AI-Driven Tele-Rehabilitation in Rural Areas: Assessing Barriers and Opportunities for Accessible Physiotherapy Services

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Abstract

Background: Physiotherapy is essential for managing musculoskeletal, neurological, and post-surgical conditions. However, access to rehabilitation services remains limited in rural areas due to a shortage of trained professionals, infrastructure constraints, and transportation barriers. Emerging technologies, such as AI-enabled tele-rehabilitation, offer the potential to bridge these gaps by delivering remote assessments, personalized exercise programs, and real-time feedback. **Objective:** This study aims to evaluate the feasibility and acceptability of AI-driven tele-rehabilitation among rural patients and healthcare providers. It also seeks to identify perceived barriers to its adoption, explore potential benefits, and assess its influence on treatment adherence and clinical outcomes. **Methods:** A cross-sectional survey was conducted involving 458 participants, including rural patients with musculoskeletal or neurological conditions, physiotherapists, and healthcare personnel. Participants were selected using convenience sampling. A self-structured questionnaire was administered to gather information on demographics, health status, access to digital technology, perceptions of AI, and barriers to tele-rehabilitation implementation. **Results:** The study anticipates uncovering key challenges to AI-based tele-rehabilitation uptake, including technological literacy, financial constraints, psychological readiness, and regulatory limitations. It is also expected to highlight opportunities for expanding physiotherapy access through AI, particularly in underserved rural regions. **Conclusions:** Findings from this study will inform strategies to facilitate the integration of AI-driven tele-rehabilitation into rural health systems. By addressing both barriers and enablers, the research aims to guide healthcare providers, policymakers, and stakeholders in enhancing rehabilitation equity and narrowing the urban–rural divide in musculoskeletal care.

Keywords: AI in physiotherapy; tele-rehabilitation; rural healthcare; musculoskeletal rehabilitation; healthcare accessibility; digital health

Ethical Statement: Ethical approval for this study was obtained from the Institutional Ethics Committee. Informed consent was obtained from all participants prior to data collection, and all procedures were conducted in accordance with the Declaration of Helsinki.

Introduction

Around 70% of India's population lives in rural areas (Kumar & Kumar, 2018).Rural populations often engage in physically demanding and hazardous work, making them prone to chronic pain, respiratory issues, and disability. Despite these health risks, access to quality primary care remains limited due to systemic gaps. As a result, many rely on informal care or delay treatment, worsening their health outcomes (Bang et al., 2021).

Physiotherapists are healthcare professionals dedicated to enhancing mobility and quality of life. They use clinical expertise to assess, plan, and implement targeted treatments aimed at promoting health, preventing injuries, and preserving functional independence (Rajan, 2017).Nevertheless, individuals living in rural and remote regions continue to face significant disparities in accessing physiotherapy services. These populations frequently encounter systemic barriers such as a shortage of trained healthcare professionals, underdeveloped medical infrastructure, transportation difficulties, and financial constraints(Felter et al., 2022).The advancement of digital health technologies has led to the development of innovative solutions aimed at overcoming these disparities, with tele-rehabilitation becoming a practical alternative to traditional in-person physiotherapy services(Cottrell et al., 2017).Tele-rehabilitation uses technology to offer online consultations, assessments, exercise plans, and track progress from a distance(Kairy et al., 2009). It also offers numerous benefits, such as reducing the need for travel, improving accessibility, being cost-effective, and providing ongoing support. The significance of remote healthcare solutions has been highlighted by recent global health crises, such as the COVID-19 pandemic (Baroni et al., 2023).

Merging Artificial Intelligence (AI) to tele-rehabilitation platforms is a big step in improving digital physiotherapy, making remote care more accurate and personalized(Rintyarna et al., 2023).AI-driven platforms can analyze patient data to customize therapy regimens, offer real-time corrective feedback during exercises, predict patient outcomes, and improve adherence through automated reminders and motivational support(Mennella et al., 2023). Despite its potential, the implementation of AI-driven tele-rehabilitation in rural settings faces several challenges. Digital illiteracy, limited broadband connectivity, lack of trust in technology, privacy and data

security concerns, and cultural resistance to non-traditional care modalities are among the primary barriers(Surya & Someshwarl, 2025).Also, healthcare providers in rural areas may not have the right training or resources to use AI-based systems properly. This shows the need for a detailed study to understand both the challenges and opportunities in using AI-driven tele-rehabilitation in these areas.

The present study aimed to address this gap by investigating the feasibility, acceptance, and perceived benefits of AI-based tele-rehabilitation among rural patients and healthcare providers. Through a cross-sectional study explored technological, psychological, financial, and infrastructural factors influencing adoption. It will also assess the potential impact of AI-driven rehabilitation on treatment adherence, patient satisfaction, and clinical outcomes.

Methodology
Study Design and Setting
This study adopts a cross-sectional, survey-based design to explore the feasibility, barriers, and opportunities associated with implementing AI-driven tele-rehabilitation in rural physiotherapy settings across selected regions. The study population included adult individuals residing in rural areas who may benefit from musculoskeletal or neurological rehabilitation services.

Sample Size and Sampling Technique
The sample size was calculated to be 458 participants, using **Cochran's formula**:

$$N = \frac{Z^2_{1-\alpha/2} \, 2 \cdot P(1-P)}{E^2}$$

Where:

Z = Z value corresponding to the desired confidence level (e.g., 1.96 for 95%)

P = estimated proportion of the population (assumed 0.5 for maximum variability)

E = margin of error (e.g., 5%)

A convenience sampling method was used to recruit participants, reflecting the logistical realities of conducting research in resource-limited rural settings.

Participants were eligible for inclusion in the study if they were aged 18 years or older, permanently resided in a rural area, had access to a smartphone or other internet-enabled device, and could understand and provide informed consent. Individuals were excluded if they resided in urban areas, lacked access to a digital communication device, had cognitive or communication impairments that could interfere with survey participation, or declined to participate or comply with the intervention protocol.

Participant Recruitment and Data Collection

Eligible participants were approached via community health centres, local physiotherapy clinics, and rural outreach programs. After confirming eligibility, participants received a detailed extension of the study and be asked to provide written informed consent.

Data was collected using a self-structured online questionnaire which was content-validated by a panel of experts and pilot-tested for reliability prior to data collection and designed to capture the following domains:

- Sociodemographic details
- Clinical condition (musculoskeletal or neurological)
- Access and familiarity with digital technology
- Perceptions of AI in healthcare
- Perceived barriers and facilitators to tele-rehabilitation

Data Analysis

Data was anonymized and securely stored. Descriptive statistics was used to summarize participant characteristics, while inferential statistics (e.g., chi-square tests, logistic regression) was be employed to examine associations between variables. Statistical analysis was be performed using SPSS version 27.

Results

The sample comprised more of female participants than male participants, with an average age of 39.10±21 years, reflecting a well-distributed adult demographic.

[Place table 1 here]

Technology literacy and Infrastructure

The survey findings reveal important insights into the current use and perception of technology-based physiotherapy services in rural areas. A substantial portion of participants, 201(43.79%) reported using technology only occasionally, indicating limited engagement with digital tools in their daily lives. Furthermore, an overwhelming majority 403 (87.79%) had never accessed online physiotherapy services, highlighting a significant gap in exposure and utilization of tele-rehabilitation options. When asked about improving access,112 (24.40%) of respondents believed that training programs focused on using health apps could enhance the adoption of technology-based physiotherapy in their communities. Notably,157 (34.2%) of participants expressed a lack of trust in the technology, suggesting that building confidence in digital health tools remains a key challenge for successful implementation.

[Place table 2 here]

Patient acceptance and compliance

The findings reveal critical insights into patient acceptance and compliance concerning AI-based physiotherapy in rural areas. Cost remains a notable concern, 129(28.1%) of participants identifying treatment expenses as the primary challenge in accessing physiotherapy services. More significantly, 172(37.47%) of respondents indicated an unwillingness to trust AI-based systems, highlighting a key psychological and cultural barrier to adoption. Despite these reservations, 244 (53.15%) of the participants expressed a preference for a hybrid model combining AI-driven and in-person physiotherapy sessions, suggesting that patients are open to integrating technology when it complements traditional care approaches. Furthermore, 144 (31.37%) of participants stated they would feel more confident using AI tools if recommended by a trusted doctor or health worker, emphasizing the importance of professional endorsement in enhancing patient trust and encouraging compliance with AI-assisted treatment modalities.

[Place table 3 here]

Lack of regulatory frameworks for AI-driven interventions

The findings underscore the pressing need for regulatory oversight and structured support in the implementation of AI-driven physiotherapy in rural areas. Nearly half of the respondents, 217(47.27%) raised concerns over the absence of local approval or certification for AI tools, along with a lack of emergency response systems and the risk of injury without professional supervision—highlighting significant safety issues associated with unregulated AI use. To mitigate these risks, 177(38.56%) of participants advocated for the establishment of local tech-support or help centres by government bodies or health systems to ensure safe and effective implementation. Moreover, 132 (28.75%) participants emphasized the necessity of training AI systems using science-based information to enhance the accuracy and reliability of physiotherapy interventions. 175(38.12%) people suggested that regular monitoring by trained staff could bolster patient safety and improve trust in AI-assisted rehabilitation. These findings collectively point to the urgent need for clear regulatory frameworks and infrastructure to support the safe deployment of AI in rural healthcare settings.

[Place table 4 here]

Patient Perspectives on Professional Support and Trust in AI Integration

The data reveals that patients place high value on human involvement and professional support when engaging with AI-driven physiotherapy solutions. Nearly half of the participants, 223 (48.58%) expressed a willingness to try mobile-based physiotherapy if guided or assisted by someone, indicating the importance of personal support in

promoting adoption. Additionally,186 (40.52%) of respondents emphasized the need for regular training, mentorship from AI specialists, and technical support to ensure ongoing learning and effective troubleshooting. 158 (34.42%) participants reported that a lack of trust in AI-based treatments negatively affects adherence to tele-rehabilitation programs. Furthermore, the majority 258 (56.20%) participants indicated they would only trust AI systems to recommend physiotherapy exercises if those recommendations were verified by a human professional. These findings underscore the critical role of healthcare providers and support systems in fostering trust and encouraging the effective integration of AI Into rural physiotherapy practices.

[Place table 5 here]

Trust in AI-based diagnostics and treatment plans

The results reflect mixed perceptions among rural participants regarding the trustworthiness and usability of AI-based diagnostic and treatment solutions. 190(41.39%) respondents indicated a preference for video-guided sessions, suggesting that visual interaction enhances comfort and engagement. However, affordability remains a concern, with 197(42.91%) stating that AI tools and apps are accessible only to a portion of the rural population. Trust issues are further compounded by apprehensions around diagnostic accuracy, emotional disconnect, and data privacy— reported by 188(40.95%) of participants as major barriers to fully embracing AI in healthcare. Importantly, 216(47.05%) of individuals expressed increased comfort in using AI-driven physiotherapy tools if a physiotherapist monitors the process. These findings highlight the necessity of human oversight, cost-effective solutions, and transparent data practices to foster trust in AI-based healthcare in rural communities.

[Place table 6 here]

Discussion

This study sheds light on the opportunities and challenges associated with integrating AI-assisted physiotherapy in rural India. The demographic profile, with a higher proportion of female participants and a mean age of 39.10 years, reflects a mature adult population that commonly experiences musculoskeletal issues, underlining the relevance of targeted interventions in this group.

A substantial portion of participants (43.79%) reported occasional use of digital technology, yet 87.79% had never accessed online physiotherapy services. This reveals a significant digital health literacy gap—an essential prerequisite for the effective adoption of AI-based musculoskeletal care. Previous literature supports that limited digital skills remain a barrier in rural populations, hindering the implementation of technology-driven health services (Trivedi, 2024).

Cost also emerged as a notable barrier, with 28.1% of respondents citing treatment expenses as a key challenge, which is consistent with broader issues of healthcare affordability in underserved areas. Furthermore, skepticism regarding AI was evident, with 37.47% of participants reluctant to trust AI-based tools. This underscores the need for trust-building strategies, particularly in sensitive domains like MSK care, where individual variation in physical function and the need for personalized attention is high. Despite these concerns, there was notable openness to innovation. Over half (53.15%) favoured a hybrid approach combining AI-guided modules with traditional, in-person physiotherapy. This suggests that patients may not reject AI outright but rather prefer it to supplement—not replace—human-led care. In fact, 31.37% expressed increased confidence when AI tools were recommended by trusted healthcare professionals, emphasizing the pivotal role of clinicians in influencing patient trust and acceptance (Alsobhi, 2022).

Safety and regulatory oversight also emerged as important considerations. Nearly half (47.27%) of participants raised concerns over the lack of official approval or certification for AI tools used in musculoskeletal care. The absence of emergency protocols and fear of injury without direct supervision were also highlighted. To address this, 38.56% of respondents recommended the establishment of local tech-support or AI-assistance centers. Ensuring clinical validation and safety of AI systems is critical for wider adoption (Palaniappan et al., 2024).

Support systems for AI usage are equally crucial. Around 48.58% indicated they would use mobile-based physiotherapy for MSK issues if assisted by someone, pointing toward the need for local facilitators or digital navigators. Continuous training for healthcare professionals, along with technical mentoring, was valued by 40.52% of respondents, who recognized the importance of adaptive learning in dealing with evolving AI interfaces. Furthermore, 56.20% wanted AI recommendations to be reviewed or approved by a human expert, reinforcing the need for human oversight in AI-integrated musculoskeletal rehabilitation (Pahune, 2023).

Trust remained central to patient acceptance. While 41.39% preferred video-guided sessions for exercises, concerns regarding affordability (42.91%), diagnostic reliability, lack of human empathy, and data privacy (40.95%) were frequently cited. Nevertheless, nearly half (47.05%) reported feeling comfortable with AI-based MSK physiotherapy when sessions were monitored by a licensed physiotherapist, reinforcing the hybrid care model as a practical pathway (Du et al., 2024).

Limitations

This study has several limitations. The convenience sampling method may limit the generalizability of results, potentially excluding segments of the rural population with the greatest need but least digital access. Reliance on self-reported data, particularly via online surveys, may introduce bias, especially in populations with varying levels of digital literacy. The cross-sectional design also restricts inferences about causality or changes in perception over time. Furthermore, individuals without access to mobile devices or internet connectivity may be underrepresented, skewing the findings toward more digitally engaged participants. Future research employing longitudinal methodologies and broader, more inclusive sampling strategies will be essential to validate and extend these findings within rural musculoskeletal healthcare settings.

Conclusion

AI-based physiotherapy holds great promise for enhancing rural healthcare in India, offering innovative solutions to bridge gaps in access and quality of care. However, several significant challenges must be addressed to ensure its successful adoption. Limited digital literacy, high treatment costs, and a general lack of trust in AI systems remain major barriers. Despite these challenges, there is a strong interest among rural populations in hybrid models that combine AI-driven care with in-person physiotherapy, particularly when supported by trusted healthcare professionals. Ensuring safety through proper regulation, certification, and the establishment of local tech-support centers is crucial. Additionally, training healthcare providers and actively involving them in the implementation of AI tools can enhance trust, encourage patient engagement, and promote effective, patient-centered physiotherapy services in rural communities.

Ethics Statement

Ethical clearance was obtained from the Institutional Ethics Committee of XXX University. Informed consent was taken from all participants. The study complied with the ethical principles outlined in the Declaration of Helsinki.

Conflicts of Interest

The authors declare no conflicts of interest.

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Table 1: Demographic details of participants

Variable	Mean (SD)
Age	39.10±21
Gender	Male:- 215 Female:- 243

Table 2: Technology literacy and Infrastructure

Variables	Frequency (%)	Result
Q1	201 (43.79)	Most of the people use technology occasionally
Q2	403 (87.79)	Majority of the people have not used physiotherapy services online
Q3	112 (24.40)	Training programs on using health apps could help improve access to technology-based physiotherapy in your area
Q4	157 (34.2)	Most people Lack trust in the technology

Table 3: Patient acceptance and compliance

Variables	Frequency (%)	Result
Q5	129 (28.1)	Cost of treatment isthe biggest challenge faced in accessing physiotherapy services
Q6	172 (37.47)	The biggest barrier to implement AI in rural physiotherapy is Patients unwillingness to trust AI-based systems
Q7	244 (53.15)	Patients prefer both AI-based and in-person physiotherapy session in rural areas
Q8	144 (31.37)	Trusted doctor or health worker make patients feel more confident using an AI tool for physiotherapy

Table 4: Lack of regulatory frameworks for AI-driven interventions

Variables	Frequency (%)	Result
Q9	217 (47.27)	The absence of local approval or certification, coupled with a lack of emergency response and the risk of injury without supervision, poses serious safety concerns.
Q10	177 (38.56)	Setting up local tech-support or help centres should be provided by the government or health system for safely implementation of AI-driven rehabilitation in rural areas
Q11	132 (28.75)	AI should be trained using science-based information to make sure AI physiotherapy works safely and correctly in rural areas
Q12	175 (38.12)	Trained staff can check on the patient from time to time

Table 5: Patient Perspectives on Professional Support and Trust in AI Integration

Variables	Frequency (%)	Result
Q13	223 (48.58)	Most of the people will try physiotherapy through mobile if someone helps them.
Q14	186 (40.52)	Regular training and updates, along with mentorship from an AI specialist and support from technical teams, ensure continuous learning and effective problem-solving.
Q15	158 (34.42)	Lack of trust in AI-based treatment affect adherence to AI-driven tele-rehabilitation programs
Q16	258 (56.20)	People trust an AI-based system to recommend physiotherapy exercises only with human verification

Table 6: Trust in AI-based diagnostics and treatment plans

Variables	Frequency (%)	Result
Q17	190 (41.39)	Video-guided sessions are preferred by patients
Q18	197 (42.91)	AI tools apps are affordable only for some in rural area
Q19	188 (40.95)	The risk of incorrect diagnosis, lack of human connection, and concerns about the privacy of medical data highlight key challenges in AI-driven healthcare.
Q20	216 (47.05)	People are comfortable if monitored by a physiotherapist