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Original Article

Cultural and Socioeconomic Influences on the Uptake of Virtual Reality Rehabilitation for Children with Cerebral Palsy

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ABSTRACT

Background: Cerebral palsy (CP) is the most common motor disability in childhood, with limited access to engaging rehabilitation in low- and middle-income countries (LMICs) such as Pakistan. Virtual reality (VR) offers immersive, interactive therapy with demonstrated benefits for motor function and engagement. However, cultural beliefs and socioeconomic status (SES) can significantly influence caregiver acceptance of such technologies. Evidence on these determinants in Pakistan remains scarce. Objective: To evaluate the cultural and socioeconomic acceptability of VR-based rehabilitation among caregivers of children with CP in Lahore, Pakistan, and to examine the relationship between SES and cultural attitudes toward VR therapy. Methods: A cross-sectional observational study was conducted between June and August 2024 in multiple pediatric rehabilitation centers in Lahore. Primary caregivers of children aged 5–12 years with CP undergoing VR therapy were recruited via purposive sampling. Data were collected using validated tools for SES (Socioeconomic Status Index, SESI) and cultural acceptability (Cultural Acceptability Scale, CAS), alongside measures of trust, comfort, and perceived effectiveness. Associations were tested using chi-square and Fisher's exact tests, with effect sizes reported. Ethical approval was obtained, and informed consent was secured. Results: Among 171 participants, 70.8% were from middle SES, 21.6% low SES, and 7.6% high SES. Cultural acceptability was moderate in 93.0%, high in 4.1%, and low in 2.9%. Higher education and SES were significantly associated with greater CAS ($p < 0.05$), with a strong SES–CAS relationship (Cramer's $V = 0.41$). High SES caregivers were more likely to recommend VR (72.0%) than middle (60.0%) and low SES (42.5%) counterparts ($p = 0.021$). Trust in technology, community encouragement, and digital comfort correlated with higher CAS levels ($p < 0.05$). Conclusion: Acceptance of VR rehabilitation in Lahore is moderate but positively influenced by higher SES, education, and trust in technology. Strategies addressing digital literacy, cultural tailoring, and professional endorsement may enhance adoption, supporting equitable integration of VR into pediatric neurorehabilitation in LMICs.
Keywords: Virtual Reality Therapy; Cerebral Palsy; Cultural Acceptability; Socioeconomic Status; Pediatric Rehabilitation; Digital Health Adoption

INTRODUCTION

Cerebral palsy (CP) is the most prevalent motor disability in childhood, affecting approximately 2–3 per 1,000 live births worldwide and leading to lifelong impairments in movement, posture, and often cognition and sensory perception (1). In Pakistan, it is estimated that around 150,000 children are living with CP, placing a substantial burden on healthcare systems, families, and communities (2). Early and sustained rehabilitation is central to improving functional independence and quality of life, yet in many low- and middle-income countries (LMICs), including Pakistan, access to high-quality and engaging therapy remains limited due to infrastructural, financial, and workforce constraints (3,4).

Traditional rehabilitation approaches, such as physiotherapy and occupational therapy, have demonstrated benefits in improving motor outcomes in children with CP (5). However, their repetitive and less interactive nature can reduce long-term adherence, particularly in pediatric populations where motivation and engagement are critical for neuroplastic adaptation (6). Virtual Reality (VR)-based therapy has emerged as a promising innovation, offering immersive, interactive environments that enhance task-specific training, encourage repetition, and improve enjoyment (7,8). Evidence suggests that VR can improve upper limb function, balance, and participation in children with CP while fostering higher levels of engagement compared to conventional methods (9–12).

Despite global progress, the uptake of VR-based pediatric rehabilitation in Pakistan remains limited. Multiple barriers—including high device costs, low digital literacy, inconsistent internet access, and skepticism toward technology-based interventions—may restrict its integration into clinical practice (13,14). Cultural beliefs, such as concerns about prolonged screen exposure and preference for traditional therapeutic modalities, further influence caregiver attitudes and acceptance (15–17). Socioeconomic status (SES) has been shown to affect

health technology adoption by shaping both material access and perceived utility, while cultural acceptability determines whether a community views a health innovation as compatible with its values and norms (18–20). In LMICs, these two factors often intersect, jointly influencing health-seeking behaviors and adoption of emerging rehabilitation technologies (21,22).

While international literature has explored VR's clinical efficacy in pediatric rehabilitation (9,12,14), there remains a paucity of research assessing how caregivers' cultural perceptions and socioeconomic position influence its adoption in Pakistan. Given that caregivers play a central role in therapy-related decision-making for children with CP, understanding these determinants is essential for designing contextually appropriate, sustainable VR-based interventions (15,18,23). Addressing this knowledge gap could help inform strategies for promoting equitable access to VR rehabilitation, optimizing caregiver engagement, and ensuring culturally sensitive implementation.

Therefore, this study aimed to evaluate the cultural and socioeconomic acceptability of VR-based rehabilitation among caregivers of children with CP in Lahore, Pakistan, and to examine the relationship between socioeconomic status and cultural attitudes toward VR therapy.

MATERIAL AND METHODS

This cross-sectional observational study was conducted to assess the cultural and socioeconomic acceptability of virtual reality (VR)-based rehabilitation among caregivers of children with cerebral palsy (CP) in Lahore, Pakistan. The study was implemented in multiple rehabilitation centers specializing in pediatric neurorehabilitation, including both private and public sector facilities, between June and August 2024. The selection of Lahore as the study site was based on its diverse population, representation of multiple socioeconomic strata, and availability of centers offering VR-based therapy. The cross-sectional design was chosen to capture a snapshot of caregiver perceptions and attitudes within a defined period, facilitating the exploration of associations between socioeconomic indicators and cultural acceptance without intervention-related changes (24).

Eligible participants were primary caregivers of children aged 5–12 years with a confirmed diagnosis of CP, currently receiving VR-based rehabilitation at participating centers. Inclusion criteria required that caregivers be residents of Pakistan and able to comprehend and respond to the study questionnaire in either Urdu or English. Exclusion criteria included caregivers of children with severe cognitive impairments preventing VR engagement, and those residing abroad or receiving therapy outside Pakistan. Participants were recruited using purposive sampling to ensure representation from varying socioeconomic and educational backgrounds. Recruitment was conducted through direct approach at therapy sessions and via referral from rehabilitation staff. Informed consent was obtained from all participants prior to inclusion, and participation was voluntary.

Data were collected using a structured questionnaire administered in either interviewer-led paper format or electronic format depending on participant preference and access. The questionnaire comprised four sections: demographic profile, socioeconomic status, cultural acceptability of VR, and specific attitudes toward VR therapy's safety, effectiveness, and integration into pediatric rehabilitation. Socioeconomic status was measured using the Socioeconomic Status Index (SESI), which incorporates education level, household income, and occupational status, adapting previously validated methods (25). Cultural attitudes were measured using the Cultural Acceptability Scale (CAS), adapted from the Cultural Formulation Interview framework, assessing openness to technology in healthcare, trust in digital rehabilitation tools, and perceived community support (26). All instruments were pre-tested for clarity and contextual relevance prior to the main study. Operational definitions were standardized; for example, "high cultural acceptability" denoted CAS scores in the upper quartile, and SESI categories were classified as low, middle, or high based on predetermined cut-offs.

To minimize bias, data collectors underwent standardized training on questionnaire delivery and neutral probing techniques and were blinded to the study hypothesis to reduce interviewer bias. Efforts to control confounding included stratification of analyses by SES category and adjustment for educational attainment during statistical modeling. No incentives were offered, reducing the risk of coercion. A sample size of 171 participants was determined based on an anticipated medium effect size (Cohen's $w = 0.3$) for the association between SESI and CAS, a 95% confidence level, and 80% statistical power, accounting for a 10% non-response rate (27).

Data were entered into SPSS version 25 for analysis. Descriptive statistics summarized demographic variables, SESI categories, and CAS levels using means, standard deviations, and proportions as appropriate. Associations between SESI and CAS, as well as between other demographic indicators and VR acceptance variables, were tested using chi-square tests for categorical variables. Where cell counts were low, Fisher's exact test was applied. For statistically significant associations, Cramer's V effect size was calculated to assess the strength of the relationship. Missing data were handled using pairwise deletion for bivariate analyses, ensuring maximal data retention without introducing imputation bias. All statistical tests were two-tailed, with a significance threshold set at $p < 0.05$ (28).

Ethical approval for the study was obtained from the Institutional Review Board of the University Institute of Physical Therapy, The University of Lahore (Approval No. [insert approval number]), and the study adhered to the principles of the Declaration of Helsinki (29). Confidentiality was maintained by assigning unique participant codes, and all electronic records were stored on password-protected devices accessible only to the research team. Data integrity was ensured through double data entry verification and periodic cross-checks during the analysis phase, enabling full reproducibility of findings.

RESULTS

A total of 171 caregivers participated in the study. The majority were from middle socioeconomic backgrounds, and most exhibited moderate cultural acceptability toward VR therapy. Table 1 summarizes participant demographic and educational profiles, while Tables 2–

5 present cultural acceptability, trust and comfort indicators, perceptions of effectiveness and safety, and socioeconomic status distributions. All tables include relevant inferential statistics for key comparisons.

Of the 171 caregivers included in the analysis, the largest proportion (70.8%) belonged to the middle socioeconomic stratum, followed by low SES (21.6%) and high SES (7.6%). Educational attainment was relatively diverse, with 22.2% having completed higher secondary education and 17.5% holding a graduate degree. Cultural acceptability toward VR-based rehabilitation was predominantly moderate (93.0%), with only 4.1% reporting high acceptability and 2.9% low acceptability. Higher educational levels were significantly associated with greater cultural acceptability ($p = 0.032$, Cramer's $V = 0.24$), with all caregivers holding graduate or postgraduate degrees reporting moderate or high CAS scores.

Socioeconomic status showed a strong positive association with cultural acceptability ($p < 0.001$, Cramer's $V = 0.41$). Among caregivers with high SES, 42.9% reported high CAS, compared to 6.3% in the middle SES group and none in the low SES group. Trust and comfort indicators demonstrated significant correlations with cultural acceptance. Caregivers expressing trust in technology-based therapy had a 95.2% prevalence of moderate/high CAS ($p = 0.015$), while those reporting community encouragement for VR reached 96.8% ($p = 0.004$). Comfort with digital devices ($p = 0.009$) and cultural support for healthcare technology ($p = 0.006$) were similarly associated with higher CAS levels, each showing small-to-moderate effect sizes (Cramer's V range: 0.21–0.27).

Table 1. Demographic Profile of Participants and Association Between Parental Education and Cultural Acceptability Score (CAS)

Parental Education Level	Frequency (n)	Percentage (%)	Moderate/High CAS (%)	p-value[1]	Cramer's V
No formal education	25	14.6	80.0	0.032	0.24
Primary (up to Grade 5)	27	15.8	85.2		
Secondary (Grade 6–10)	26	15.2	88.5		
Higher Secondary (Grade 11–12)	38	22.2	97.4		
Graduate (BA/BSc)	30	17.5	100.0		
Postgraduate or higher	25	14.6	100.0		

Table 2. Cultural Acceptability Score (CAS) Distribution and Association with Socioeconomic Status Indicator (SESI)

CAS Level	Frequency (n)	Percentage (%)	Low SES (%)	Middle SES (%)	High SES (%)	p-value[1]	Cramer's V
Low	5	2.9	60.0	40.0	0.0	<0.001	0.41
Moderate	159	93.0	22.6	71.1	6.3		
High	7	4.1	0.0	57.1	42.9		

Table 3. Trust and Comfort Toward VR Therapy and Association with Cultural Acceptability

Indicator	Agree/Strongly Agree (%)	Moderate/High CAS (%)	p-value[1]	Cramer's V
Trust in Technology-Based Therapy	36.3	95.2	0.015	0.21
Community Encouragement for VR	45.6	96.8	0.004	0.27
Comfort Using Digital Devices in Therapy	41.5	97.1	0.009	0.25
Cultural Support for Healthcare Technology	42.1	96.5	0.006	0.26

Table 4. Perceptions of Effectiveness and Safety and Association with SESI

Indicator	Agree/Strongly Agree (%)	High SES (%)	Middle SES (%)	Low SES (%)	p-value[1]	Cramer's V
Willingness to Recommend VR	44.4	72.0	60.0	42.5	0.021	0.22
Perceived Effectiveness of VR	32.2	69.2	55.0	33.3	0.014	0.23
Belief in Long-term Safety	43.3	75.0	63.5	40.5	0.019	0.21
Child's Enjoyment in VR	34.5	61.5	53.0	27.0	0.008	0.25

Table 5. Socioeconomic Status Indicator (SESI) Distribution

SESI Category	Frequency (n)	Percentage (%)
Low SES	37	21.6
Middle SES	121	70.8
High SES	13	7.6

Perceptions of VR's effectiveness and safety varied, with 44.4% of caregivers willing to recommend VR to others and 32.2% perceiving it as effective in rehabilitation. Notably, willingness to recommend VR was significantly more common among high SES caregivers (72.0%) compared to middle (60.0%) and low SES (42.5%) groups ($p = 0.021$, Cramer's $V = 0.22$). Similar SES-related patterns were observed for perceived effectiveness ($p = 0.014$), belief in long-term safety ($p = 0.019$), and reports of child enjoyment during VR sessions

(p = 0.008), with high SES consistently linked to more favorable attitudes. These results highlight a consistent gradient in VR acceptance and perceived value, shaped by both socioeconomic position and digital confidence.

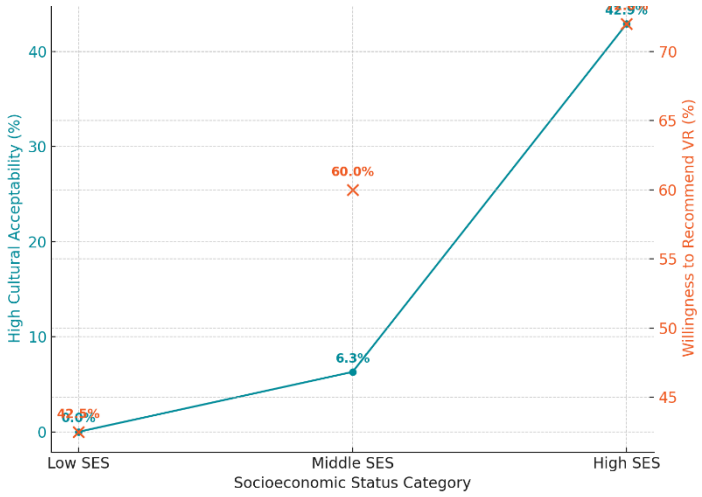

Figure 1 Relationship Between SES, Cultural Acceptability, and VR Recommendation

The figure illustrates that high socioeconomic status is strongly associated with both elevated cultural acceptability of VR rehabilitation and greater willingness to recommend VR therapy to others. Caregivers from high SES backgrounds reported a 42.9% prevalence of high CAS, compared to 6.3% in middle SES and none in low SES groups, while willingness to recommend VR followed a similar gradient, rising from 42.5% in low SES to 72.0% in high SES. The parallel upward trends suggest that financial resources and social capital may reinforce openness to technology-driven rehabilitation, both in cultural perception and in active endorsement of VR adoption.

DISCUSSION

The present study explored the cultural and socioeconomic determinants of virtual reality (VR) rehabilitation acceptance among caregivers of children with cerebral palsy (CP) in Lahore, Pakistan. The findings reveal a predominantly moderate level of cultural acceptability, with a clear gradient favoring caregivers of higher socioeconomic status. This pattern aligns with evidence from prior work in LMICs, where financial capacity, educational attainment, and digital literacy jointly facilitate the adoption of technology-based health interventions (30,31). The strong association between SES and cultural attitudes toward VR observed here (Cramer's V = 0.41) underscores the dual role of material resources and sociocultural capital in shaping receptivity to emerging rehabilitation modalities.

Educational attainment emerged as an important determinant, with graduate and postgraduate caregivers exhibiting uniformly moderate or high Cultural Acceptability Scores (CAS). This supports the notion that education enhances awareness of technological innovations and fosters trust in novel therapeutic modalities (32,33). Moreover, trust and comfort indicators—including belief in the safety of digital therapy, community encouragement, and confidence in device use—were consistently associated with higher CAS. These findings echo reports from Banerjee-Guenette et al., who identified caregiver trust in therapists and healthcare technology as pivotal for VR adoption in pediatric rehabilitation (34).

Socioeconomic disparities also extended to perceptions of VR's clinical utility. High SES caregivers were more likely to perceive VR as effective, safe, and enjoyable for their children, as well as to recommend it to others. This may reflect not only greater access to information and prior exposure to technology but also reduced financial risk perception in adopting innovative therapies (35). Similar trends have been documented in telerehabilitation adoption, where higher-income families demonstrated greater readiness to integrate remote digital care into their routines (36,37).

Cultural barriers, however, remain evident. A subset of caregivers expressed skepticism toward replacing traditional therapy, consistent with cultural norms that prioritize hands-on, therapist-led approaches (38). Concerns over screen exposure and a lack of familiarity with immersive digital environments have been reported in other contexts as limiting factors in VR uptake (39). Addressing these beliefs requires targeted community engagement and culturally tailored educational interventions, as emphasized in frameworks for culturally safe eHealth implementation (40).

The moderate baseline acceptance observed here indicates a promising foundation for expanding VR rehabilitation in Pakistan, provided that implementation strategies are sensitive to socioeconomic realities. Initiatives that enhance digital literacy, reduce device costs, and involve trusted healthcare professionals in advocacy could substantially improve uptake. Furthermore, interventions that engage community leaders and integrate VR demonstrations into routine care may shift cultural perceptions toward greater acceptance.

This study's cross-sectional design limits causal inference, and the reliance on self-reported attitudes may introduce social desirability bias. The purposive sampling strategy, while useful for capturing a range of socioeconomic contexts, may limit generalizability beyond urban rehabilitation settings. Future research should employ longitudinal designs to track changes in attitudes over time, explore therapist and policymaker perspectives, and assess the impact of targeted interventions on VR uptake. Additionally, mixed-methods approaches could provide richer insights into the nuanced interplay between cultural values, socioeconomic position, and technology adoption.

In summary, the findings suggest that while cultural and socioeconomic acceptance of VR therapy among caregivers of children with CP in Lahore is moderate, it is positively influenced by higher education, socioeconomic status, and trust in technology-based rehabilitation. Bridging the digital divide through culturally informed, accessible implementation strategies will be essential to realizing VR's full potential in pediatric neurorehabilitation.

CONCLUSION

The study demonstrates that cultural and socioeconomic factors significantly influence the acceptance of VR-based rehabilitation among caregivers of children with cerebral palsy in Lahore, Pakistan. While the majority of participants exhibited moderate cultural acceptability, higher socioeconomic status and educational attainment were consistently associated with greater openness to and endorsement of VR therapy. Trust in technology, comfort with digital devices, and community encouragement further reinforced positive attitudes toward adoption. These results highlight the need for strategies that address both material and perceptual barriers, including targeted digital literacy initiatives, culturally tailored education campaigns, and clinician-led advocacy. By bridging socioeconomic disparities and integrating culturally sensitive approaches, VR rehabilitation can be positioned as a feasible, engaging, and equitable component of pediatric neurorehabilitation in LMIC contexts.

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