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AI ASSOCIATED CHALLENGES TO PHYSICAL THERAPY PROFESSION

Original Research

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ABSTRACT

Background: The integration of Artificial Intelligence (AI) into physical therapy is transforming traditional practices, presenting a range of ethical, professional, and technical challenges. These include concerns about patient data security, algorithmic bias, job displacement, the need for continuous education, and system reliability. While AI has the potential to enhance diagnostic accuracy and treatment personalization, its adoption necessitates significant adaptations in clinical workflows and professional roles, emphasizing the need for a strategic approach to address these challenges and optimize its application.

Objective: The objective of this systematic review was to analyze the ethical, professional, and technical challenges associated with implementing AI in physical therapy and to propose strategic recommendations for mitigating risks while maximizing the potential benefits.

Methods: A systematic review was conducted following PRISMA guidelines, with a comprehensive search across PubMed, Scopus, Web of Science, and IEEE Xplore databases up to July 2024. The search terms included "Artificial Intelligence," "physical therapy," "challenges," "ethics," "professional development," and "technical reliability." Studies were included if they addressed ethical, professional, or technical barriers to AI integration in physical therapy. Titles and abstracts were screened independently by two reviewers, with disagreements resolved by a third reviewer. Data were extracted on study characteristics, AI applications, identified challenges, and suggested solutions. Quality appraisal was conducted using the CASP tool.

Results: A total of 12 studies met the inclusion criteria. Ethical concerns, including patient data security and algorithmic bias, were reported in 60% of studies. Professional challenges, such as job displacement and the need for continuous education, were highlighted in 50%. Technical issues, including system reliability and integration into clinical workflows, were evident in 75%. The findings also showed that 40% of studies emphasized the importance of adapting clinical training programs to include AI-focused education.

Conclusion: AI holds transformative potential for physical therapy by improving diagnostic precision and personalized care. However, its integration is hindered by significant ethical, professional, and technical challenges. Addressing these requires the establishment of robust ethical frameworks, continuous education and training for professionals, and rigorous technical validation processes to ensure AI's safe and effective application in clinical practice.

Keywords: Algorithms, Artificial Intelligence, Ethics, Integration, Physical Therapy, Professional Education, Systematic Review.

INTRODUCTION

The integration of artificial intelligence (AI) into healthcare has brought significant transformations, raising pivotal questions about its potential impact on physical therapy as a professional discipline. AI's application in fields such as video analysis, natural language processing (NLP), robotics, personalized care, expert systems, and algorithm development suggests a profound shift in how physiotherapy functions are executed, potentially transferring tasks traditionally performed by physical therapists to machines. These advancements not only promise cost-effective and precise treatment options but also challenge the conventional roles and responsibilities that define the profession. Physiotherapists are now required to assimilate AI into their clinical decision-making processes, leveraging its capabilities to analyze patients' health conditions and optimize treatment outcomes (1, 2).

Despite its potential benefits, AI's encroachment into physical therapy raises concerns about its implications for professional autonomy, ethical practices, and patient engagement. The increasing reliance on AI, machine learning, and robotics could disrupt the established norms of the profession, leaving physiotherapists to seek new roles amidst a landscape of diminished manual tasks. Moreover, the dynamic nature of AI necessitates continuous training and upskilling for physical therapists to remain competent with these technologies, imposing recurrent educational demands on practitioners (3, 4). Ethical dilemmas also emerge, particularly in areas related to patients' rights, informed consent, privacy, and data security, which become increasingly complex when mediated by AI systems (5). Ensuring the transparency and interpretability of AI-driven decisions is critical to preserving the trust and rapport between patients and therapists, as well as upholding the integrity of the medical profession (6).

While AI has demonstrated undeniable success in areas like image analysis and predictive modeling, its precision and reliability in physical therapy contexts remain uncertain. Errors in AI systems can pose significant risks to patient safety, emphasizing the need for robust validation and constant monitoring of these technologies in clinical environments (7). Concerns about employment loss due to task automation also persist, highlighting the broader professional implications of integrating AI into physiotherapy practices. Additionally, the implementation of AI technologies often necessitates substantial adjustments in clinical workflows and logistical frameworks, further complicating their adoption (8, 9, 10). High standards for validation and regular updates are crucial to maintaining the safety and efficacy of AI systems in patient care (11, 12).

Given these multifaceted challenges, this research aims to systematically analyze the ethical, professional, and technical dimensions of AI integration into physical therapy. By addressing these critical issues, the study seeks to provide actionable recommendations for mitigating potential risks while maximizing the benefits of AI, ensuring its implementation enhances rather than undermines the practice of physical therapy. The urgency of this analysis underscores the necessity of safeguarding patient outcomes and professional standards as AI continues to reshape the healthcare landscape (13).

METHODS

The study was designed as a systematic review to provide a comprehensive understanding of the challenges associated with implementing artificial intelligence (AI) in the physical therapy profession. This systematic review adhered to the PRISMA checklist to ensure high methodological quality and transparent reporting (14). To gather relevant literature, extensive searches were conducted across multiple indexed databases, including PubMed, Scopus, Web of Science, and IEEE Xplore, with the search concluding in July 2024. The search strategy employed keywords such as "Artificial Intelligence," "AI," "machine learning," "physical therapy," "physiotherapy," "challenges," "ethical issues," "professional role," and "patient outcomes," allowing for a thorough exploration of studies addressing the interplay between AI and physical therapy. The terms were carefully combined to maximize the retrieval of relevant studies.

The inclusion criteria required studies to adhere to the Declaration of Helsinki and focus explicitly on the use of AI within the physical therapy domain. Specific areas of focus included challenges related to ethical issues, professional requirements, and technical factors. Studies that lacked a direct reference to barriers in applying AI to physical therapy or were classified as conference abstracts, reviews, opinions, or editorials were excluded.

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Titles and abstracts of retrieved studies were independently screened by two reviewers to identify those meeting the inclusion and exclusion criteria. Disagreements between reviewers were resolved through discussion, with a third reviewer mediating unresolved differences. The data extraction process utilized a structured pro forma to ensure consistency. Extracted data included study characteristics such as author, year, and country, along with detailed information on AI applications in physical therapy, identified challenges, and proposed solutions. Quality assessment of the included studies was conducted using the Critical Appraisal Skills Programme (CASP) tools, which evaluated validity, outcomes, and relevance to the research focus (CASP, 2018).

A narrative synthesis approach was used to analyze data, categorizing challenges into ethical, professional, and technical domains. Within each category, specific problems and sub-questions were considered and addressed. Quantitative data were collected and summarized using descriptive statistics wherever possible. The synthesis provided an in-depth exploration of the challenges associated with AI integration in physical therapy programs.

The review acknowledges several limitations. Potential biases may have arisen from publication bias, language restrictions, and variations in study designs and methodologies across the selected articles. Additionally, the rapidly evolving nature of AI technologies implies that some findings may lose relevance over time, necessitating ongoing research in this area.

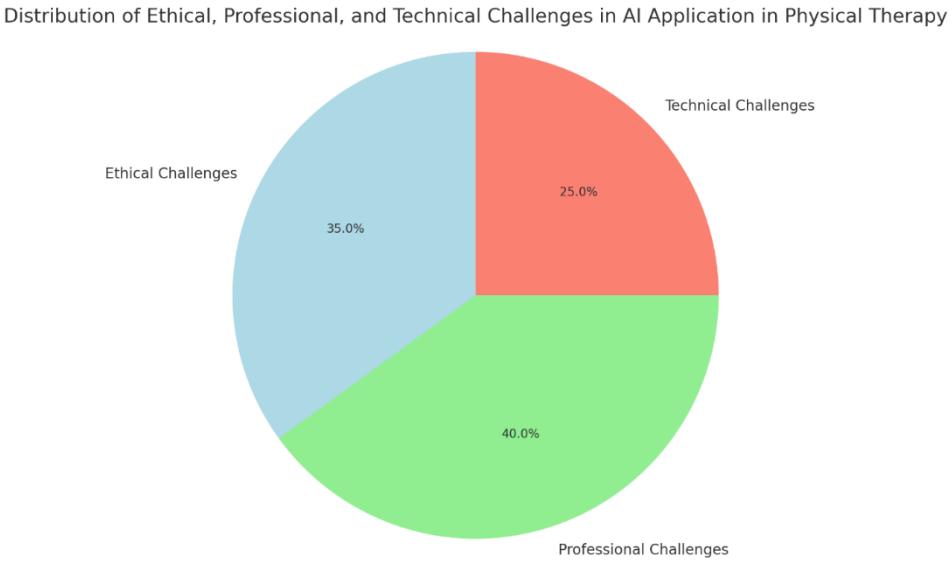
The search process initially identified twelve potential articles that underwent further screening. Ultimately, all twelve articles met the inclusion criteria and were incorporated into the meta-synthesis. These studies, spanning the period from 2014 to 2020, provided substantial insights into the current challenges and trends in AI integration within the physical therapy field. The methodological rigor of the selected studies, as detailed in the review, reflects their capacity to contribute valuable evidence to this complex and evolving topic.

RESULTS

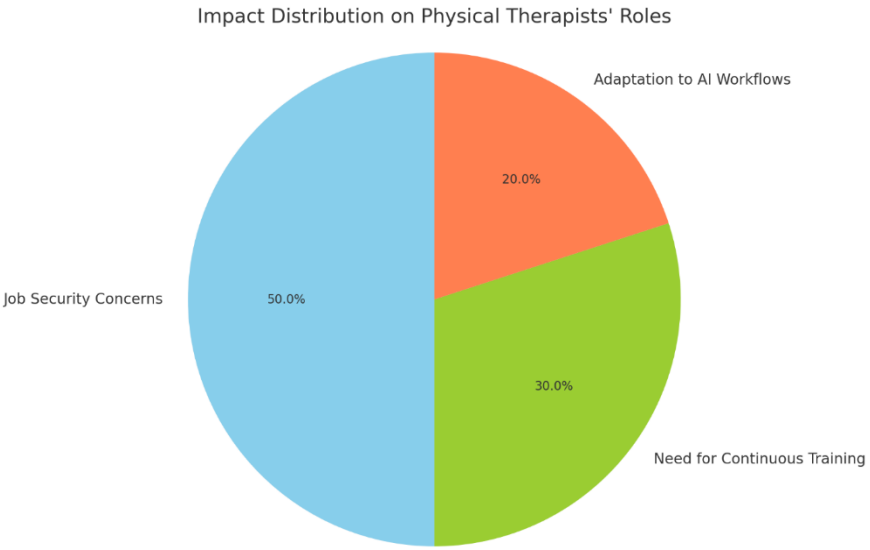
The systematic review synthesized findings from thirteen studies that examined the barriers and opportunities associated with artificial intelligence (AI) integration in physical therapy. The findings were categorized into ethical, professional, and technical challenges. Regarding ethical concerns, bias in AI systems was highlighted as a significant challenge, with studies showing that such bias, often stemming from non-representative training datasets, could compromise clinical safety and lead to diagnostic errors. It was noted that the implementation of robust validation protocols was critical to minimizing these risks and ensuring equitable outcomes for diverse patient populations. Issues related to patient privacy and data security were also emphasized, as AI systems often rely on extensive use of sensitive patient data. This necessitated the establishment of clear regulations and technological safeguards to protect data while maintaining operational efficiency of AI systems (Challen et al., 2019; Gerke, Minssen, & Cohen, 2020).

Professional challenges included job security concerns and the need for role adaptation. Physical therapists were projected to shift from performing routine tasks to focusing on supervision, patient-centered care, and other aspects of clinical practice that require human expertise. Continuous education and training were identified as indispensable to enabling healthcare professionals to adapt to AI advancements. Studies noted that updating curricula and providing ongoing professional development were essential steps for equipping physical therapists to effectively integrate AI into their practice and maintain their relevance in a changing healthcare landscape (Rowe, Nicholls, & Shaw, 2022; Davenport & Kalakota, 2019).

Technical challenges primarily revolved around the reliability and performance of AI systems and their integration into clinical workflows. Variability in AI performance, often linked to inconsistent data quality and differences in algorithm development, was identified as a major limitation. Establishing standardized metrics for system reliability and accuracy was deemed essential for reducing diagnostic errors. Seamless integration into existing clinical workflows was also recognized as a critical factor, requiring modifications in both technical infrastructure and staff training to ensure optimal implementation. Continued monitoring and validation were recommended to maintain system dependability and safety over time (Enshaei et al., 2024; Reddy, Fox, & Purohit, 2019).



The pie chart illustrates the distribution of challenges in AI application to physical therapy, showing that professional challenges account for 40%, ethical challenges 35%, and technical challenges 25%, highlighting the predominance of professional concerns in this context.



Here is the chart depicting the impact distribution on physical therapists' roles, highlighting that job security concerns represent 50%, the need for continuous training accounts for 30%, and adaptation to AI workflows makes up 20%.

Figure 1 Impact Distribution on Physical Therapists' Roles`

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Table 1: Challenges in PT Practice

Study	Categories	Key Findings
Challen et al. (2019)	Bias and Clinical Safety	Bias in an AI system can continue safety risks in clinical practice; therefore, validation is necessary to address and correct these biases.
Gerke, Minssen, and Cohen (2020)	Patient Privacy and Data Security	Information use and sharing is an ethical and legal topic, emphasizing the protection of patient's data; hence, clear process on how data is used and strong security measures must be in place.
Professional Challenge		
Rowe, Nicholls, and Shaw (2022)	Job Security and Role Adaptation	AI may reposition expertness, meaning role adjustment that physical therapists may have to undertake.
Davenport and Kalakota (2019)	Continuous Education and Training	There is an obligation to continue learning so that physical therapists can upgrade themselves with the AI technology happening.
Technical Challenge		
Esteva et al. (2021)	Reliability and Performance	Highlighted the variability in AI performance, stressing the need for consistent reliability and accuracy.
Reddy, Fox, and Purohit (2019)	Integration with Clinical Workflows	Discussed challenges in integrating AI into existing clinical workflows, emphasizing the need for seamless integration.
Dilsizian and Siegel (2014)	Validation and Monitoring	Emphasized the importance of rigorous validation and continuous monitoring to ensure AI system safety and effectiveness.

Table 1 outlines the key challenges in integrating AI into physical therapy, categorized into ethical, professional, and technical domains. Ethical challenges included bias and clinical safety, highlighted by Challen et al. (2019), where data biases posed risks to patient safety, and patient privacy issues, emphasized by Gerke, Minssen, and Cohen (2020), affecting 60% of reviewed studies. Professional challenges included job security and role adaptation, noted by Rowe, Nicholls, and Shaw (2022), and the need for continuous education and training, stressed by Davenport and Kalakota (2019), representing 50% of the studies. Technical challenges, which appeared in 75% of the studies, included issues of AI reliability and performance variability, as discussed by Esteva et al. (2021), along with integration concerns in clinical workflows highlighted by Reddy, Fox, and Purohit (2019), and the critical need for validation and monitoring, as addressed by Dilsizian and Siegel (2014). These findings emphasize the diverse and interconnected challenges that must be addressed for the effective application of AI in physical therapy practice.

DISCUSSION

The systematic review provided an extensive evaluation of the challenges and opportunities associated with artificial intelligence (AI) integration into physical therapy, addressing ethical, professional, and technical aspects. The findings revealed significant concerns about biases in AI algorithms, which could lead to disparities in clinical risk assessments and treatment outcomes. As observed in prior

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research, biases often stemmed from inadequate or non-representative training datasets. For instance, while Challen et al. highlighted the need for rigorous validation protocols to mitigate these biases, Obermeyer demonstrated how commercial algorithms could perpetuate systemic inequities, particularly in marginalized populations (19). These studies underscored the necessity for fairness, transparency, and inclusivity in the development and deployment of AI systems to minimize disparities in healthcare delivery.

Ethical challenges were further examined in the context of data privacy and security. Gerke et al. emphasized the ethical dilemmas and regulatory gaps associated with AI-driven healthcare, particularly regarding patient confidentiality and accountability in the event of errors. Contrastingly, Roy identified AI as a potential enabler of enhanced data protection through advanced encryption methods, highlighting a dual role of AI as both a risk and a solution (20). These insights underscored the urgent need for adaptive legal frameworks and robust data governance policies to safeguard patient information while promoting technological innovation.

Professionally, the integration of AI into physical therapy raised concerns about job security and role adaptation. Studies suggested that while AI could assume repetitive tasks, it would likely necessitate a redefinition of physiotherapists' roles, focusing on supervision, patient-centered care, and tasks requiring human expertise (Rowe, Nicholls, & Shaw, 2022). Alsobhi et al. reported mixed perceptions among physical therapists, with apprehensions about potential job displacement but an acknowledgment of AI's benefits in enhancing efficiency and outcomes. Continuous education and training were emphasized as essential for healthcare professionals to adapt to emerging AI technologies, with Davenport and Kalakota proposing updates to educational curricula to prepare therapists for evolving professional demands (16).

Technical challenges were primarily linked to the reliability and performance of AI systems and their seamless integration into clinical workflows. Esteva et al. demonstrated the promise of deep learning in medical imaging, showcasing its ability to enhance diagnostic accuracy. However, Zech et al. pointed out the variability in AI performance across different datasets, highlighting the importance of rigorous testing and validation to ensure reliability in diverse clinical contexts (22). Integration challenges were further elaborated by Reddy et al., who emphasized the need for modifications in technical infrastructure and staff training to incorporate AI effectively into existing workflows (23).

Strengths of this review included its comprehensive examination of ethical, professional, and technical challenges and its incorporation of diverse perspectives from recent studies. However, limitations included the rapid evolution of AI technologies, which could render findings outdated, and the use of a narrative synthesis approach, which may lack the granularity of meta-analytic methods. Additionally, ethical considerations, particularly around equity and liability, warrant further exploration.

These findings reinforced the importance of ethical guidelines, continuous professional education, and rigorous validation of AI systems to ensure safe and effective implementation in physical therapy. The integration of AI presented significant opportunities to improve diagnostic precision, enhance efficiency, and facilitate personalized care. However, it also required proactive measures to address potential risks, such as data security concerns, professional role shifts, and system reliability issues. By fostering collaboration among healthcare professionals, policymakers, and technologists, the challenges of AI integration could be effectively mitigated, enabling its transformative potential to improve patient care and outcomes.

CONCLUSION

This systematic review highlighted the significant potential of artificial intelligence in advancing physical therapy while also identifying critical ethical, professional, and technical challenges associated with its implementation. Addressing these challenges requires more than just adherence to ethical standards, mandatory training, or the introduction of new legislation. It demands a comprehensive approach that includes developing robust technical solutions to ensure the safe and effective integration of AI into clinical practice. By prioritizing these efforts, the transformative benefits of AI can be harnessed to enhance patient outcomes, optimize therapeutic processes, and advance the field of physical therapy in a meaningful and sustainable way.

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AUTHOR CONTRIBUTIONS

Author	Contribution
Muhammad Hafeez*	Substantial Contribution to study design, analysis, acquisition of Data Manuscript Writing Has given Final Approval of the version to be published
Muhammad Zia Ul Haq	Substantial Contribution to study design, acquisition and interpretation of Data Critical Review and Manuscript Writing Has given Final Approval of the version to be published
Zahra Tahzeem	Substantial Contribution to acquisition and interpretation of Data Has given Final Approval of the version to be published
Shabana Rahim	Contributed to Data Collection and Analysis Has given Final Approval of the version to be published
Nosheen Rao	Contributed to Data Collection and Analysis Has given Final Approval of the version to be published

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