

Virtual Reality in Musculoskeletal Rehabilitation: Knowledge, Experience and Perceptions of Physiotherapists in Lahore

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ABSTRACT

Background: Virtual reality (VR) is increasingly being explored as an adjunct to conventional musculoskeletal rehabilitation because of its potential to enhance therapeutic engagement and support functional rehabilitation. However, its implementation depends partly on clinicians' knowledge, practical exposure, and perceptions, and evidence regarding these factors among physiotherapists in Pakistan remains limited. **Objective:** To evaluate the knowledge, experience, and perceptions of physiotherapists regarding VR-based interventions in musculoskeletal rehabilitation settings in Lahore, Pakistan. **Methods:** A cross-sectional survey was conducted among 377 physiotherapists working in musculoskeletal rehabilitation settings in Lahore using non-probability convenience sampling. A structured questionnaire assessed demographic characteristics and domains related to knowledge, experience, perceptions, and VR exposure. Data were analyzed using SPSS version 27. Continuous variables were summarized as mean $\pm$ standard deviation, categorical variables as frequencies and percentages, and chi-square tests were used to assess reported associations among knowledge, experience, and perception. **Results:** Participants had a mean age of 37.46 ± 6.38 years. The mean knowledge, experience, and perception scores were 12.06 ± 2.13 , 11.85 ± 2.62 , and 9.11 ± 2.41 , respectively. Moderate knowledge was observed in 285 (75.6%) participants, while 219 (58.1%) demonstrated neutral perceptions. No statistically significant association was observed between knowledge and experience ($p = 0.282$) or between knowledge and perception ($p = 0.716$). Experience and perception were significantly associated ($p = 0.024$). **Conclusion:** Physiotherapists in Lahore demonstrated predominantly moderate knowledge and neutral perceptions regarding VR-based musculoskeletal rehabilitation, with variable practical exposure. Experience was associated with perception, whereas knowledge was not significantly associated with either experience or perception. These findings indicate a gap between awareness and practical engagement with VR that may be relevant to future professional training and implementation strategies. **Keywords:** Virtual Reality; Physiotherapy; Musculoskeletal Rehabilitation; Knowledge; Perception; Clinical Experience

INTRODUCTION

Musculoskeletal disorders (MSDs) are an important cause of pain, functional limitation, reduced mobility, work impairment, and disability across diverse populations (1,2). Their clinical and socioeconomic consequences are particularly important because persistent musculoskeletal symptoms can interfere with physical functioning, participation, and quality of life; evidence from Lahore has similarly demonstrated considerable quality-of-life impairment among individuals with musculoskeletal conditions (3). Physiotherapy is central to conservative musculoskeletal rehabilitation and commonly incorporates therapeutic exercise, functional rehabilitation, education, and multimodal approaches to improve pain and physical function (4). Nevertheless, rehabilitation outcomes may be influenced by adherence, motivation, and sustained participation in prescribed exercise, which remain recognized challenges in long-term rehabilitation programs (5).

Virtual reality (VR) has emerged as a technology-assisted rehabilitation approach that uses interactive computer-generated environments to facilitate therapeutic activities, exercise participation, motor training, and patient engagement. Both immersive and non-immersive VR systems have been investigated in musculoskeletal rehabilitation, with evidence suggesting potential benefits for pain, physical function, exercise engagement, and selected functional outcomes (6). An umbrella review of musculoskeletal rehabilitation studies reported beneficial effects of VR across several rehabilitation outcomes, although the magnitude and certainty of benefit varied across conditions and intervention formats (7). Similarly, systematic-review evidence suggests that VR can contribute to pain management in musculoskeletal disorders, while substantial clinical and methodological heterogeneity remains across anatomical regions and treatment protocols (8). In individuals with low back pain, VR-based rehabilitation has also been associated with reductions in pain intensity, supporting its potential role as an adjunct to conventional rehabilitation rather than as a uniform replacement for established treatment approaches (9).

Despite increasing evidence supporting the clinical potential of VR, implementation within routine healthcare and physiotherapy practice remains inconsistent. Research from Pakistan examining extended-reality technologies has identified variable levels of knowledge, attitudes, and perceptions among healthcare professionals, indicating that technological awareness does not necessarily translate into routine clinical adoption (10). Surveys of physiotherapists have similarly reported awareness of VR and augmented-reality applications alongside limitations in practical exposure and clinical implementation (11). International evidence indicates that many physical therapy professionals remain interested in VR while reporting relatively limited clinical use (12). Surveys specifically examining VR in musculoskeletal physiotherapy have highlighted gaps between perceived knowledge, practical experience, and willingness or preparedness to incorporate VR into rehabilitation practice (13). Comparable findings among physiotherapy students and clinicians have further emphasized the importance of professional exposure and education when considering implementation of VR-based rehabilitation technologies (14).

Although VR is increasingly discussed in rehabilitation research, evidence specifically describing the knowledge, experience, and perceptions of physiotherapists working in musculoskeletal rehabilitation settings in Pakistan remains limited, with existing Pakistani research addressing extended-reality technologies more broadly across healthcare populations (10). Understanding clinician knowledge, practical exposure, and perceptions is important for identifying implementation gaps and informing future educational and service-development strategies. Therefore, this study aimed to evaluate the experience, knowledge, and perceptions of physiotherapists regarding VR-based interventions in musculoskeletal rehabilitation settings in Lahore, Pakistan.

MATERIALS AND METHODS

A cross-sectional survey was conducted among physiotherapists working in musculoskeletal rehabilitation settings in Lahore, Pakistan. A total of 377 physiotherapists were recruited using non-probability convenience sampling. Physiotherapists were eligible if they were working in a musculoskeletal rehabilitation setting in Lahore, were 25–55 years of age, had at least six months of clinical experience, and were willing to participate. Individuals who were not physiotherapists, were not practicing in musculoskeletal rehabilitation, were not working in Lahore, or submitted incomplete questionnaire responses were excluded from the analysis.

Data were collected using a structured questionnaire comprising items addressing participant demographic characteristics and domains related to knowledge, experience, perceptions, and barriers concerning VR-based interventions in musculoskeletal rehabilitation. Knowledge was summarized both as a composite score and according to the study categories of low, moderate, and high knowledge. Perception was similarly summarized as a composite score and categorized as negative, neutral, or

positive. Experience with VR was assessed through the reported experience score and through specific forms of exposure, including previous VR use, entertainment-related exposure, research participation, treatment use, home- and community-based use, conference exposure, and formal training.

Statistical analysis was performed using SPSS version 27. Continuous variables were summarized using mean and standard deviation, while categorical variables were reported as frequencies and percentages. Descriptive analyses were performed for demographic characteristics and questionnaire domains. Chi-square tests were used to assess the reported associations among knowledge, experience, and perception variables. Statistical findings are presented using the p-values available from the study analysis.

RESULTS

A total of 377 physiotherapists were included in the analysis. The mean age of participants was 37.46 ± 6.38 years. Of the total sample, 191 (50.7%) were male and 186 (49.3%) were female. The largest clinical-experience category was 5–10 years, comprising 170 participants (45.1%), followed by 10–20 years in 96 participants (25.5%), 2–5 years in 86 participants (22.8%), and 1–2 years in 25 participants (6.6%).

Table 1. Demographic characteristics of physiotherapists (n = 377)

Variable	Value
Age, years, mean $\pm$ SD	37.46 ± 6.38
Gender, n (%)	
Male	191 (50.7)
Female	186 (49.3)
Clinical experience, n (%)	
1–2 years	25 (6.6)
2–5 years	86 (22.8)
5–10 years	170 (45.1)
10–20 years	96 (25.5)

The mean knowledge score was 12.06 ± 2.13 , the mean experience score was 11.85 ± 2.62 , and the mean perception score was 9.11 ± 2.41 .

Table 2. Knowledge, experience, and perception scores (n = 377)

Variable	Mean $\pm$ SD
Knowledge score	12.06 ± 2.13
Experience score	11.85 ± 2.62
Perception score	9.11 ± 2.41

When knowledge was categorized according to the study classification, 285 participants (75.6%) were classified as having moderate knowledge, 50 (13.3%) as having high knowledge, and 42 (11.1%) as having low knowledge. Perception was predominantly neutral, with 219 participants (58.1%) classified in the neutral category. Negative perceptions were reported for 95 participants (25.2%), whereas 63 (16.7%) were classified as having positive perceptions.

Table 3. Distribution of knowledge and perception categories (n = 377)

Domain	Category	n (%)
Knowledge	Low	42 (11.1)
	Moderate	285 (75.6)
	High	50 (13.3)
Perception	Negative	95 (25.2)
	Neutral	219 (58.1)
	Positive	63 (16.7)

Patterns of VR exposure varied across participants. Ninety-four physiotherapists (24.9%) reported no previous VR experience, while 92 (24.4%) reported entertainment-related VR exposure. Experience through research projects was reported by 103 participants (27.3%), and 88 (23.3%) reported experience using VR as a treatment intervention. Home-setting exposure was reported by 95 participants (25.2%), community-setting exposure by 82 (21.8%), and conference-related exposure by 108 (28.6%). Seventy

participants (18.6%) reported no formal VR training. Because these exposure categories were not mutually exclusive, their percentages should not be summed to 100%.

Table 4. Reported experience with virtual reality (n = 377)

VR experience/exposure	n (%)
No prior VR experience	94 (24.9)
VR for entertainment	92 (24.4)
VR in research projects	103 (27.3)
VR as a treatment intervention	88 (23.3)
VR use in home settings	95 (25.2)
VR use in community settings	82 (21.8)
Exposure through conferences	108 (28.6)
No formal VR training	70 (18.6)

Percentages are calculated using the total sample of 377 participants; experience/exposure categories are not mutually exclusive.

Table 5. Association analyses for knowledge, experience, and perception

Variables compared	p-value
Knowledge × Experience	0.282
Knowledge × Perception	0.716
Experience × Perception	0.024

The reported chi-square analyses showed no statistically significant association between knowledge and experience ($p = 0.282$) or between knowledge and perception ($p = 0.716$). An association was observed between experience and perception ($p = 0.024$). Because the available analysis reports only the p-value for this comparison, the finding demonstrates evidence of an association but does not independently establish the direction or magnitude of that association.

DISCUSSION

The present study evaluated knowledge, experience, and perceptions regarding VR-based interventions among physiotherapists working in musculoskeletal rehabilitation settings in Lahore. Most participants demonstrated moderate knowledge, while perceptions were predominantly neutral rather than positive. Practical exposure to VR varied across clinical, research, educational, home, community, and entertainment contexts, and approximately one-quarter of participants reported no prior VR experience. The association analysis demonstrated a statistically significant relationship between experience and perception, whereas knowledge was not significantly associated with either experience or perception. These findings suggest that awareness of VR and practical familiarity with the technology represent related but distinct dimensions of readiness for clinical implementation.

The predominance of moderate knowledge alongside limited or variable practical exposure is broadly consistent with previous surveys examining VR adoption among physiotherapy professionals. Salama et al. reported that physiotherapists recognized the potential value of VR in musculoskeletal rehabilitation but showed variability in practical experience and perceived knowledge, highlighting a gap between theoretical awareness and routine application (13). Similarly, Felsberg et al. found that clinical use of VR among physical therapy professionals in the United States remained limited despite interest in its future application (12). Ghrouz et al. also identified differences in awareness and perceptions of VR among physiotherapy students and clinicians, emphasizing the relevance of exposure and educational opportunities when considering technology adoption (14). Collectively, these findings indicate that growing awareness of VR does not necessarily correspond to extensive hands-on clinical experience.

The present finding that knowledge was not significantly associated with perception may indicate that familiarity with the theoretical concept of VR alone does not necessarily correspond to a more favorable view of its clinical use. This observation is relevant because clinicians may understand the potential applications of a rehabilitation technology while remaining uncertain about its feasibility, accessibility,

usability, or integration into routine workflows. Research among healthcare professionals in Pakistan has similarly demonstrated variability in knowledge, attitudes, and perceptions toward extended-reality technologies, suggesting that acceptance of such technologies is influenced by factors beyond basic awareness (10). Joshi and Musale likewise reported awareness of VR and augmented reality among physiotherapists while identifying limitations in practical implementation, supporting the distinction between knowing about a technology and being prepared to use it clinically (11).

Experience and perception were statistically associated in the present analysis, although the available results do not establish the direction or magnitude of this relationship. Accordingly, the finding should not be interpreted as evidence that greater experience causes more positive perceptions. Nevertheless, the association is clinically relevant because direct exposure to VR may coexist with differences in perceived usefulness, feasibility, confidence, or acceptability. Previous clinician surveys have similarly indicated that practical familiarity and actual clinical use vary substantially even among professionals who express interest in VR-based rehabilitation (12,13). Because the present study was cross-sectional, temporal sequencing between experience and perception cannot be determined, and favorable perceptions may encourage exposure just as exposure may influence perceptions.

The potential clinical relevance of these implementation findings should also be considered alongside evidence concerning VR effectiveness in musculoskeletal rehabilitation. A scoping review by Lin et al. identified potential benefits of VR and exergaming across musculoskeletal rehabilitation applications, although interventions and outcome measures varied considerably between studies (6). Tang et al., in an umbrella review, reported beneficial effects of VR across several musculoskeletal rehabilitation outcomes but also emphasized heterogeneity in the underlying evidence (7). Similarly, Zitti et al. found that VR could contribute to pain management across musculoskeletal disorders, with variation in effectiveness among anatomical regions and intervention approaches (8). In low back pain specifically, Choi et al. reported reductions in pain with VR-based rehabilitation interventions (9). These findings provide a clinical rationale for increasing physiotherapists' familiarity with VR while also indicating that implementation decisions should remain condition-specific and evidence-informed rather than assuming uniform effectiveness across all musculoskeletal disorders.

The distribution of VR exposure in the present study further suggests that professional contact with the technology is not confined to direct treatment delivery. Participants reported exposure through research projects, conferences, home and community settings, and entertainment, while fewer than one-quarter reported using VR as a treatment intervention. Such variation is important because non-clinical exposure may increase familiarity with VR interfaces without necessarily providing the clinical competencies required for patient selection, therapeutic progression, safety monitoring, or integration with conventional rehabilitation. Surveys of physiotherapy professionals have similarly highlighted the distinction between general familiarity with VR and actual implementation within patient care (12-14). Consequently, future educational initiatives may benefit from emphasizing clinically oriented practical exposure rather than awareness alone.

The findings have implications for physiotherapy education and service development. Because moderate knowledge was considerably more common than high knowledge and perceptions were predominantly neutral, educational strategies should focus not only on conceptual information but also on the practical application of VR in appropriate musculoskeletal conditions. Evidence from existing clinician surveys indicates that limited use of VR persists despite professional interest, reinforcing the importance of accessible training and implementation pathways (12,13). However, the current data should not be interpreted as demonstrating that training would necessarily improve perceptions or increase clinical adoption, because neither an educational intervention nor longitudinal change was evaluated in this study.

This study has several strengths. It provides data from a relatively large sample of physiotherapists working in musculoskeletal rehabilitation settings in Lahore and simultaneously examines knowledge,

experience, perceptions, and different forms of VR exposure. The study also contributes context-specific evidence from Pakistan, where available research has more often addressed extended-reality technologies across broader healthcare populations rather than focusing specifically on physiotherapists involved in musculoskeletal rehabilitation (10). The inclusion of both descriptive and association analyses provides an initial characterization of relationships among the principal study domains.

Several limitations should be considered when interpreting the findings. The cross-sectional design prevents determination of temporal or causal relationships between knowledge, experience, and perception. Convenience sampling may have introduced selection bias and limits the representativeness of the sample, while recruitment from a single metropolitan area restricts generalizability to physiotherapists practicing in other regions of Pakistan. Questionnaire-based self-reporting may also be affected by recall and response biases. In addition, the reported association analysis provides p-values without corresponding chi-square statistics, degrees of freedom, effect sizes, or detailed cross-tabulations, limiting evaluation of the magnitude and pattern of the observed associations. The findings should therefore be interpreted as descriptive evidence of clinician knowledge, exposure, and perceptions and as preliminary evidence of associations requiring confirmation through more comprehensive multicenter and longitudinal research.

CONCLUSION

Physiotherapists working in musculoskeletal rehabilitation settings in Lahore demonstrated predominantly moderate knowledge and neutral perceptions regarding VR-based interventions, while practical exposure varied across clinical and non-clinical contexts. Experience was significantly associated with perception, whereas knowledge was not significantly associated with either experience or perception. These findings indicate that knowledge alone may not adequately characterize readiness for VR implementation and highlight the relevance of practical exposure when evaluating clinicians' engagement with emerging rehabilitation technologies. The results support further investigation of educational, organizational, and implementation factors influencing the integration of VR into musculoskeletal physiotherapy practice.

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