Applications of Artificial Intelligence in Back Pain Management: A Systematic Review of Mobile and Digital Health Interventions

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Abstract

The objective of this systematic review is to evaluate the effectiveness and impact of artificial intelligence (AI)-based applications in the management of back pain, particularly through mobile health solutions. The review examines current AI interventions for their potential to improve pain outcomes, enhance self-management, and increase patient adherence. We conducted a comprehensive literature search across multiple databases, including PubMed, Scopus, and IEEE Xplore, following a rigorous inclusion and exclusion process. Studies were selected based on their focus on AI-enabled mobile applications specifically designed to aid back pain patients, with data extracted on outcomes such as pain reduction, patient engagement, and quality of life improvements. The findings reveal promising results, with many AI applications achieving notable success in pain management and user satisfaction; however, certain limitations, such as user engagement rates and app accessibility, were identified. This review underscores the potential of AI-driven health interventions in personalizing care and improving back pain outcomes, while also highlighting areas for future research, particularly in advancing AI algorithms and expanding access to digital health tools.

Keywords: Artificial intelligence, Back pain, Mobile health applications, Pain management, Systematic review, Digital health, Patient adherence.

Background

Back pain is one of the most prevalent health concerns worldwide, significantly impacting individuals' quality of life, work productivity, and overall well-being. It is estimated that over 80% of individuals will experience back pain at some point in their lives, with chronic back pain representing a leading cause of disability globally [1]. The complexity of back pain management stems from its multifaceted nature, often involving physical, psychological, and lifestyle-related factors [2]. Treatment strategies vary widely, from pharmacological interventions and physical therapy to psychological support and lifestyle modifications; however, no single approach has proven universally effective. This variability in response highlights the need for personalized and adaptive treatment methods that can cater to individual patient needs and preferences [3].

In recent years, artificial intelligence (AI) has shown promise in addressing some of these challenges, particularly through mobile and digital health applications that support self-management and personalized care plans. By leveraging machine learning algorithms, these applications can analyze user data and provide customized recommendations for pain relief exercises, behavioral modifications, and self-monitoring techniques [4]. However, while AI-powered applications have demonstrated effectiveness in enhancing self-management, they face significant challenges, including user engagement,

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privacy concerns, and variability in effectiveness across different patient demographics [5]. Furthermore, a lack of standardized protocols and regulatory guidance for AI-driven health tools adds to the complexity of their integration into routine clinical practice [6].

Despite these challenges, the potential of AI in transforming back pain management is substantial. AI-driven applications provide a unique opportunity to bridge the gap in healthcare access, especially in rural or underserved areas where traditional healthcare resources may be limited [7]. In addition, by offering continuous monitoring and instant feedback, these tools can improve adherence to therapeutic exercises and promote long-term lifestyle adjustments necessary for pain prevention and management [8]. This systematic review, therefore, seeks to evaluate the current state of AI-based applications in managing back pain, focusing on their effectiveness, limitations, and potential to personalize care and address barriers to effective back pain management.

Methodology

To ensure a comprehensive and systematic approach, the methodology includes a structured search strategy, clear inclusion and exclusion criteria, a meticulous data extraction process, and rigorous quality assessment.

Search strategy

A systematic search was conducted across several major databases, including PubMed, Scopus, IEEE Xplore, and Web of Science, using keywords "Artificial Intelligence," "AI," "back pain," "mobile app," and "digital health" with Boolean operators. Inclusion criteria focused on studies examining AI-based applications specifically targeting back pain management, with outcome measures such as pain reduction, functional improvement, user engagement, or quality of life. Exclusion criteria included studies not involving back pain or lacking AI-based components. Only English language studies published in the past 10 years were included.

Data extraction and quality assessment

Data were extracted on study characteristics, AI components, intervention details, and outcomes. The Preferred Reporting Items for Systematic Reviews and Meta-Analyses and GRADE frameworks were used to assess study quality.

Results

Overview of included studies

The studies included in this systematic review provide a comprehensive look at the integration of AI in mobile applications designed to manage back pain. For example, the selfBACK app, an AI-driven tool aimed at back pain self-management, proved effective in providing tailored interventions even for patients with high levels of stress or depression, addressing a critical barrier in pain management [3].

Other studies explored the effectiveness of AI-based self-management apps in specialist care and found improvements in musculoskeletal health for both neck and back pain [4]. These apps offered adaptive recommendations and improved engagement in specialist care settings. An AI-integrated mobile app for chronic neck/back pain management showed enhanced satisfaction and a sense of empowerment for self-management, highlighting how AI with evidence-based guidelines can support independent management [1].

Further, AI algorithms have been applied to identify key patterns within back pain literature, supporting practitioners in accessing relevant findings [9]. The combined findings

Table 1: Characteristics of included studies							
Author	**Year**	**App name**	**AI type**	**Sample size**	**Intervention**	**Key findings**	**Limitations**
Rughani et al. [3]	2023	selfBACK	Machine learning	500	Personalized exercise/advice for back pain	Effective in reducing back pain, even with depression or stress	Limited to short-term outcomes
Marcuzzi et al. [4]	2023	Unspecified	Deep learning	400	Self-management, specialist care	Improved health, higher engagement	Small specialist sample
Lo et al. [1]	2018	AI-integrated app	Evidence-based	200	Self-management for chronic neck/back pain	Enhanced satisfaction, empowerment	Observational design, self-report
Kawchuk et al. [9]	2020	Unspecified	Data mining	N/A	Knowledge pattern identification	Valuable for clinicians	No direct patient outcomes
AI: Artificial intelligence							

highlight the scope of AI applications in back pain, from self-management tools to supportive applications in specialist environments. Unique aspects of AI integration, such as adaptive recommendations, data-driven insights, and user empowerment, support a more patient-centered approach (Table 1).

Discussion

The findings reveal significant trends and implications for AI-based applications in back pain management. Notably, the adaptability of AI for personalized interventions allows applications to adjust recommendations based on individual patient data and progress [4], resulting in higher engagement and improved outcomes. Patients report feeling empowered by these tools, as instant feedback facilitates better self-care [1].

Challenges include sustaining long-term engagement and addressing privacy concerns. Limitations around data quality, sample diversity, and the accuracy of AI algorithms restrict wider applicability [5]. Privacy and accessibility, especially among older adults or those with lower digital literacy, are additional concerns needing future research.

Comparing AI-driven applications with traditional back pain management reveals both unique advantages and some limitations. While in-person physical therapy allows for immediate adjustment, AI apps provide continuous remote support, real-time adjustments, and broader reach [3].

Conclusion

This review highlights the transformative role of AI-based applications in back pain management, showcasing their ability to provide accessible, personalized, and adaptive care solutions outside traditional settings. The findings illustrate that AI-driven apps, such as selfBACK, can effectively address pain management by offering tailored plans, real-time adjustments, and tools based on individual needs. For underserved areas, AI-based tools are particularly beneficial.

Continued work is needed to improve algorithm accuracy, data privacy, and sustained engagement. The ongoing expansion of evidence-based AI health tools holds considerable promise for personalizing care and improving back pain outcomes.

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