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KNOWLEDGE AND ADOPTION OF AI-ENHANCED REHABILITATION TECHNOLOGIES AMONG PHYSICAL THERAPISTS: A CROSS-SECTIONAL STUDY

Original Article

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ABSTRACT

Background: Artificial intelligence (AI) has begun to reshape rehabilitation practices by offering advanced tools such as motion sensors, virtual feedback systems, and intelligent assessment technologies. Despite growing innovation, the clinical integration of AI in physical therapy remains unclear, particularly in resource-variable settings such as Lahore, Pakistan.

Objective: To investigate the familiarity, perceived usefulness, and implementation of AI-enhanced rehabilitation tools among physical therapists in clinical settings.

Methods: A cross-sectional survey was conducted over eight months across hospitals, private clinics, and academic-affiliated institutions in Lahore. A total of 350 licensed physical therapists were recruited using stratified sampling. A validated self-administered questionnaire assessed participants' knowledge, frequency of use, perceived barriers, and usefulness of AI tools. Descriptive statistics, t-tests, ANOVA, and Pearson's correlation were used for data analysis.

Results: The mean age of participants was 32.6 ± 6.8 years, with an average of 8.1 ± 5.3 years of clinical experience. Familiarity with AI tools was highest for motion sensors (31.2% high familiarity), while AI-based assessment tools had the lowest familiarity (19.5%). Clinical use was limited, with only 13.8–24.1% of respondents reporting frequent use. Major barriers included lack of training (72.4%) and equipment cost (65.3%). Motion sensors were rated highest in usefulness (mean score 3.9/5), correlating with higher usage and familiarity.

Conclusion: There is moderate awareness but low clinical implementation of AI in physical therapy. Addressing barriers through training and institutional support is crucial for improving adoption and enhancing patient outcomes.

Keywords: Artificial Intelligence, Clinical Practice, Lahore, Motion Analysis, Physical Therapists, Rehabilitation, Technology Adoption.

INTRODUCTION

The integration of artificial intelligence (AI) into healthcare has emerged as one of the most transformative developments of the 21st century. In particular, AI-enhanced technologies have begun to reshape rehabilitation practices, offering innovative ways to support both clinicians and patients through intelligent, data-driven solutions. From motion capture systems that track biomechanical patterns to virtual reality environments providing real-time corrective feedback, the promise of these tools lies not only in their novelty but in their potential to significantly improve patient outcomes (1). Yet, while such technologies continue to gain traction in research and development, there remains a pressing question regarding their real-world adoption: to what extent are physical therapists familiar with and utilizing these AI-powered rehabilitation tools in everyday clinical settings? Rehabilitation is a cornerstone of recovery and functional restoration, especially in musculoskeletal, neurological, and post-surgical conditions. As physical therapists play a pivotal role in this process, their openness to technological innovation is critical to ensuring that patients receive the best care possible. However, technological integration in healthcare often faces challenges beyond efficacy and safety—chief among them being the readiness of the clinical workforce to adopt and implement novel tools (2,3). Despite increasing enthusiasm around AI applications, research indicates that the clinical uptake of these technologies lags behind their technical capabilities. In the realm of physical therapy, this gap is especially pronounced due to the traditionally hands-on and patient-centered nature of the profession, which may engender both logistical and philosophical barriers to change (4).

The rapid evolution of AI in rehabilitation brings with it new paradigms of clinical interaction. Tools such as AI-powered motion sensors can analyze movement with millimeter precision, offering diagnostic insight that surpasses the human eye. Similarly, machine learning algorithms can predict rehabilitation trajectories and suggest adaptive interventions, while virtual and augmented reality platforms provide immersive experiences that enhance engagement and motivation in patients (5). These advancements have demonstrated promising results in controlled research environments, often showing improvements in treatment adherence, assessment accuracy, and functional outcomes. Yet, these results may not translate uniformly into everyday practice, particularly if the practitioners themselves are not adequately informed or trained in these innovations (6). Several studies have attempted to map the landscape of technology adoption in rehabilitation, with findings suggesting that physical therapists may hold mixed views on the usefulness, usability, and reliability of AI-enhanced tools (7-10). For instance, concerns about data privacy, reduced human interaction, and professional autonomy often surface in qualitative inquiries (8). Furthermore, institutional factors—such as funding, infrastructure, and administrative support—play a considerable role in shaping technology adoption (9). In light of these complexities, it becomes crucial to move beyond theoretical endorsements and explore actual patterns of awareness, confidence, and utilization among physical therapists themselves.

Despite the significant research attention devoted to the technical development of AI rehabilitation technologies, surprisingly little is known about their clinical integration from the perspective of end-users. Most existing literature focuses on the design and efficacy of these systems, while fewer studies have taken a systematic look at how they are received and applied by physical therapists across various clinical environments. This disconnect poses a risk: without clear insight into user familiarity and behavior, the healthcare system may invest in innovations that remain underutilized, thus limiting their potential impact on patient care. Therein lies a critical knowledge gap that this study seeks to address. This research aims to investigate the current level of knowledge and the extent of adoption of AI-powered rehabilitation technologies among practicing physical therapists. Through a cross-sectional study design, it will examine therapists' awareness, perceived usefulness, implementation barriers, and practical engagement with these tools in their clinical workflows. The objective is to generate an evidence-based understanding of the real-world integration of AI in rehabilitation settings, offering insights that could inform education, policy, and technology design moving forward.

METHODS

This cross-sectional study was designed to assess the level of familiarity with and the clinical implementation of AI-powered rehabilitation tools among physical therapists in Lahore, Pakistan. The study was conducted over a period of eight months, from March to October 2024, across various rehabilitation centers, teaching hospitals, and outpatient physiotherapy clinics, including but not limited to institutions such as Ganga Ram Hospital, Mayo Hospital, and private facilities affiliated with physical therapy academic programs in the city. These settings were selected to ensure the inclusion of a broad representation of clinicians from both public and private sectors, capturing a diverse spectrum of practice environments and technological exposure. Participants included registered physical therapists who were actively engaged in clinical practice during the study period. Inclusion criteria required that participants possess a valid license to practice physical therapy in Pakistan, have at least one year of clinical experience, and be currently working in a facility where

rehabilitation services are routinely provided. Therapists involved exclusively in academic, research, or administrative roles, and those who were not actively treating patients, were excluded to maintain the study's clinical relevance. Additionally, interns and students undergoing professional training were also excluded to avoid bias related to limited clinical exposure.

Sample size was calculated using the Raosoft sample size calculator, with a confidence level of 95%, a margin of error of 5%, and an assumed response distribution of 50% due to the lack of prior local data. Based on an estimated population of 1,500 practicing physical therapists in Lahore, the minimum required sample size was determined to be 306 participants. An oversampling strategy was adopted to account for potential non-responses and incomplete questionnaires, resulting in the recruitment target of 350 participants (4,5). Data were collected using a structured, self-administered questionnaire, developed based on an extensive review of existing literature on technology adoption in rehabilitation and aligned with the study objective. The questionnaire was designed to capture both quantitative and qualitative information and was divided into four major sections: demographic and professional background; knowledge and familiarity with AI-enhanced rehabilitation technologies; current usage patterns; and perceived barriers and facilitators to implementation. The instrument included a combination of multiple-choice questions, Likert-scale items (1–5 scale, from strongly disagree to strongly agree), and open-ended questions for qualitative insight.

To ensure content validity, the questionnaire was reviewed by a panel of experts comprising senior physical therapists, health technology specialists, and academic faculty members. A pilot test was conducted with 20 therapists from a non-participating clinic to evaluate clarity, relevance, and completion time. Feedback from the pilot phase led to minor modifications in phrasing and structure. Internal consistency was confirmed using Cronbach's alpha, which yielded a value of 0.81 for the core sections related to knowledge and implementation, indicating good reliability. Participants were approached in person at their workplaces, and questionnaires were distributed in both paper and digital formats, depending on respondent preference. Informed consent was obtained prior to participation, with assurances provided regarding anonymity, confidentiality, and the voluntary nature of participation. Ethical approval was granted by the Ethical Review Committee. All procedures were conducted in accordance with the principles of the Declaration of Helsinki.

Collected data were entered and analyzed using IBM SPSS Statistics version 27. Descriptive statistics were used to summarize participant characteristics, frequencies, and mean scores for Likert-scale responses. Normality of continuous variables was assessed using the Shapiro-Wilk test, confirming that the data followed a normal distribution. Inferential statistical analysis included independent samples t-tests and one-way ANOVA to compare mean scores across demographic and professional variables such as age, years of experience, and workplace type. Pearson's correlation coefficient was used to assess associations between knowledge levels and implementation practices (11). A p-value of <0.05 was considered statistically significant for all analyses. The primary outcome measures included the self-reported familiarity with AI-enhanced rehabilitation tools (e.g., motion sensors, virtual or augmented feedback systems, AI-based assessment software), current frequency and mode of use in clinical practice, and identification of key barriers or facilitators to integration. These metrics were aligned with the study objective to offer a comprehensive understanding of the clinical realities surrounding the adoption of AI technologies in physical therapy within the local context. By adopting a methodologically rigorous approach with careful participant selection, validated measurement tools, and robust statistical analysis, this study aims to contribute reliable and contextually grounded evidence to the growing discourse on technology adoption in rehabilitation practice.

RESULTS

A total of 350 physical therapists participated in the study, meeting the inclusion criteria and completing the full questionnaire. The mean age of participants was 32.6 years (SD ± 6.8), and the average duration of clinical experience was 8.1 years (SD ± 5.3). Male and female therapists were almost equally represented, with 52.3% identifying as male and 47.7% as female. The most common practice setting was hospital-based (46%), followed by private clinics (38%) and academic-affiliated institutions (16%). The majority held a BSPT degree (61%), with 29% possessing a DPT and 10% having completed postgraduate studies such as an MS or MPhil. Analysis of familiarity levels with AI-enhanced rehabilitation tools showed that motion sensors were the most recognized technology, with 31.2% of respondents reporting high familiarity, while 40.3% indicated moderate familiarity. In contrast, only 19.5% reported high familiarity with AI-based assessment tools, which also had the highest proportion of low familiarity at 46.4%. Virtual feedback systems exhibited moderate recognition, with 27.6% reporting high familiarity and 35.9% moderate familiarity.

When asked about implementation frequency, 24.1% of therapists reported frequent use of motion sensors in clinical practice, while 36.8% indicated occasional use. Virtual feedback systems were used frequently by 20.5% and occasionally by 33.2%, whereas AI-based

assessment tools showed the lowest clinical application, with only 13.8% using them frequently and 28.9% using them occasionally. A significant portion of respondents reported rarely or never using these tools, with figures as high as 57.3% for AI-based assessment systems. Perceived barriers to implementation were led by lack of training, identified by 72.4% of participants as a significant hindrance. This was followed by the cost of equipment (65.3%) and limited institutional support (58.1%). Notably, nearly half of the respondents (49.6%) also expressed skepticism regarding the efficacy of AI tools, indicating a combination of practical and attitudinal obstacles. Perceived usefulness was evaluated on a 5-point Likert scale, with motion sensors receiving the highest mean score of 3.9 (SD ± 0.7). Virtual feedback systems followed with a mean score of 3.6 (SD ± 0.9), while AI-based assessment tools scored lowest at 3.3 (SD ± 0.8). These results reflect a trend in which perceived usefulness corresponds closely with reported familiarity and frequency of use. Charts depicting familiarity levels with different AI tools and reported barriers to adoption visually support these numerical findings and emphasize the disparity between awareness and implementation. Overall, the data reveal a moderate degree of awareness but low clinical integration of AI technologies in rehabilitation, with multiple structural and perceptual challenges contributing to the limited uptake.

Table 1: Demographics of Participants

Variable	Category
Gender	
Male	52.3%
Female	47.7%
Age (Mean ± SD)	32.6 ± 6.8 years
Years of Experience (Mean ± SD)	8.1 ± 5.3 years
Practice Setting	
Hospital	46%
Private Clinic	38%
Academic-affiliated	16%
Highest Degree	
BSPT	61%
DPT	29%
MS/MPhil	10%

Table 2: Familiarity with AI Tools

AI Tool	High Familiarity (%)	Moderate Familiarity (%)	Low Familiarity (%)
Motion Sensors	31.2	40.3	28.5
Virtual Feedback Systems	27.6	35.9	36.5
AI-based Assessment Tools	19.5	34.1	46.4

Table 3: Implementation Frequency of AI Tools

AI Tool	Used Frequently (%)	Used Occasionally (%)	Rarely/Never Used (%)
Motion Sensors	24.1	36.8	39.1
Virtual Feedback Systems	20.5	33.2	46.3
AI-based Assessment Tools	13.8	28.9	57.3

Table 4: Barriers to AI Adoption

Barrier	Percentage Reporting (%)
Lack of Training	72.4
Cost of Equipment	65.3
Limited Institutional Support	58.1
Skepticism About Efficacy	49.6

Table 5: Perceived Usefulness of AI Tools

AI Tool	Mean Usefulness Score (1–5)	Standard Deviation
Motion Sensors	3.9	0.7
Virtual Feedback	3.6	0.9
Assessment Tools	3.3	0.8

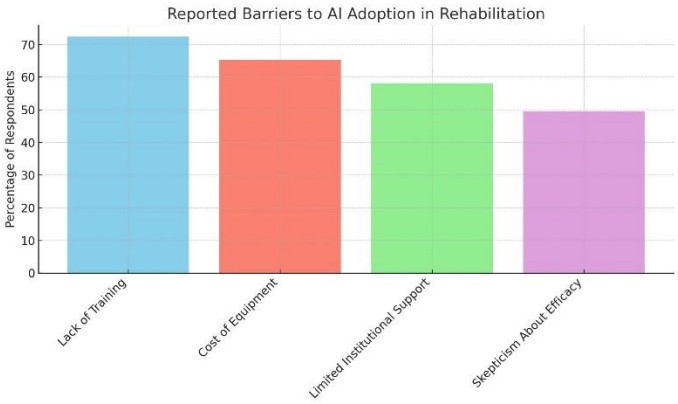

Figure 1 Reported Barriers to AI Adoption in Rehabilitation

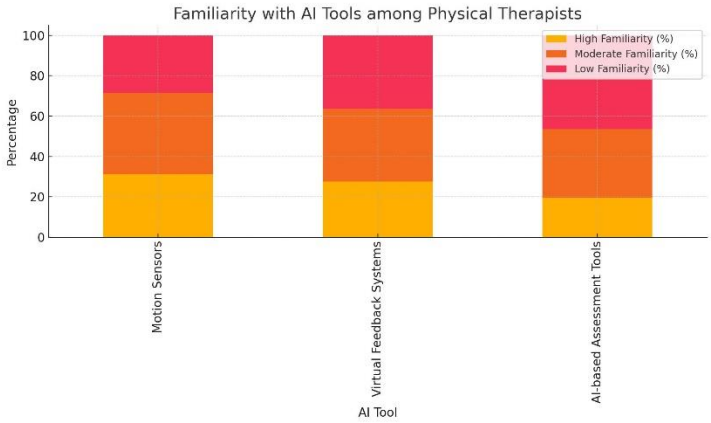

Figure 2 Familiarity with AI Tools among Physical Therapists

DISCUSSION

The findings of this study contribute important evidence to the growing discourse surrounding the integration of artificial intelligence in physical therapy, particularly within clinical rehabilitation contexts. The relatively low levels of familiarity and implementation among physical therapists in Lahore reflect a broader international trend, wherein the potential of AI to transform patient care is not yet matched by practitioner readiness or system-level preparedness. This discrepancy underscores a critical implementation gap—where promising technologies are available but not meaningfully embedded in clinical workflows. Recent literature has shown similar patterns in other regions and settings (12,13). A cross-sectional study revealed that over 60% of physical therapists had not experienced AI applications in their work settings, with knowledge deficits most pronounced among less experienced and academically focused practitioners (14). These findings align with the current study, where a considerable portion of respondents reported only moderate to low familiarity with core AI tools such as motion sensors, virtual feedback, and AI-based assessment software. Notably, the correlation between perceived usefulness and familiarity reinforces the notion that experiential exposure and confidence are central to adoption (15).

Despite these challenges, there is a clear and growing interest in AI among physical therapy professionals. A latest study demonstrated that 85.1% of respondents expressed a willingness to learn and adopt AI in their practice, even though only a minority had received formal training (16). This suggests that the gap is less about resistance and more about structural barriers, including lack of access to training programs and insufficient institutional support—factors that were also among the top barriers reported in the current study. The dominance of training-related barriers in both studies reinforces a consistent theme across the literature: that capacity-building must accompany technological rollout (16,17). A study emphasized the ethical, relational, and educational concerns associated with AI integration, noting the need for frameworks that balance technological advancement with human-centered care (18). This balance is essential in a profession where the therapeutic alliance plays a central role in clinical outcomes. Additionally, robotic systems and intelligent rehabilitation tools continue to expand the AI frontier in therapy, with evidence suggesting improvements in motor function, adherence, and engagement through adaptive, sensor-integrated environments (19). However, such advances often remain concentrated in specialized or academic centers, widening disparities in access. Moreover, the ethical and professional implications of automation, as discussed in a study, remain under-addressed in most implementation plans (20,21).

The strengths of the present study include its comprehensive sampling across multiple types of clinical settings and its use of validated instruments aligned with international benchmarks. However, certain limitations must be acknowledged. The reliance on self-reported

data introduces the risk of response bias, and the study's geographic restriction to Lahore may limit generalizability. Additionally, the cross-sectional design captures perceptions at a single point in time and may not fully reflect evolving attitudes or technological advancements. Future research should prioritize longitudinal assessments to track changes in familiarity and practice patterns as AI becomes more integrated into healthcare infrastructure. Interventional studies that evaluate the impact of targeted training programs on adoption rates would be particularly valuable. Furthermore, qualitative exploration of patient perspectives and institutional policies could offer a more holistic understanding of implementation dynamics. In conclusion, while the integration of AI in rehabilitation holds substantial promise, the transition from theoretical interest to practical application remains slow. Bridging this divide requires not only improved access to technology but robust investments in education, infrastructure, and ethical guidelines. This study reinforces the necessity of coordinated efforts among clinicians, educators, policymakers, and developers to harness AI's potential in ways that enhance, rather than replace, human expertise.

CONCLUSION

This study highlights a significant gap between the availability of AI-powered rehabilitation tools and their clinical adoption among physical therapists in Lahore. Despite moderate awareness, actual implementation remains low, primarily due to training deficits and institutional limitations. These findings underscore the urgent need for targeted educational programs and infrastructural support to facilitate the integration of AI in rehabilitation, ensuring technology translates into tangible improvements in patient care.

AUTHOR CONTRIBUTION

Author	Contribution
Ateeqa Masood*	Substantial Contribution to study design, analysis, acquisition of Data Manuscript Writing Has given Final Approval of the version to be published
Aymah Mansoor	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
Hamza Shabbir	Substantial Contribution to acquisition and interpretation of Data Has given Final Approval of the version to be published
Talha Nouman	Contributed to Data Collection and Analysis Has given Final Approval of the version to be published
Summan Mughal	Contributed to Data Collection and Analysis Has given Final Approval of the version to be published
Sajjal Naeem Gul	Substantial Contribution to study design and Data Analysis Has given Final Approval of the version to be published

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