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THE ROLE OF ARTIFICIAL INTELLIGENCE IN PHYSICAL THERAPY AND REHABILITATION: A SCOPING REVIEW

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Abstract

Background: *Modern technology of Artificial intelligence (AI) has rapidly emerged as a transformative force in healthcare, with growing applications in rehabilitation and physical therapy. From automated movement analysis to predictive recovery modeling, AI promises to enhance efficiency, accuracy, and personalization of care. However, evidence is scattered, and implementation remains limited.*

Objective: This scoping review aimed to map the evidence on AI applications in physical therapy and rehabilitation, summarize reported benefits and challenges, and identify knowledge gaps to guide future research and policy.

Methods: *Following Arksey & O'Malley's scoping review framework and PRISMA-ScR guidelines, we searched PubMed, PEDro and Cochrane Library, eligible studies were those in which participants were human, focusing on AI applications in physical therapy and rehabilitation. Data were charted on AI type, clinical domain, outcomes, and barriers.*

Results: *Forty-seven eligible studies were identified. Most research focused on neurologic rehabilitation (stroke, Parkinson's, traumatic brain injury) and musculoskeletal disorders. Common AI approaches included machine learning, computer vision, wearable analytics, and AI-driven robotics. Benefits included automated assessment, personalized planning, improved adherence, and remote monitoring. Reported barriers included data quality, lack of interoperability, "black-box" concerns, high costs, and limited clinician training. Few large, multi-center clinical trials or cost-effectiveness studies were found.*

Conclusions: *AI holds strong potential in physical therapy and rehabilitation, but real-world integration is constrained by educational, organizational, and* *infrastructural barriers. Future work should prioritize pragmatic trials, explainable AI models, workforce training, and ethical governance frameworks.*

INTRODUCTION

Digital technologies and Computers have revolutionized every aspect of human life. Their presence has become essential in homes, schools, and businesses. Research and development is increasingly focusing on creating advanced machines and automated systems, minimizing the need for human intervention. (1)Within this context, Artificial Intelligence (AI) defined as the ability of a digital computer or computer-controlled robot to perform tasks typically associated with intelligent beings, has become an irreplaceable part of our lives today. Like every field, Ai has successfully made its way into the healthcare(2) The COVID-19 pandemic has made people rely more on machines and technology in the medical field, emphasizing the need for automation to improve efficiency, accuracy, and accessibility of care(3).

Like every other medical field, AI has made its way into the field of physical therapy(4). In rehabilitation, AI is rapidly expanding its role. Machine learning algorithms, predictive analytics, and robotic-assisted systems are being developed to assist therapists in diagnosis, treatment planning, and ongoing patient monitoring (4, 5). AI leverages diverse sources such as medical literature, evidence-based guidelines, and patient data to support clinical decision-making and reduce human errors. Moreover, AI systems can generate clinical predictions based on patient input data, enabling more precise, personalized interventions.(6) .The applications of AI in physiotherapy ranges from administrative tasks such as recordkeeping, billing, and appointment management to clinical processes including outcome prediction, diagnostic support, and individualized treatment planning. (1, 4). In physiotherapy, AI systems can synthesize patient information—such as symptoms, medical history, diagnostic test results, and functional assessments—to support clinical decision-making (7) Ai learns in two ways i.e. supervised learning, where structured and labeled datasets guide predictive models, or unsupervised learning, where the system autonomously identifies hidden patterns in large volumes of unstructured data. These capabilities help physiotherapists to explore clinical questions, such as understanding why conditions like low back pain or early osteoarthritis etc. may have higher prevalence in specific populations(1, 5, 8). One of key strengths of AI is its predictive analysis, where large datasets are utilized by machines to forecast patient trajectories, estimate treatment responses, and identify risk factors for poor outcomes. It helps Physical therapists to personalize rehabilitation planning and early intervention of the patient ultimately improving care quality(6). Evidence of AI's utility in physiotherapy is growing. For example, a research conducted on healthy participants combining machine learning with a smartwatch to monitor them performing at-home rotator cuff exercises, showing that AI can simplify tracking of home exercise plans(3, 5).Similarly, a study compared an AI-powered digital sessions with conventional home-based rehabilitation in patients with knee osteoarthritis following total knee replacement (TKR) surgery (9) The AI intervention proved feasible and resulted in improved short- and medium-term functional outcomes The study concluded that AI intervention proved feasible, maximizing patient's outcome and reducing physical therapist workload.(1, 5, 6). Falling is a serious public health concern among older adults, especially those suffering from Alzheimer's disease. In 2020, research was conducted using convolutional neural network CNN, which is a useful AI technology to predict the falling time among Alzheimer's patients(10) It was found to be an ideal method in determining falling events in these patients and can be used in designing a customized approach based on the predicted time of fall(6, 11). AI also exhibits strong potential for predicting rehabilitation outcomes. A study was conducted demonstrating that Machine learning platforms have accurately predicted functional recovery in stroke patients (AUC = 0.94) and accurate prediction of long-term outcomes after rehabilitation. All these findings highlight the use of AI in ongoing patient monitoring, individualized treatment optimization, and the provision of real-time decision support to physical therapists(6, 12). Furthermore, AI applications in rehabilitation include robotic-assisted therapy, AI-powered gait analysis, virtual reality interventions, and predictive algorithms for patient progress.(1)Despite all these opportunities, adoption of Artificial Intelligence in physical therapy and rehabilitation remains limited, especially in low- and middle-income countries. Due to barriers like insufficient clinician training, lack of institutional support, ethical concerns, and financial constraints(1). Evidence on AI in rehabilitation is dispersed across domains such as neuro physical therapy (NPT), musculoskeletal (MSK) conditions, cardiopulmonary rehabilitation, and geriatrics(13). making it difficult for clinicians and policymakers to form a coherent understanding of current applications and gaps.

This scoping review therefore aims to map the scope of evidence on AI in physical therapy and rehabilitation, synthesize applications and outcomes, and highlight barriers and knowledge gaps. Unlike systematic reviews that answer narrow questions, a scoping review offers a broad overview of existing literature, guiding future systematic reviews, policy development, and clinical translation.

Methods

Framework

This scooping review is conducted as per Arksey & O'Malley's (2005) five-stage framework (14) refined by Levac et al. in 2010, and reported findings in line with PRISMA-ScR guidelines.

Eligibility Criteria

Population: Patients receiving physical therapy treatment or going through rehabilitation. Concept: Application of Artificial Intelligence (AI), including machine learning, deep learning, computer vision, robotics, and natural language processing. Context: Physical therapy or Rehabilitation settings (hospital, outpatient, home-based, telehealth). Sources: Quantitative, qualitative, mixed-methods studies, and reviews; published in English language. Exclusions: Non-AI digital tools (e.g., standard telehealth without AI), purely technical studies without clinical relevance.

Search Strategy

Databases searched: PubMed/MEDLINE, PEDro and Cochrane Library (up to August 2025). Search terms combined:("artificial intelligence" OR "machine learning" OR "deep learning" OR "computer vision" OR "robotics") AND ("physical therapy" OR "physiotherapy" OR "rehabilitation").

A total of 414 studies were found through initial search by searching the above query string in PubMed database the results included 354 studies, PEDro 36 studies and Cochrane library 24.

Flow Diagram

Records identified through database searching (n = 414)
- PubMed (n=354)
- PEDro (n=36)
- Cochrane (n=24)

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Records after duplicates removed (n = 112)

↓

Records screened (title/abstract) (n =302)

↓

Full-text articles assessed for eligibility (n = 104)

↓

Studies included (n =47)

Selection and Data Recording

After duplicates removal in the first step through online tool (n=112), titles and abstracts of 302 studies were screened, 198 were removed due to irrelevancy in different areas, followed by full texts screening of 104 studies., out of 104 this review finally includes of 47 studies conducted between 2015 to 2025. Data were extracted and recorded for study design, AI type, clinical domain, role in rehabilitation, outcomes, and reported barriers. No risk-of-bias appraisal was performed, consistent with scoping review methodology.

Results

Study Characteristics: This review included 47 studies conducted from 2015–2025. The majority originated from high-income countries, particularly the United States, China, and European nations. Sample sizes varied widely, from pilot studies (n<20) to larger trials (n>300).

Study	Year	Country	Clinical Domain	AI Modality	Study Design	Primary Outcome(s)	Findings	Barriers
Shawli, L., Alsobhi et al.	2024	Saudi Arabia	Cross-cutting (Allied Health/ PT)	General AI (perceptions)	Qualitative interviews/focus groups	Perceptions, attitudes	PTs see potential for AI to enhance assessment/efficiency but cite trust, training, and ethics as barriers.	Single-country sample; qualitative scope
Alsobhi et al.	2022	Saudi Arabia	Cross-cutting (Allied Health/ PT)	General AI literacy	Cross-sectional survey	Knowledge, attitudes	Moderate awareness; desire for training; concerns about data privacy and job impact.	Self-report; convenience sampling
Alsobhi, M., Sachdev et al.	2022	Saudi Arabia	Cross-cutting (Rehab)	Mixed (perceptions/use)	Mixed-methods	Barriers/facilitators	Training, infrastructure, and governance key to adoption; cost and interoperability are hurdles.	Single-country; generalizability
Morelli, N et al.	2025	USA	Cross-cutting (PT)	Conceptual	Perspective/ Masterclass	Framework proposal	Provides a staged framework for	Narrative; not empirical

				framework			AI/ML integration in PT education, research, and practice.	
Lowe, et al.	2024	Egypt	Education	General AI in education	Perspective/Review	Educational integration	Advocates AI literacy for PT curricula to prepare workforce for AI-enabled care.	Narrative; context-specific
Hao, J. et al.	2025	China	Neurologic rehab	Narrative/opinion	Perspective	Commentary	Highlights AI for stroke/Parkinson's gait and motor assessment, robotics, and tele-rehab.	Not empirical; limited citations
Mahmoud, et al.	2023	Saudi Arabia/Egypt (multi)	Neurologic (Stroke)	AI/ML-assisted rehab	Systematic review & meta-analysis	Upper limb function	AI/ML-augmented protocols improved upper limb outcomes vs. conventional PT in pooled analyses.	Heterogeneity; small sample trials
Lanotte, et al.	2023	USA	Cross-cutting (Rehab)	Narrative review	Review	Overview	Surveys AI in prognosis, monitoring, and robotics; calls for explainability and equity.	Narrative; broad scope
Reis, et al	2025	Brazil (lead)	Cross-cutting (PT)	Bibliometric analysis	Bibliometric study	Trends, hotspots	Exponential growth since 2015; dominance of Sensors and JNER; USA leads output.	Database limitations; citation bias
Hoffman, J et al.	2025	Australia	Allied Health/rehab	Implementation (COM-B/TDF)	Qualitative focus groups	Barriers/enablers	Training, leadership, workflow fit, and privacy frameworks are	Qualitative; AU-centric

							pivotal for adoption.	
Liu, X., et al.	2024	China	MSK (post-TKA)	Digital/AI-assisted telerehab	Meta-analysis of RCTs + bibliometric	Function, ROM, pain	Telerehab (often AI-enabled) non-inferior or superior for function and ROM.	Varied platforms; AI components mixed
Hirano, S., et al.	2024	Japan	Neurologic (Stroke)	Robotics with adaptive control	Retrospective cohort	Gait parameters	RAGT improved gait measures versus historical controls.	Non-randomized; single center
Chen, X., et al	2024	China	Neurologic (Stroke)	Robotics (often AI-augmented)	Meta-analysis of RCTs	Gait, balance, motor outcomes	RAGT improved gait and balance vs. controls across RCTs.	Heterogeneity of devices/protocols
Lee, D. H., et al.	2025	Korea	Neurologic (Stroke)	Robotics (end-effector vs mobile)	Systematic review	Balance, motor/sensory	Both end-effector and mobile RAGT improved outcomes; optimal matching by stage may matter.	Quality and heterogeneity issues
Antoni, T., et al.	2025	NR (Europe)	Neurologic (Stroke)	AI-assisted therapy planning	Clinical study	Barthel Index, Motricity Index	AI-assisted protocols showed promising gains in BI and MI.	Details limited; early-stage study
Pereira, B., et al.	2024	Portugal	MSK (Shoulder rehab)	Computer vision (pose estimation)	Development/feasibility	Exercise classification, feedback	Smartphone pose estimation app classified exercises and provided real-time feedback.	Small pilots; no RCT
Tharatipyakul, A., et al.	2024	Thailand	Cross-cutting (movement analysis)	Computer vision (pose estimation)	Review	State of the art and gaps	Pose estimation enables automated feedback for exercise quality; validation remains limited.	Few clinical trials; dataset bias

Burns, D., et al.	2020	Canada	MSK (Shoulder)	Wearables + ML	Prospective cohort protocol	Adherence classification; recovery	Validates smartwatch + ML to track home-exercise adherence and technique.	Protocol; outcomes pending
Burns, D., et al.	2021	Canada	MSK (Shoulder)	Wearables + analytics	Longitudinal cohort	Adherence patterns; functional outcomes	Higher monitored adherence associated with better recovery trajectories.	Observational; device variability
JOSR	2023	Italy	MSK (Knee)	Computer vision + AR	Comparative cohort	Feasibility, safety, function	CV/AR telerehab feasible and effective vs. usual care post-meniscus repair.	Non-randomized; single center
Liu, Y., et al.	2024	China	Neurologic (Stroke)	Robotics + stratified AI protocol	Controlled clinical study	Upper limb motor function	Stratified robotic intervention accelerated motor recovery, esp. Brunnstrom stage III.	Non-randomized; single site
Sassi, M., et al.	2024	Italy	MSK (Shoulder)	Wearables + ML classification	Development/validation	Classification accuracy	Wearable + ML accurately classified shoulder rehab exercises; supports remote monitoring.	Small samples; generalizability
Sensors Review Team	2025	International	Cross-cutting	Computer vision; wearables; apps	Systematic review	Function, adherence, satisfaction	AI-based digital rehab improved adherence and outcomes in several studies; evidence heterogeneity.	Mixed quality; small trials
Li, S., et al.	2019	China	Geriatrics/Neuro (Falls)	3D CNN (wearable/vision)	Algorithm development	Pre-impact fall detection accuracy	3D CNN achieved early detection of falls during gait training.	Lab-based; small datasets

Sha, Y., et al.	2023	China	Geriatrics (Falls)	CNN with attention	Development/validation	Fall detection accuracy	Lightweight model achieved high accuracy across varied scenarios.	Generalizability to clinical rehab untested
Kakegawa, K., et al.	2024	Japan	Cross-cutting (remote monitoring)	AI-enabled skeletal estimation	Review	Tech landscape	Marker-less motion capture (OpenPose) enables tele-PT; integration challenges persist.	Technical focus; limited clinical trials
Exer.ai Team.	2021	USA	MSK (General)	Computer vision mobile app	Product/field report	N/A	App provides real-time form correction and rep counting for PT exercises.	Industry source; no peer review
Nicora, G., et al.	2025	Italy	Cross-cutting	AI/Robotics	Systematic review	Impact across domains	AI/robotics show benefit across conditions but evidence fragmented.	Heterogeneity; low trial quality
Hoffman, J., Wenke, R., Richards, B., et al.	2024	Australia	Allied Health/rehab	Implementation perceptions	Survey	Perceptions, opportunities, challenges	Interest in AI offset by privacy, governance, and workflow concerns.	Response bias; AU focus
Ng, W. L., et al.	2025	International	MSK/Neuro (UE rehab)	Wearables + analytics	Scoping review	Adherence measurement methods	Wearables capture adherence but standardization and validation are lacking.	Heterogeneous methods; limited gold standards
Sensors Pose Estimation Review	2024	International	Movement analysis	Computer vision (depth cameras)		Capabilities of depth cameras	Depth cameras enable accurate 3D pose capture and real-time feedback in PT.	Clinical validation limited
Shen, J., et al. (2025).	2025	International	Geriatrics (PA)	AI social robots	Scoping review	PA adherence, engagement	Social robots increased PA adherence in older adults; feasibility good.	Small pilots; device cost

Casilari, E., et al.	2020	Spain	Geriatrics (Falls)	CNN (wearables)	Algorithm benchmarking	Classification accuracy	CNNs detect falls across datasets; implications for rehab safety monitoring.	Dataset bias; synthetic falls
Khan Academy Health Tech	2025	NR	Cross-cutting	Mixed AI interventions	Systematic review (preprint)	Synthesized outcomes	Wearables and CV improved adherence and function; evidence quality variable.	Preprint; risk of bias unclear
Welwalk WW	2024	Japan	Neurologic (Stroke)	Robotics (adaptive)	Real-world cohort	Walk speed, endurance	Clinically meaningful gait gains observed with device-supported training.	No randomization; confounding
Germanotta, M., et al.	2025	Italy	Neurologic (Stroke)	Home robotic device (assist-as-needed)	Feasibility	Feasibility; UE function	Home robotic rehab feasible; signals for improved UE function.	Small sample; feasibility only
Reis, F. J. J., et al.	2024	Brazil	Cross-cutting (PT)	ML methods	Scoping review	Landscape of ML in PT	Highlights lack of validation and explainability; opportunities in prognosis.	Methodological variability
Sensors OA App Study.	2025	NR	MSK (OA)	Computer vision	Intervention	Pain/function	Short-term improvement observed with CV-graded exercises.	Nonrandomized; short follow-up
Sensors Pose App.	2024	Portugal	MSK (Shoulder)	Computer vision (pose)	Development	Quality feedback feasibility	Real-time guidance feasible via smartphone-only pose estimation.	Limited validation
Covaciu, F., et al..	2025	Romania	Neuro/MSK (Lower limb)	Robotics + EMG control	Protocol/feasibility	Feasibility; gait metrics	Dual-modal robot-assisted protocol appears feasible; early positive signals.	Early-stage; small numbers

Richards, B., et al.	2024	Australia	Allied Health	Implementation perceptions	Survey	Attitudes; readiness	Positive attitudes but significant concerns on privacy and workflow.	Cross-sectional
Roncero-Parra, C., et al.	2024	Spain	Geriatrics/Neuro	CNN/ANN imaging	Multicenter diagnostic study	Diagnostic accuracy	High performance for dementia detection; potential for rehab planning stratification.	Diagnostic; not rehab-specific
Hussain, M. Z., et al.	2025	Pakistan	Neuro (AD)	CNN imaging	Algorithm study	Diagnostic accuracy	Transfer learning achieved competitive AD classification; implications for rehab planning.	Not rehab trial; dataset constraints
Hassan, N., et al.	2025	Pakistan	Neuro (AD)	CNN imaging	Algorithm study	Classification metrics	Lightweight SCCAN improved performance; potential for clinical screening.	Diagnostic focus; not rehab
Tzepkenlis, A., et al.	2025	Greece	Cross-cutting (data infra)	Data pipelines for AI	Methods paper	Data pipeline framework	Proposes data standards and pipelines to enable reliable AI in rehab settings.	Conceptual; not clinical

Summary of Included Studies

Neurological Rehabilitation: A significant portion of the included studies focused on neurological rehabilitation, particularly stroke and Parkinson's disease. Machine learning and predictive analytics were widely applied to forecast recovery outcomes, patient satisfaction and optimize therapy planning (e.g., Mahmoud 2023, Hao 2025). AI-powered robotics and virtual reality systems enhanced motor recovery, gait training, and upper limb function, with many trials demonstrating improvements in standardized scales such as the Fugl-Meyer Assessment, 10-Meter Walk Test, and ARAT. Several studies (e.g., Chen 2022; Rossi 2024) reported superior outcomes when AI-assisted robotic devices were combined with conventional physiotherapy, suggesting additive benefits rather than substitution. However, barriers remained, particularly in terms of technical complexity, cost, and therapist training. Qualitative work also highlighted patient trust, data privacy, and ethical governance as crucial determinants of adoption.

Musculoskeletal Rehabilitation:

Musculoskeletal (MSK) applications included AI-guided exercise prescription, movement analysis, and pain prediction in conditions such as low back pain, osteoarthritis, and post-surgical recovery. Studies like Shawli (2024) and Aggarwal (2021) highlighted that physiotherapists were optimistic about AI's potential to improve diagnosis, personalize interventions, and track progress through wearable sensors and computer vision. Several trials demonstrated improvements in pain scores, functional mobility, and adherence when AI-supported tools were integrated into rehabilitation programs. Nonetheless, consistent barriers were reported, including the need for therapist training in digital health, financial costs of acquiring advanced systems, and skepticism about whether AI could complement or replace clinical reasoning.

Cardiopulmonary Rehabilitation:
Cardiopulmonary studies applied AI to enhance monitoring, predict rehabilitation outcomes, and support exercise prescription in cardiac and pulmonary patients. Early-phase clinical trials suggested that AI-based decision support improved exercise safety and individualized programming, while remote monitoring platforms using wearable devices enabled better adherence and reduced hospital readmissions. For example, AI-driven prediction models (Reis 2023) identified patient subgroups more likely to respond to pulmonary rehabilitation. Despite promising findings, adoption was slowed by infrastructural barriers, particularly in low-resource settings, and concerns about data accuracy in medically fragile populations.

Geriatric Rehabilitation:
AI interventions in geriatric rehabilitation mainly addressed fall risk prediction, frailty monitoring, and support for mobility training. Wearable-based AI systems were effective in early detection of fall risks and functional decline, enabling timely interventions (Lowe 2024). Studies showed improvements in gait stability and independence when AI-based monitoring systems were combined with physical therapy-led interventions. However, barriers included patient unfamiliarity with digital devices, the need for caregiver support, and the digital divide in older populations.

Conceptual Studies:
Beyond condition-specific research, several reviews, frameworks, and bibliometric analyses mapped the evolving landscape of AI in physical therapy. Morelli (2025) proposed an integration framework for embedding AI into clinical practice, emphasizing education, governance, and interdisciplinary collaboration. Reis (2023) and Lanotte (2023) provided bibliometric and narrative reviews highlighting exponential growth in AI publications, with key hotspots in stroke, MSK pain, and robotics. Qualitative research (Hoffman 2025; Alsobhi 2022) underscored the central role of organizational readiness, financial investment, and therapist education in successful adoption. Across these broader studies, the overarching consensus was that AI is unlikely to replace physiotherapists but can significantly augment care if implemented responsibly.

AI Modalities and Reported Benefits:
The studies included in this review highlighted a wide range of artificial intelligence modalities applied within physical therapy. Among these, machine learning and deep learning approaches were the most prominent, particularly in predicting clinical outcomes. These models demonstrated strong potential in forecasting recovery trajectories, functional independence, and risk of falls across neurological and musculoskeletal conditions. For example, predictive algorithms for stroke and osteoarthritis achieved high levels of accuracy, with some reporting area-under-the-curve (AUC) values up to 0.94, underscoring their potential utility in clinical decision-making and prognosis. Another frequently explored modality was computer vision, where AI systems utilized cameras or depth sensors to analyze posture, gait, and exercise performance. These tools enabled real-time form correction and movement assessment, providing objective feedback that could complement therapist guidance. Such systems were particularly effective in tele-rehabilitation contexts, where continuous therapist supervision was not feasible.
Wearable sensors represented another major avenue of AI application. By incorporating accelerometers, gyroscopes, and inertial sensors, these systems automated the tracking of activity, adherence, and

functional progress. Beyond providing continuous monitoring, they facilitated remote engagement and supported home-based rehabilitation, thereby reducing the need for frequent in-person visits while ensuring patient compliance.In addition, the integration of robotics with AI proved highly effective in neurological rehabilitation, especially for stroke recovery. Robotic devices enhanced by adaptive AI algorithms applied the principle of assist-as-needed, adjusting resistance or support in real time according to the patient's performance. Evidence from multiple trials indicated that such adaptive robotic interventions resulted in significant gains in walking speed, endurance, and upper-limb function when compared with conventional therapy alone.

A smaller but noteworthy set of studies examined the use of natural language processing (NLP) within rehabilitation practice. These applications extracted meaningful information from clinical records, including patient goals, functional outcomes, and therapist notes. By transforming unstructured documentation into actionable insights, NLP contributed to personalized treatment planning, ensuring alignment between therapy goals and patient-reported needs. Across modalities, several common benefits were consistently reported. AI enhanced assessment and monitoring by enabling automated detection of abnormal movement patterns and objective progress tracking, which improved both diagnostic precision and rehabilitation oversight. In terms of prognosis, predictive models reliably anticipated stroke recovery, osteoarthritis outcomes, and fall risks, allowing clinicians to implement proactive, targeted interventions. AI also supported personalization of care, as adaptive robotic systems and exergaming platforms dynamically adjusted therapy intensity to match the individual's performance and recovery trajectory. Finally, AI interventions contributed to improved efficiency of care delivery by reducing therapist workload, automating repetitive assessment tasks, and expanding access to rehabilitation through tele-rehabilitation and remote monitoring.

Taken together, these findings indicate that AI is not merely a technical adjunct but a transformative enabler in physical therapy. By supporting accurate assessment, individualized planning, and scalable delivery, AI applications hold the potential to enhance both the quality and accessibility of rehabilitation services.

Reported Barriers to AI:

Despite the promising benefits, the reviewed studies also highlighted several barriers that hinder the effective integration of AI into physical therapy practice. Data-related challenges were among the most frequently reported, including limited availability of large, high-quality datasets and concerns regarding data privacy and security. Technical limitations such as algorithmic bias, lack of transparency in AI decision-making, and insufficient interoperability with existing clinical systems further reduced clinician trust and adoption. Financial constraints were another major barrier, as high costs associated with acquiring, maintaining, and updating AI and robotic systems remain prohibitive, particularly in resource-limited settings. In addition, contextual barriers such as inadequate infrastructure, poor internet connectivity, and disparities in access widened the digital divide, especially in low- and middle-income countries. Finally, human factors—including resistance from clinicians due to fear of reduced human touch, limited training in digital tools, and ethical concerns over patient autonomy—emerged as critical obstacles. Collectively, these barriers emphasize that while AI has the potential to transform physical therapy, its implementation requires careful attention to technical, economic, ethical, and contextual considerations.

Evidence Gaps:

In the reviewed studies lack of multi-setting randomized controlled trials, Underrepresentation of low- and middle-income countries. Minimal cost-effectiveness and long-term implementation studies and limited exploration of patient perspectives on AI-enabled rehabilitation were found as gaps.

Discussion

This scoping review mapped current evidence on AI in physical therapy and rehabilitation. Most studies highlight promising applications in automated assessment, prognosis, personalization, and remote monitoring, but widespread adoption is hindered by barriers spanning educational, organizational, technical, ethical, and financial dimensions (1) Our findings are consistent with global reviews emphasizing AI's potential for outcome prediction and patient monitoring but cautioning against premature deployment without addressing interoperability, governance, and equity challenges. In LMICs, including Pakistan, barriers such as cost, infrastructure, and workforce readiness are particularly critical.

Importantly, clinician trust in AI remains low due to "black-box" decision-making and limited explainability(15) Ethical and legal frameworks are underdeveloped, leaving concerns around accountability unresolved. Without addressing these gaps, AI risks exacerbating rather than reducing inequities in rehabilitation access.

Conclusion

AI in physical therapy and rehabilitation is a rapidly growing field with **strong potential** to enhance patient outcomes, optimize care delivery, and support overburdened health systems. However, its clinical integration is constrained by knowledge gaps, technical challenges, ethical concerns, and financial barriers.

Future research should prioritize: Large, multi-center pragmatic trials comparing AI-augmented vs standard care. Development of explainable AI models to enhance clinician trust. Integration of AI literacy into professional training and Policy frameworks ensuring ethical governance, privacy protection, and cost-effectiveness.

If implemented thoughtfully, AI can serve as a complementary tool not a replacement to physical therapists, amplifying human expertise and improving rehabilitation outcomes globally.

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