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Physiotherapy Section

Evaluation of Efficacy and Usability of mHealth Applications in Management of Neck Pain: A Scoping Review

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ABSTRACT

Introduction: Neck pain is a prevalent condition that contributes significantly to disability worldwide. Traditional management often involves pharmacological treatments and physical therapy; however, adherence to home exercise programs remains a major challenge. The rise of mobile Health (mHealth) applications offers a novel solution, with the potential to enhance adherence and support self-management of neck pain.

Aim: To evaluate and synthesise existing literature on the efficacy, usability, and potential benefits of mHealth applications for pain management, functional recovery, and overall health status in individuals with neck pain.

Materials and Methods: The present comprehensive literature search for this scoping review was conducted across PubMed, Embase, ProQuest, and Google Scholar, covering studies published from 2004 to 2024. Inclusion criteria comprised randomised controlled trials, pre-post study designs, and cohort studies assessing mobile applications delivering exercises for neck pain. Parameters analysed in the review included neck pain, neck function, health status, and app usability.

Results: Eleven studies met the inclusion criteria, with eight reporting significant reductions in pain through the use of mHealth applications. Exercises delivered via the apps ranged from neck mobility routines to postural re-education programs. Improvements were observed in pain intensity (measured by Numeric Pain Rating Scale (NPRS) and Visual Analog Scale (VAS), neck function (measured by Neck Disability Index (NDI) and Patient Specific Functional Scale (PSFS), and overall health status (measured by MUSCULOSKELETAL HEALTH QUESTIONNAIRE (MSK-HQ) and Short Form(SF) -36). High patient satisfaction and adherence were reported in multiple studies, supporting the usability and effectiveness of these interventions.

Conclusion: mHealth applications show significant potential in enhancing neck pain management by improving adherence to therapeutic exercise programs. Their integration into clinical practice may offer a more personalised and accessible approach to rehabilitation, ultimately improving patient outcomes and quality of life.

Keywords: Digital health, Disability, Mobile health applications, Physical therapy, Pain management, Quality of life

INTRODUCTION

In 2021, approximately 206 million people worldwide were affected by neck pain, with an age-standardised prevalence rate of 2,696 per 100,000 population [1]. Around half of all individuals will experience a clinically significant episode of neck discomfort at some point in their lives [2]. Most epidemiological studies report an annual prevalence of neck pain ranging from 15 to 50%, with one systematic review reporting a mean rate of 37.2% [3-6]. A sedentary lifestyle, poor posture, and prolonged sitting are important lifestyle-related factors contributing to this increasing prevalence [7].

Neck pain is a leading cause of disability, affecting not only individuals' quality of life but also work productivity. A positive correlation has been observed between the severity of neck pain and health-related quality of life in a sample of 1,131 individuals [8]. A qualitative review assessing the impact of neck pain on work productivity reported negative influences on employment status and absenteeism [9]. Although the physical disability associated with neck pain is widely reported, a cross-sectional study of 1,809 patients with neck pain also documented a negative impact on mental health, including symptoms of anxiety and depression, in addition to impaired health-related quality of life [10].

Traditionally, the management of neck pain has involved pharmacological treatments, physical therapy, and lifestyle modifications. Within physical therapy, exercises (supervised, home-based, or a combination of both) are considered the mainstay treatment for chronic neck pain [11]. However, poor adherence to exercise programs is widely reported in the management of musculoskeletal conditions. Data from 358 surveys across 168 countries, including 1.9 million participants, were pooled to assess non-compliance with exercise programs. Surprisingly, non-compliance was highest among American and Southeast Asian populations [12]. A similar trend was observed in individuals with chronic neck pain, where poor adherence to home exercise programs resulted in reduced functional outcomes [13].

Advent of Technology for Neck Pain Management

The advent of mobile Health (mHealth) applications has introduced a promising alternative, enabling individuals to engage in self-management and play a more active role in their recovery. Recent advancements in Information and Communication Technology (ICT) emphasise supporting self-management programs for chronic pain through mobile software applications [14,15]. According to Abaza H. and Marschollek M., "mHealth refers to the use of mobile devices and applications to support healthcare, often providing resources for monitoring, diagnosing, and managing various health conditions" [16].

With the rapid growth of smartphones and wearable technologies, mHealth apps have become increasingly accessible and effective tools for managing chronic pain, including neck pain [17]. In fact, mobile apps have been identified as a means to reduce the financial burden of individuals suffering from chronic neck and back pain [18,19]. The use of ICT as part of rehabilitation has been suggested as an effective approach to improving adherence to self-management programs [20].

These apps commonly deliver interventions such as exercise programs, educational content, posture correction guidance, pain tracking, and relaxation techniques, offering a convenient and personalised approach to self-management [21]. By empowering individuals to monitor their symptoms and receive real-time feedback, mHealth apps provide a scalable solution to pain management and rehabilitation, reducing reliance on in-person visits and enabling continuous support [22].

One of the key advantages of mHealth apps in neck pain management is their ability to deliver low-cost, accessible, and personalised interventions [23]. Educational modules within apps can guide users on ergonomics, risks of prolonged sitting, and self-care strategies, which are essential for preventing recurrence of neck pain. Additionally, features such as symptom tracking and real-time biofeedback help users monitor pain levels and adjust their routines, fostering a proactive approach to managing chronic conditions [20,24].

Challenges of Mobile Health Applications

Despite the potential benefits of mHealth apps, several challenges hinder their widespread adoption. Literature indicates that 65% of mobile apps related to neck and back pain show no evidence of healthcare professional involvement in their development [25,26]. Issues related to data privacy, user engagement, app usability, and integration with clinical care must be addressed for these tools to be safe and effective. Moreover, the clinical validity of these apps and their impact on long-term outcomes require further investigation through robust experimental studies [27].

This paper explores the role of mHealth apps in the self-management of neck pain, evaluating their effectiveness, potential benefits, and challenges. By synthesising current research on mobile app-based interventions, the present study aimed to provide insights into how mobile health technologies can contribute to the management of neck pain. Thus, the objective of the present review is to evaluate and synthesise literature on the efficacy of mobile applications for pain management, functional recovery, health status, and usability in individuals with neck pain.

MATERIALS AND METHODS

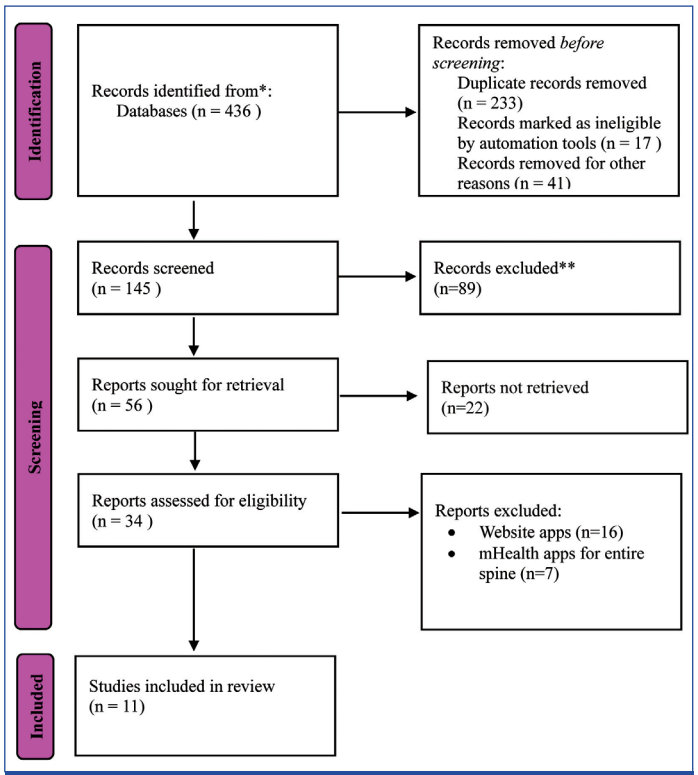
The present scoping review was created according to PRISMA-ScR (Preferred Reporting Items for Systematic Reviews and Meta-Analyses Extension for Scoping Reviews), 2024 [28]. The databases searched were PubMed, Embase, ProQuest, and Google Scholar using the keywords: “neck/cervical pain”, “neck/cervical rehabilitation”, “mobile apps”, “mHealth apps”, “digital intervention”, and “telerehabilitation”. Boolean operators used included “AND”, “OR”, and “*”. The search was conducted independently by two investigators for studies published between 2004 and 2024. Primary references and additional articles were identified by cross-referencing all search terms with review articles and manually screening reference lists.

Inclusion and Exclusion criteria: Inclusion criteria were studies published in English that assessed the efficacy of mobile applications delivering exercises for the management of neck pain from 2004 to 2024. All randomised controlled trials, pre-post study designs, and cohort studies were included. Exclusion criteria were studies delivering exercise programs through web-based interventions or in-person consultations. Systematic reviews, narrative reviews, scoping reviews, and meta-analyses were excluded. However, cross-references from these reviews were used to identify additional experimental studies.

Study Procedure

Title and abstract screening: All retrieved articles were screened for relevance by two independent reviewers. Studies were included if they met the inclusion criteria.

Full-text screening: Full-text articles of potentially eligible studies were retrieved and assessed. Disagreements between reviewers were resolved through discussion. The screening procedure adopted for the systematic literature search is represented in the flow chart [Table/Fig-1].



[Table/Fig-1]: Search Strategy used for review using PRISMA-ScR guidelines.

Synthesis of Results: mHealth apps used among patients with neck pain were evaluated for the following data items:

1. Pain management
2. Functional recovery
3. Health status
4. Usability.

RESULTS

Among the 11 studies, eight reported the effectiveness of mHealth apps for neck pain management. All eight studies primarily delivered exercises for neck pain, with only one study additionally including educational content on neck care. Exercise durations ranged from six weeks to six months, with outcomes measured as early as four weeks in one study and up to six months in two studies. Exercises were delivered as audio-video instructions through the apps in all included studies. Exercise types included neck mobility, cervical isometric, neck flexibility, postural re-education, or a combination of these. The remaining three studies focused on the usability of mHealth apps for neck pain management [Table/Fig-2] [29-39].

Efficacy of mHealth Apps for Pain Management in Patients with Neck Pain: Pain intensity was assessed using the Visual Analogue Scale (VAS) in five studies and the Numerical Pain Rating Scale (NPRS) in three studies. Additionally, a Likert scale and pain pressure threshold over the upper trapezius were used alongside NPRS in two studies. Lo WLA et al., (2018, China) used AI algorithms to deliver customised exercises for chronic neck pain. The median NPRS scores reduced from six to four (IQR 3-6) using the AI-embedded mobile app ($p=0.04$). The greatest reduction in pain occurred in patients who used the app for six months [29]. Thongtipmak S et al., (2020, Thailand) delivered stretching exercises and deep breathing techniques via a mobile app, reporting a significant reduction in pain (NPRS: pre-intervention 4; post-intervention 2, $p<0.01$), observed as early as four weeks [30]. Marcuzzi A et al., (2023, Norway)

S. No.	Author	Year, country	Study design	Population	Mean age (years)	Intervention	Comparison	Outcome	Other outcomes	App name
1	Lo W et al., [29]	2018, China	Retrospective evaluation study	161 participants with chronic neck pain	25	AI-embedded mobile app with NICE guideline-recommended biomechanical exercises were delivered for 6 months (assessment at 3 and 6 months)	NA	i. Pain: a) NPRS b) Likert Scale	i. Adherence to therapeutic exercises	Not available
2	Thongtipmak S et al., [30]	2020, Thailand	A mixed-method design	100 participants with neck pain	22.86	Video and Audio based stretching exercises along with deep breathing exercises intervention for 1 month	NA	i. Pain: a) VAS b) Pressure Pain Threshold over Upper Trapezius	i. Grip strength ii. Neck range of motion iii. BMI	Neck Protector app
3	Marcuzzi A et al., [31]	2023, Norway	Randomised clinical trial	294 patients with Neck and low back Pain	52.3	Video and Audio based exercises delivered via mobile App intervention for 6 months (assessment at 6 weeks, 3 months and 6 months)	Video and Audio based exercises delivered via Web based intervention (assessment at 6 weeks, 3 months and 6 months)	i. Pain: NPRS ii. Function: NDI iii. Health status: MSK-HQ	Nil	SELFBACK app
4	Beresford L and Noorwood T, [32]	2022, United States	Observational retrospective Study	36 patients with chronic neck pain	40.85	Video based exercises App-based exercises for three months	NA	i. Pain: VAS ii. Function: PSFS	i. Comorbid conditions and adverse symptoms	Not available
5	Abadiyan F et al., [33]	2021, Iran	Randomised controlled trial	60 office workers with neck pain	41.3	Video based exercises delivered via mobile App-based exercises for neck pain for 3 months	Group 1 (GPR + smartphone app, n=20), group 2 (GPR, n=20), and group 3 control group (n=20)	i. Pain: VAS ii. Function: NDI iii. Health Status: SF-36	i. Forward Head Posture (FHP degree) ii. Endurance Scale	Not available
6	Lee M et al., [34]	2017, South Korea	Single-group repeated-measures design	24 office workers with neck pain	30	Video based exercises delivered via mobile App-based exercises for neck pain for 6 weeks	NA	i. Pain: VAS ii. Function: NDI iii. Health Status: SF-36 iv. Usability: Patient satisfaction: Likert scale	i. Neck Range of motion ii. Fear Avoidance Belief Questionnaire	Not available
7	Pach D et al., [35]	2022, Germany	2-armed, randomised, parallel-group, single-centre pragmatic trial	RelaxNeck app (autogenic training, mindfulness meditation, and guided imagery) versus app providing only reminders	34	App supported notification features, a diary, questionnaire options, it provided audio relaxation exercises only for those in intervention group.	Control group received the same app with daily reminder but no relaxation exercises for 6 months	i. Pain: NPRS	i. Neck Range of Motion	Not available
8	Sun Y et al., [36]	2024, China	Randomised control group concurrent controlled trial	20 participants with neck pain (19 University students and 1 community person)	Not mentioned	The app employed motion capture technology alongside the smartphone's built-in sensors to simulate accurate somatic interactions.	Daily cervical spine health information in text and video formats via a WeChat group.	ii. Function: NDI	i. Functional activities such as driving, reading ii. Headache intensity	Not available
9	Lee J et al., [37]	2017, Korea	Pragmatic Study	20 graduate students with h/o of neck pain	21.1	Neck exercise was performed as directed by the mobile app in the workplace environment for atleast 10 min/day, 3 days/week for 8 weeks	NA	i. Pain: Visual Analogue Scale (VAS) ii. Function: Neck Disability Index (NDI) iii. Health Status: SF-36 iv. Usability: level of exercise adherence, FABQ	i. Fear Avoidance Belief Questionnaire	Not available
10	Marcuzzi A et al., [38]	2024, Norway	Qualitative study design	Focus group discussion & structured interview	52.3	2 focus group discussions, 1 semi-structed interview	NA	i. Usability: a. Overall impression of app: Patients discussed interface & content, usability issues & usage; b. Perceived value of app: Patients & health care practitioners described value of app and its potential to supplement usual care c. Suggestions for future use: patients and health care practitioners addressed aspects that determine acceptance.	Nil	SELFBACK app

11	Hurmuz MZ et al., [39]	2025, Iran	Qualitative descriptive study	32 patients chronic neck pain and low back pain		Interviews and Focus Group Discussion	NA	Interviews and Focus Group Discussion		

[Table/Fig-2]: Characteristics of studies included in the review.
Abbreviations: 1. VAS: Visual Analogue Scale, 2. NPRS: Numerical Pain Rating Scale, 3. NDI: Neck Disability Index, PSFS: Patient Specific Functional Scale, FABQ: Fear Avoidance Belief Questionnaire, SF-36: Short Form 36 Health Survey, h/o: history of, MSK-HQ: Musculoskeletal Health Questionnaire, GPR: Global Postural Re-education [29-39].

compared exercises delivered through a mobile app versus a web-based platform and found significantly greater pain reduction in the mobile app group (NPRS: mobile app 7, web app 5, p<0.01) [31]. Similarly, Beresford L and Noorwood T (2022, United States) delivered neck mobility and flexibility exercises via a mobile app and reported significant pain reduction on the VAS (p<0.01) [32].

Abadiyan F et al., (2021, Iran) compared global postural re-education exercises delivered via app, in-clinic sessions, and a control group. The greatest reduction in pain occurred in the group receiving mobile app-based exercises (p<0.01) [33]. A similar trend was seen among working individuals. Lee M et al., (2017, South Korea) evaluated the effect of a mHealth app on 24 office workers with chronic neck pain and found significant reduction on VAS after six weeks (p<0.01) [34]. Pach D et al., (2013, Germany) conducted a randomised pragmatic trial on chronic neck pain using the RelaxNeck app and reported significant pain reduction on NPRS after six months (p<0.01) [35].

Efficacy of mHealth Apps for Improving Neck Function in Patients with Neck Pain: Out of the 11 studies reviewed, six reported changes in neck function following the use of mHealth apps. Of these, five assessed neck function using the NDI, while one study used the PSFS.

Marcuzzi A et al., reported a reduction in NDI scores from 18.4 to 14.6 (p<0.01) after six months of mobile app use, indicating improved neck function [31]. Abadiya F et al., delivered video-based exercises through a mobile app to 60 office workers with neck pain. Significant improvement in neck function was observed in the app-based group compared with the in-clinic and conventional exercise groups (p=0.01) [33]. Beresford L used app-based video exercises among 36 patients with chronic neck pain for three months and found significant functional improvement on PSFS (p=0.01) [32]. Sun Y et al., (2024, China) conducted a randomised controlled trial involving 20 patients with neck pain using a mobile app that provided video-based cervical range-of-motion exercises. A significant improvement in NDI scores was reported following the intervention [36].

Efficacy of mHealth Apps on Health Status in Patients with Chronic Neck Pain: In addition to pain and neck function, the health status of patients with neck pain was considered a primary variable in several studies. A positive relationship between neck pain and decreased overall health status is well established and supported by scientific literature. Out of the 11 studies included in this review, three evaluated the efficacy of mHealth apps on the health status of patients with neck pain. Of these, one study used the Musculoskeletal Health Questionnaire (MSK-HQ), while two used the SF-36 to assess health status.

Marcuzzi A et al., (Norway) studied the effect of a mobile app-based intervention administered for six weeks, three months, and six months on the health status of 294 patients with low back pain and neck pain, using the MSK-HQ. Scores increased from 29.2 (pre-intervention) to 35.4 (post-intervention) in the experimental group (p<0.01), indicating improved musculoskeletal health among participants receiving the app-based intervention [31].

Among the studies using the SF-36, a similar positive trend was observed. Abadiya F et al., (Iran) and Lee M et al., (Korea) assessed overall health status in patients with neck pain using the SF-36. Abadiya F et al., delivered video-based global postural stabilisation exercises along with in-clinic exercises, while Lee M et al., delivered only video- and audio-based neck mobility and strengthening exercises, selected after patient categorisation using an AI algorithm. Interestingly, both studies implemented app-based exercises for office workers with neck pain over an eight-week period. Following the intervention, overall health status improved in both studies [33,34].

Efficacy of mHealth Apps on Usability among Patients with Neck Pain: The successful use of mHealth apps depends on both an engaging user interface and robust scientific content. Recognising this, several researchers evaluated usability among patients and app users. Of the 11 studies included, five reported on the usability of mHealth apps for neck pain management. Lee M et al., assessed patient satisfaction using a 5-point Likert scale. Adherence to the exercise program was measured by the number of exercise sessions completed. The present study was conducted on 30 office workers in Korea who received eight weeks of video- and audio-based exercises for neck pain. Patient satisfaction was 3.91±0.51 out of 5.0. The adherence rate was 91.85±37.78%, and the mean duration per exercise session was 16.86±7.38 minutes [37].

Thongtipmak S et al., (2020, Thailand) examined the effects of mobile app-based stretching exercises combined with deep breathing exercises for neck pain management. Quantitative and qualitative feedback was collected through an acceptability survey and open-ended questionnaires to understand user experience. Qualitative responses indicated that the application was easy to use and that the exercise program was helpful in coping with neck pain [30].

Marcuzzi A et al., assessed the usability of the SELFBACK app. A purposive sample of 11 patients (aged 27-75 years; 8 female) participated in semi-structured individual interviews based on app usage. Two focus group interviews were conducted with specialist healthcare practitioners (n=9). Three themes emerged from the interviews:

1. Overall app impression-including interface design, content, usability, and usage;
2. App value-highlighting its primary benefits and potential to supplement clinical care; and
3. Future suggestions-focusing on factors influencing acceptance [38].

Lo WLA et al., (2018, China) used an Artificial Intelligence (AI)-based mobile app to deliver customised exercises for patients with chronic neck pain. The evaluation questionnaire included 14 items aimed at determining whether using the AI rehabilitation system would:

1. Increase time spent on therapeutic exercise,
2. Affect pain level (assessed by the 0-10 NPRS), and
3. Reduce the need for other interventions.

The study demonstrated a positive self-perceived benefit from using the AI-embedded mobile app to provide personalised therapeutic exercise programs. The median System Usability Scale score across all responses was 73 (IQR 60-85) [29]. A qualitative descriptive study among adults with neck and/or low back pain was conducted by Hurmuz MZ et al., [39]. The Artificial Intelligence (AI)-based SELFBACK app supported tailored self-management of neck and low back pain and was used for six weeks. After this six-week intervention, participants were interviewed by phone. Thirty-two adults (17 males) with neck and/or low back pain participated. Results showed that the mode of delivery and the novelty of the SELFBACK app were most often perceived as barriers to its use [39].

DISCUSSION

This is the first scoping review on the efficacy of mHealth apps on pain, function, health status, and usability among patients with neck pain. The evidence gathered from these 11 studies provides a comprehensive overview of the potential benefits of mHealth apps for managing neck pain, improving function, enhancing health status, and understanding their usability. This review demonstrates the potential of mHealth apps as effective tools for delivering therapeutic exercises to patients with neck pain.

The studies included in the review collectively highlighted that mHealth apps-primarily delivering exercises through audio-video instructions-are effective in reducing pain intensity among patients with neck pain. All relevant studies [29,30,33,34,37,39] reported significant pain reductions using validated scales such as the NPRS, VAS, Likert Scale, and pain pressure threshold. The consistency in these findings suggests that mHealth apps can reliably deliver pain-relieving exercises. These interventions were effective across various geographical locations, including Norway, United States, Iran, China, Thailand, and South Korea, underscoring the universal applicability and effectiveness of mHealth interventions for neck pain.

The types of exercises delivered through mHealth apps varied but generally included neck mobility exercises, cervical isometrics, neck flexibility training, postural re-education, and global postural stabilisation exercises. This variety allows for tailored interventions based on individual patient needs, which may be a key factor contributing to the observed effectiveness [40].

Improvement in neck function was another critical outcome evaluated in these studies. The NDI and PSFS were commonly used to measure functional outcomes. The significant reductions in NDI scores suggest that app-based interventions can positively impact patients' daily activities. This finding is crucial as it aligns with the broader goal of rehabilitation: restoring function and improving patients' ability to perform daily tasks.

The positive impact of mHealth apps on overall health status was documented in studies using the MSK-HQ and SF-36. These findings indicate that the benefits of mHealth apps extend beyond pain reduction and functional improvements, supporting enhanced overall health and well-being. This highlights the potential advantage of combining mHealth interventions with traditional clinical exercises [41,42].

Usability and adherence to mHealth apps are critical factors determining their effectiveness. The reviewed studies reported high levels of patient satisfaction and adherence. Beresford L et al., documented an adherence rate of 91.85% and a positive patient satisfaction score of 3.91 out of 5 [32]. Thongtipmak S et al., (2020) also reported positive qualitative feedback, indicating that the apps were easy to use and the exercise programs were beneficial [30]. High adherence rates and positive user feedback are essential for the long-term success of mHealth interventions, as they ensure consistent patient engagement with therapeutic exercises.

The findings from these studies suggest several implications for future research and clinical practice. Firstly, there is a need for more large-scale, randomised controlled trials to further validate the efficacy of mHealth apps across different populations and settings. Secondly, future research should explore the long-term effects of mHealth interventions to determine their sustainability and their potential to prevent recurrence of neck pain [43]. Thirdly, integrating advanced technologies-such as AI to customise exercise programs, as demonstrated in the study by Kheirinejad S et al., (2023)- holds promise for enhancing the personalisation and effectiveness of mHealth apps [44].

In clinical practice, healthcare providers should consider incorporating mHealth apps as part of a comprehensive neck pain management program [45]. These apps provide a convenient and accessible means for patients to engage in therapeutic exercises, which can be particularly beneficial for individuals with limited access to in-person therapy. The positive outcomes associated with mHealth apps underscore their potential as valuable adjuncts to traditional rehabilitation approaches [46,47].

Overall, the reviewed studies highlight the promising role of mHealth apps in managing neck pain, improving function, and enhancing health status. The consistent positive outcomes across diverse settings and populations suggest that these digital interventions could become integral to modern healthcare delivery for patients with neck pain.

The reviewed studies consistently emphasise the promising role of mHealth apps in managing neck pain, improving function, and enhancing overall health status. The uniformity of positive results suggests that such digital interventions may become a vital component of future rehabilitation strategies.

Healthcare providers should integrate mHealth apps into neck pain management programs due to their demonstrated ability to improve neck function, health status, and patient satisfaction. High adherence rates and positive feedback reinforce their effectiveness. Combining mHealth apps with traditional rehabilitation can serve as a useful adjunct to enhance accessibility, personalisation, and overall patient outcomes, ultimately improving quality of life for individuals with neck pain. Addressing potential limitations-such as user variability, technical issues, and accessibility challenges for older adults or individuals with low digital literacy-is essential for broader and more equitable adoption.

Limitation(s)

The names and key features of many mobile apps were not available in the reviewed articles; therefore, these could not be described in detail. Additionally, most mobile apps were accessible only in specific countries, limiting comprehensive assessment of their features. These were the major limitations of the review.

CONCLUSION(S)

The reviewed studies reveal that mHealth apps significantly improve neck function, overall health status, and patient satisfaction. High adherence rates and positive user feedback support their feasibility as effective interventions. Future research should focus on large-scale trials and long-term outcomes to further establish their role in rehabilitation. Integrating mHealth apps into clinical practice can serve as an effective adjunct to enhance neck pain management by making therapeutic exercises more accessible and personalised, thereby fostering better patient outcomes and improving quality of life.

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