clear receptivity to AI if systemic and educational barriers are adequately addressed. Furthermore, literature from low- and middle-income countries emphasizes that AI holds significant potential to bridge healthcare and rehabilitation gaps where human resources are limited, provided that infrastructural and governance issues are resolved (23).

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The strengths of this study include its focus on physiotherapists in Peshawar, providing the first regional insight into AI-related barriers in rehabilitation, as well as the inclusion of participants across a range of experience levels and specialties. Online data collection further allowed for greater reach across the clinical community. However, certain limitations must be acknowledged. The cross-sectional design prevents inference of causality and does not evaluate interventions for overcoming barriers. Convenience sampling introduces potential selection bias and reduces generalizability. Additionally, reliance on online survey distribution excluded therapists without internet access, creating further bias. These factors limit the applicability of findings to the wider population beyond Peshawar. The results have important implications for practice and policy. Integration of AI literacy into pre-service training and professional development programs is essential to address knowledge gaps. Institutional policies must be strengthened to encourage adoption, supported by sustained funding and leadership initiatives. Investment in infrastructure and interoperable systems tailored to low-resource settings is critical to reduce technical barriers. Moreover, cost-effective and scalable AI models should be explored to overcome financial limitations. Ethical and regulatory frameworks need to be developed in parallel to ensure patient trust, accountability, and equitable application of AI in rehabilitation. Finally, future research should move beyond descriptive surveys to include longitudinal and intervention studies, evaluating the effectiveness of training programs, organizational strategies, and policy frameworks in overcoming barriers to AI adoption. Overall, the study highlights that AI adoption in rehabilitation remains at an early stage in Pakistan, limited by knowledge, organizational, technical, ethical, and financial challenges. Nonetheless, the findings confirm that physiotherapists are receptive to adopting AI if adequate support structures are put in place, suggesting a strong foundation for future integration efforts.

CONCLUSION

This study concluded that although physiotherapists in Peshawar possess a degree of awareness regarding artificial intelligence in rehabilitation, their practical exposure remains limited and significant barriers hinder its integration. Institutional support gaps, inadequate training opportunities, financial constraints, and ethical concerns such as data privacy were identified as key challenges restricting adoption. These findings underscore the urgent need to embed AI-focused education within professional training, establish robust institutional frameworks, and prioritize cost-effective, context-appropriate AI solutions. By addressing these barriers, physiotherapists in Pakistan and other resource-limited settings can be better equipped to integrate AI as a supportive tool, ultimately enhancing patient outcomes, strengthening clinical decision-making, and improving the overall efficiency of rehabilitation services.

AUTHOR CONTRIBUTION

Author	**Contribution**
Zakir Ullah*	Substantial Contribution to study design, analysis, acquisition of Data Manuscript Writing Has given Final Approval of the version to be published
Mian Waleed Ahmed	Substantial Contribution to acquisition and interpretation of Data Has given Final Approval of the version to be published
Mian Awais Ahmed	Contributed to Data Collection and Analysis Has given Final Approval of the version to be published
Mehran Khan	Contributed to Data Collection and Analysis Has given Final Approval of the version to be published
Sadaf Naveed	Contributed to Data Collection and Analysis Has given Final Approval of the version to be published
Syed Ibadat Ali Shah	Substantial Contribution to study design and Data Analysis Has given Final Approval of the version to be published
Hadia Hassan	Contributed to study concept and Data collection Has given Final Approval of the version to be published

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