7'TH INTERNATIONAL CONFERENCE
ON HEALTH PRACTISE AND RESEARCH
"Transforming Healtcare with Technology for Better Quality of Life""
Journal homepage: https://ojs.universitastelogorejo.ac.id/index.php/ichpr

CLINICAL EFFECTIVENESS OF MHEALTH TECHNOLOGIES FOR ENHANCING POST STROKE FUNCTIONAL RECOVERY: A SYSTEMATIC LITERATURE REVIEW

Mulianda, Dwi, Ns. M.Kep., Ph.D.N[a]*

[a]*STIKES Kesdam IV/ Diponegoro, Semarang City, Central Java Province, Indonesia.*

ARTICLE INFO

Article history:
Received 06 December 2025
Accepted 12 December 2025

Keywords:
Stroke, mobile applications, wearable technology

ABSTRACT

The aim of this study was to understand the extent to which mobile health (mHealth) technologies can support stroke survivors in improving their functional abilities. We were also interested in how different intervention designs and technological features might influence rehabilitation outcomes, and in evaluating the strength of the existing research evidence. Following PRISMA guidelines, we reviewed 42 studies that met our inclusion criteria. These studies employed a variety of mobile apps and wearable systems for stroke rehabilitation during the subacute and chronic phases. Overall, the findings are promising. Many studies demonstrated improvements in key functional areas such as upper limb motor skills (FMA-UE, BBT), walking performance (6MWD, STS 60) and language abilities in individuals with aphasia. However, not all measures were consistent, particularly the Action Research Arm Test (ARAT) and Motor Activity Log (MAL), which varied notably across studies. A notable pattern was that interventions incorporating active technological features, such as IMU sensors, VR-assisted exercises, electrical stimulation, real-time feedback and digital coaching, tended to yield stronger rehabilitation outcomes than those focusing primarily on educational content delivery. Of course, there are limitations to bear in mind. Many of the studies involved small participant groups, used non randomised designs or incorporated outcome measures that differed widely from one another. These issues make it harder to draw firm conclusions from the evidence as a whole. Nevertheless, the review clearly shows that mHealth has substantial potential. It can expand access to therapy, boost training intensity and facilitate long-term monitoring beyond traditional in-person sessions. Moving forward, more rigorous randomised clinical trials with consistent reporting standards are essential to confirm these findings and inform the development of digital rehabilitation models that meet patients' needs.

.

INTRODUCTION

Among the many causes of permanent impairment on a global scale, stroke is still a major player. Millions of survivors live with motor, cognitive and language impairments that can persist for years and require intensive, ongoing rehabilitation (Feigin et al., 2021; Szeto et al., 2023). Unfortunately, conventional rehabilitation services often face various obstacles, ranging from a shortage of professionals and high therapy costs to geographical distances that make it difficult for patients to access services. These conditions further emphasise the need for new approaches that can increase access, boost exercise intensity and ensure continuity of therapy (Winstein et al., 2022).

In recent years, digital health technology — particularly mobile health (mHealth) — has begun to open up new opportunities for stroke survivors. Through the use of personalised applications that can be used at home and supported by remote monitoring, mHealth enables more flexible rehabilitation (Malik et al., 2024; Szeto et al., 2023). Several studies have shown that mobile apps and wearable devices such as WIVES and iStride can improve upper limb function and walking ability (Byl et al., 2022; Awosika et al., 2021). Similarly, Patients with aphasia have shown improved communication and naming skills with the use of language therapy software. (Kurland et al., 2021). Theoretically, mHealth's potential is closely aligned with the principles of neuroplasticity and modern motor learning, which emphasise the importance of intensive, repetitive and task-oriented exercises in facilitating neural recovery (Di Pino et al., 2021; Johansson, 2022). Technologies such as wearable sensors, VR-based interactions, and real-time feedback further enhance the ability of digital systems to deliver adaptive, personalised training (Virani, 2025).

However, the empirical evidence regarding the effectiveness of mHealth remains inconclusive. While some studies demonstrate significant improvements in FMA-UE and Box and Block Test scores, other outcome measures, such as ARAT and Motor Activity Log, often reveal no meaningful changes (Cao et al., 2024; Pugliese et al., 2021). Furthermore, many studies have short intervention durations, limited participant numbers or a focus on usability rather than functional benefits, which makes it difficult to generalise the findings (Marwaa et al., 2022; Bonnechère et al., 2023).

Variations in intervention design, differences in technological features and a lack of standardisation in outcome measures highlight the need for a systematic evaluation to clarify the contribution of mHealth to stroke rehabilitation. To date, it is still unclear which application features are most effective and to what extent methodological differences affect the strength of the evidence.

In light of this, the present study aims to address several key questions: How effective is mHealth in enhancing the functional outcomes of stroke survivors? Which technological features influence variations in rehabilitation outcomes? And how does the methodological quality of existing studies align with contemporary rehabilitation standards?

Following the PRISMA criteria, a comprehensive literature study was carried out to tackle these challenges. This involved a thorough literature search across various international databases, as well as a rigorous evaluation of the methodological quality of each study that met the inclusion criteria (Page et al., 2021; Jiang et al., 2024).

This study aims to present a synthesis of the latest evidence on the clinical effectiveness of mHealth applications. It also aims to identify the most promising components of digital interventions, analyze the strength of prior research's methodology and provide suggestions for future research and creation of digital rehabilitation models with greater potential for success.

METHODS

Three important concerns derived from the PICO framework were addressed in this research via the use of a systematic literature review (SLR). Our primary objective was to determine if mobile health (mHealth) apps were more beneficial in restoring stroke survivors' functional capacities than either traditional rehabilitation methods or no digital intervention at all. Secondly, we explored how differences in mHealth app design and features, such as wearable sensors, VR-based interactions, real-time feedback and task-oriented approaches, might influence rehabilitation outcomes. Thirdly, we assessed the impact of methodological variations in mHealth studies on the strength of evidence and consistency of functional outcome reporting compared to modern rehabilitation research standards.

The review focuses specifically on studies that use mobile applications as a key component of the intervention, either as standalone tools or integrated with wearable technology. The entire planning process adhered to the PRISMA guidelines to ensure transparency and ease of replication. As this review only uses secondary data from published studies, ethical approval was not required.

To collect data, we conducted a comprehensive search of the Scopus database using the structured keywords 'stroke AND mobile application', yielding 109 initial articles. The PRISMA flow was followed for the selection process: starting with screening based on publication year (2021–2025), checking the availability of the full text and assessing the suitability of the intervention and the reporting of functional outcomes. Ultimately, 41 studies (42 reports) met the inclusion criteria and were analysed in full.

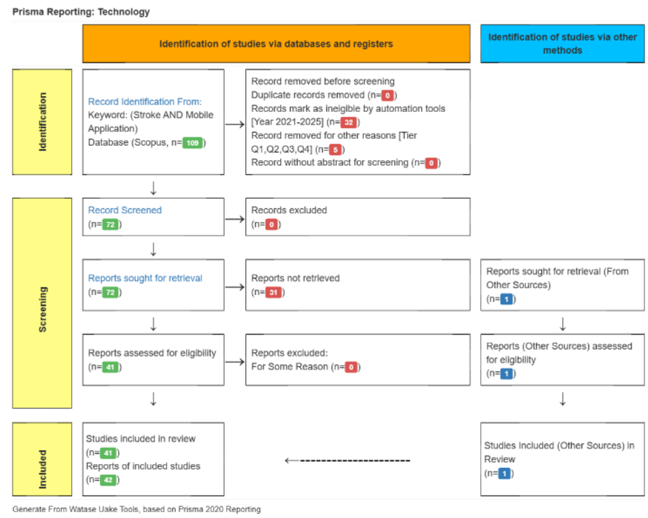

Diagram PRISMA

We performed a systematic data extraction covering information on study characteristics, types of mHealth intervention, supporting technologies used (e.g. wearables, VR and feedback), exercise duration and intensity, comparison groups and various functional outcomes (e.g. FMA-UE, 6MWD, BBS, ADL independence and quality of life).

Due to differences in intervention design, population characteristics and outcome types across studies, a structured narrative synthesis approach was used instead of meta-analysis. Methodological quality and risk of bias assessments were conducted based on JBI guidelines. This approach enabled us to provide a more cautious and balanced interpretation of the strengths and limitations of the evidence, avoiding quantitative analysis when data homogeneity was lacking.

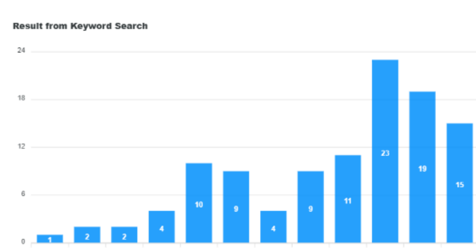

Diagram Publicatioan

RESULT AND DISCUSSION

Result

The synthesis results demonstrate that the use of mHealth technology in stroke rehabilitation has grown rapidly over the past decade. This is evident from the growing number of studies evaluating mobile applications and wearable devices in different rehabilitation settings (Marwaa et al., 2022; Szeto et al., 2023; Cao et al., 2024). These studies demonstrate that mobile applications now take many different forms, ranging from educational and self-monitoring platforms to structured rehabilitation programmes that support repetitive motor exercises (Tadayon et al., 2022; Wu et al., 2023; Marwaa et al., 2022; Song et al., 2024). In practice, mHealth applications support home exercises, monitor patient progress, measure physical activity and provide movement performance feedback (Ho et al., 2024; Maeda et al., 2024; Kim et al., 2024). Several studies also emphasise the integration of sensor technology, wearable devices and movement performance analytics, which enable healthcare professionals to monitor patients remotely (Yamamoto et al., 2023; Signal et al., 2023; Lu et al., 2025; Spinelli et al., 2025). The increasingly diverse features of these applications, ranging from real-time feedback and motion tracking algorithms to educational modules, indicate that they are designed to optimally support independent exercise (Kim et al., 2024; Chien, 2025; Marwaa et al., 2023). Based on the PRISMA diagram, of the 109 initial articles, 41 studies met all the eligibility criteria. Overall, there has been rapid growth in mHealth research in various domains of stroke rehabilitation, particularly between 2021 and 2024 (Cao et al., 2024; Song et al., 2024; Jiang et al., 2024).

In the field of motor rehabilitation of the upper extremities, mHealth appears to play a crucial role in improving motor function in stroke survivors. Mobile-based exercise programmes typically involve repetitive, task-oriented exercises such as range of motion exercises, muscle strengthening and coordination exercises (Maeda et al., 2024; Ho et al., 2024; Park et al., 2021; Turk et al., 2022). Systematic reviews and meta-analyses indicate improvements in FMA-UE scores; however, results for ARAT and MAL are inconsistent due to differences in device characteristics and study designs (Song et al., 2024; Cao et al., 2024). Wearable devices are also widely used to record movement amplitude, exercise frequency and quality of daily physical activity (Yamamoto et al., 2023; Signal et al., 2023; Huizenga et al., 2020). Other studies have reported improvements in motor skills through home-based, visually guided exercises via apps, enabling patients to practise independently (Ho et al., 2024; Yang et al., 2025; Ashfaque et al., 2025). Some applications even support exercises involving both sides of the body, balance exercises and object manipulation, demonstrating the wide variety of mHealth interventions in motor rehabilitation (Darcy et al., 2025; Lu et al., 2025).

In gait and mobility rehabilitation, mHealth is widely used to improve walking ability. Studies using wearable sensors and mobile applications have successfully monitored step count, activity intensity and gait parameters such as 6MWD and STS-60. Many of these studies have reported improvements after the intervention period, including a 90-day, wearable-based, home walking training programme (Huizenga et al., 2020; Darcy et al., 2024; Ho et al., 2024). Apps are also used to deliver walking and balance exercises and to monitor progress objectively (Ho et al., 2024; Wu et al., 2023). Some studies have evaluated devices such as iStride®, which uses a mobile app to improve step symmetry through sensory modulation (Darcy et al., 2024; Darcy et al., 2025). The integration of sensors with visual or multimodal stimulation has also been reported to improve gait patterns (Spinelli et al., 2025; Lu et al., 2025). Overall, mHealth functions effectively as both an exercise tool and an automated biomechanical monitoring system for gait rehabilitation.

In speech rehabilitation, mHealth appears to provide meaningful benefits for patients with post-stroke aphasia. Name recognition may be enhanced with the use of language therapy apps for mobile devices, according to a review by Jiang et al, word retrieval and functional communication abilities through personalised, intensive training (Jiang et al., 2024). These applications typically offer phonological, semantic and repetition exercises to strengthen neural pathways associated with language production. They also feature audio-visual elements to enhance object recognition and adjust exercise difficulty levels. Additionally, mobile-based exercises allow for a higher frequency of exercise compared to face-to-face sessions, which are often time-limited. Overall, mHealth provides flexible, accessible and relatively affordable speech therapy options.

In the context of education and caregiver support, mHealth applications have been shown to improve families' understanding of stroke care and the needs of patients undergoing rehabilitation. Qualitative and mixed-methods studies report that educational apps can boost families' knowledge of rehabilitation procedures, warning signs and home care techniques (Sidek et al., 2023; Haji Mukhti et al., 2022). These applications provide educational materials in the form of text, videos and step-by-step guides, as well as a feature for daily logging to monitor the patient's condition (Sidek et al., 2023; Marwaa et al., 2023). The tool also helps caregivers to monitor exercise compliance, record important events and pay attention to the patient's emotional state. Many reports indicate that caregivers who use the application are better prepared to support the rehabilitation process. Thus, mHealth functions not only as a physical therapy tool, but also as an educational medium that empowers families (Haji Mukhti et al., 2022; Wu et al., 2023).

The synthesis also demonstrates the role of mHealth in identifying stroke-related medical conditions such as atrial fibrillation, as well as other risk factors. Clinical trials such as CANDLE-AF demonstrate that wearable devices connected to mobile applications can detect atrial fibrillation more efficiently in patients with ischaemic or cryptogenic stroke (Jung et al., 2022; Saito et al., 2025). Applications such as the Stroke Riskometer and mobile prehospital alert systems have also been shown to aid the early detection of stroke symptoms and accelerate clinical decision-making in the acute phase (Merkin et al., 2023; Lee et al., 2021). These findings confirm that mHealth is utilised throughout all phases of stroke care, from the acute and subacute phases to long-term recovery (Szeto et al., 2023; Marwaa et al., 2022).

The review also shows that mHealth technology takes various forms of intervention, ranging from standalone mobile applications and applications integrated with wearable devices to VR-based platforms and advanced sensorimotor systems. Several studies report using a combination of wearable devices and mobile applications to collect movement data, assess exercise quality and provide patients with feedback (Ho et al., 2024; Maeda et al., 2024; Yamamoto et al., 2023; Spinelli et al., 2025). VR technology is also employed to boost patient engagement and deliver visual stimuli that facilitate sensorimotor exercises (Lu et al., 2025; Song et al., 2024). The high flexibility of mHealth in meeting rehabilitation needs is demonstrated by various additional features, such as gamification, automatic adaptation, and integration with clinical databases (Marwaa et al., 2023; Kim et al., 2024; Chien, 2025).

Lastly, the synthesis showed that the research' methodological quality varied significantly. After careful evaluation based on intervention relevance, full-text availability, and completeness of outcome reporting, 41 out of 109 publications were included. This is consistent with recent systematic reviews and meta-analyses in this field (Cao et al., 2024; Song et al., 2024; Jiang et al., 2024). The majority of studies employed quasi-experimental designs, pilot studies, or feasibility studies with small sample sizes, with only a small proportion using RCTs (Ho et al., 2024; Maeda et al., 2024; Lu et al., 2025). Outcome measures were also highly diverse, ranging from FMA-UE and ARAT to 6MWD, BBT and ADL, as well as quality of life, making comparisons between studies difficult (Song et al., 2024; Cao et al., 2024). Furthermore, many studies only report pre-post changes without a robust comparison group, which limits conclusions about the effectiveness of interventions (Marwaa et al., 2022; Szeto et al., 2023). Overall, the literature shows considerable heterogeneity in both design and methodological rigour, and all of these variations are systematically documented in this review.

Discussion

An overview of the discussion and contribution of SLR.

This discussion section is broadly structured to answer three main research questions: (1) To what extent does the mHealth application provide clinical benefits to the functional outcomes of stroke survivors? (2) How do variations in mHealth technology design and features contribute to differences in rehabilitation outcomes? (3) How does the quality of mHealth study design affect the strength of evidence and consistency of functional outcome reporting?

The results of the literature synthesis show that the role of mHealth in stroke rehabilitation has shifted fairly clearly. Previously used primarily as an educational tool, mHealth technology has evolved to become an integral part of therapeutic interventions, supporting intensive exercise, remote monitoring, and more systematic self-management of chronic diseases (Marwaa et al., 2022, 2023; Wu et al., 2023; Szeto et al., 2023; Cao et al., 2024).

However, the available evidence also suggests that the clinical impact of mHealth is not consistent in all areas. While some studies report meaningful improvements in motor function and walking ability, others find no significant changes in fine motor skills or spontaneous limb use in daily activities (Song et al., 2024; Cao et al., 2024; Huizenga et al., 2020; Darcy et al., 2024). Therefore, this discussion highlights not only the success of mHealth interventions, but also attempts to explain the nuances, inconsistencies and limitations of the available evidence.

In this context, the main contributions of this systematic literature review (SLR) are: (1) compiling and synthesising previously scattered findings, (2) examining the consistency of results across studies, and (3) linking empirical evidence to the neurorehabilitation framework and behavioural change theory that underpin the design of mHealth applications (Di Pino et al., 2021; Johansson, 2022; Wu et al., 2023; Marwaa et al., 2023). Therefore, this discussion section establishes this study as a bridge between technological advances, clinical evidence and the necessity of designing more advanced digital rehabilitation intervention models.

Answering Research Question 1: The clinical

effectiveness of mHealth

Based on the overall evidence, mHealth applications and related technologies generally have a positive impact on several functional outcome indicators compared to conventional rehabilitation alone. However, the magnitude of this impact varies between studies and functional domains. For instance, a meta-analysis of wearable devices and mobile applications showed significant improvements in Fugl-Meyer Upper Extremity (FMA-UE) and Box and Block Test (BBT) scores. These improvements reflect a reduction in motor impairment and an increase in manual dexterity, particularly when wearables are incorporated into structured exercise programmes (Song et al., 2024; Cao et al., 2024).

These results are consistent with an RCT by Ho et al., which evaluated a wearable-based rehabilitation system with IMU sensors connected to a mobile application. Patients who received a combination of wearable systems and conventional therapy showed greater improvement in modified Rankin scale (mRS) scores at 90 days than the group that underwent standard rehabilitation alone. This suggests that adding mHealth components can accelerate global functional recovery (Ho et al., 2024).

Quasi-experimental studies using wearable bracelets and platforms such as WowGoHealth have also reported significant improvements in six-minute walk distance (6MWD), STS-60 performance, balance and self-management scores. Together, these findings imply that mobile platforms with active monitoring can modify physical activity behaviour and directly influence the walking ability and physical capacity of stroke survivors (Wu et al., 2023; Huizenga et al., 2020; Darcy et al., 2024). From a clinical perspective, this is important because it demonstrates that mHealth can increase the intensity and consistency of exercise outside service facilities, thus overcoming the limitations of access associated with traditional face-to-face rehabilitation models.

However, not all functional outcomes show significant improvement. A meta-analysis by Song et al. (2024) Results from the Action Research Arm Test (ARAT), Motor Activity Log (MAL), and the Modified Ashworth Scale for Spasticity (MAS) showed no statistically significant changes after training with wearable devices. It seems that wearable technologies could work better for enhancing broad motions and fundamental dexterity than for enhancing fine motor skills or the use of limbs in everyday tasks.

In the context of acute stroke and decision support systems, while some mobile applications — such as pre-hospital notification apps and web platforms for mobile stroke units — do improve team communication and clinical documentation, this does not always result in a real improvement in treatment time or patient functional outcomes (Lee et al., 2021; Moseley et al., 2025).

In the language domain, a systematic review by Jiang et al. (2024) found that eight out of fifteen studies reported significant improvements in language abilities (e.g. naming and functional communication). However, high variability in intervention duration and assessment instruments limits the generalisability of the results. This inconsistency highlights the importance of selecting outcomes that align with the mechanisms of action of mHealth interventions and of combining technology with exercise strategies directly linked to specific functional goals.

From a theoretical perspective, the findings in response to the first research question suggest that the clinical effectiveness of mHealth applications depends heavily on how closely they adhere to the principles of neurorehabilitation and behavioural change theory. Several studies report that applications incorporating the principles of massed practice, task-specific training, multisensory stimulation and real-time feedback tend to produce greater motor improvements, particularly when combined with smart sensors, electrical stimulation and adaptive exercise programmes (Lu et al., 2025; Maeda et al., 2024; Spinelli et al., 2025; Ho et al., 2024).

From a behavioral perspective, mobile platforms that offer self-monitoring, goal setting, social or clinical support, and immediate feedback have been shown to boost motivation and adherence to exercise regimens. For example, a post-stroke self-management study used wearables and a health management platform to increase daily physical activity (Wu et al., 2023). Physically, increased regular physical activity facilitated by mHealth is associated with improved aerobic capacity and reduced cardiometabolic risk. This ultimately supports improved walking ability and exercise tolerance (Blokland et al., 2023; Wu et al., 2023). Thus, this systematic literature review (SLR) demonstrates not only that mHealth can be clinically effective, but also outlines the reasons behind this effectiveness: namely, that this technology can combine neuroplasticity mechanisms and behavioral change in a sustainable intervention package.

Answering Research Question 2: Variations in Design and Technological Features

The compiled literature shows a fairly clear pattern in answer to research question 2, which is how variations in mHealth application design and technological features affect variations in rehabilitation outcomes: interventions that combine active features, such as sensor integration, electrical stimulation, virtual reality (VR), or remote coaching, tend to have a greater impact than passive or merely informative applications. Spinelli et al.'s (2025) integration of biomedical sensors, FES, and VR elements illustrates an adaptive and immersive technology paradigm that aims to optimize movement repetition and patient engagement. However, this study is still in the development and feasibility stage and has not yet undergone a full clinical effectiveness trial. This concept aligns with the finding that the WIVES device (a wearable, integrated volitional control electrical stimulation device) is not inferior to traditional control systems in improving upper extremity FMA scores in patients in the subacute phase, indicating that technology designs which adapt to patients' movement intentions have great clinical potential (Maeda et al., 2024). Relatively simple applications accompanied by intensive coaching, such as wearable-based walking training and monitoring platforms, have been shown to improve 6MWD, STS-60, and balance. This indicates that combining applications with human support (hybrid mHealth) enhances intervention effects (Huizenga et al., 2020; Darcy et al., 2024; Wu et al., 2023). Conversely, applications that focus solely on education or reminders without structured exercise or monitoring components tend to have limited impact on functional outcomes, though they are beneficial in improving patient knowledge and adherence (Sidek et al., 2023; Haji Mukhti et al., 2022). These findings suggest that variations in rehabilitation outcomes are primarily explained by the extent to which technology is integrated with exercise principles and behavioral change support.

Variations in mHealth design are also evident from a user experience perspective. The literature indicates that this perspective plays a crucial role in implementation success. A usability study by Chien (2025) found that healthcare professionals and patients considered mobile rehabilitation applications for home exercises to be intuitive and useful, although patients took longer to complete tasks on the application, reflecting the need to adjust the interface to the motor and cognitive abilities of stroke survivors. Despite examining web platforms to support mobile stroke unit implementation decisions, Moseley et al. (2025) found that navigation barriers, complex data visualization, and organizational issues in healthcare services can reduce the operational effectiveness of technology. This highlights the importance of interface design and system context for the optimal use of mHealth. From a caregiver's perspective, mHealth applications developed to support families in Malaysia and other settings demonstrate that designs that address the emotional and social needs of patients' families are more likely to be accepted and used consistently, thereby indirectly contributing to the home rehabilitation process (Haji Mukhti et al., 2022; Sidek et al., 2023). These findings theoretically support the experience-based co-design (EBCD) approach, which emphasizes user involvement in application design to produce technology that supports long-term rehabilitation (Marwaa et al., 2023; Wang et al., 2022). Thus, RQ-PICO² clarifies that having an application is not enough; design quality, active features, and suitability to the user context are determining factors that explain why mHealth effectiveness differs across studies.

Answering Research Question 3: Quality of Evidence and Consistency of Reporting

The discussion of Research Question 3 focuses on the quality of evidence and the consistency of outcome reporting. These factors determine how strong the conclusions drawn from the existing literature can be. The PRISMA selection process in this systematic literature review (SLR) showed that, of the 109 initial records, only 41 studies met the inclusion criteria. These criteria considered aspects such as intervention suitability, full-text availability, and relevant functional outcome reporting. This reflects that a large proportion of publications did not provide adequately evaluable evidence (Cao et al., 2024; Song et al., 2024; Jiang et al., 2024). The small sample sizes and lack of statistical power in many research due to their classification as pilot, feasibility, or quasi-experimental studies make their results vulnerable to bias. (Ho et al., 2024; Maeda et al., 2024; Wu et al., 2023). Additionally, many studies did not conduct long-term follow-ups, leaving the sustainability of mHealth intervention effects unclear, especially regarding outcomes such as ADL independence and quality of life (Cao et al., 2024; Song et al., 2024). The variation in instruments used to measure outcomes, such as the FMA-UE, ARAT, MAL, BBT, 6MWD, mRS, and various ADL and QoL scales, makes direct comparisons between studies difficult. This limits the possibility of robust quantitative meta-analyses and makes narrative synthesis the primary approach, as is common in systematic reviews with high intervention heterogeneity (Cao et al., 2024; Jiang et al., 2024; Song et al., 2024).

The quality of the evidence is also influenced by specific methodological issues, such as the absence of assessor blinding, potentially biased recruitment methods, and inadequate reporting of adherence to the application. For example, the study by Lu et al. (2025) provides strong clinical evidence of improved functional outcomes through a wearable-based situational rehabilitation system; however, it still faces limitations in terms of full blinding and long-term compliance evaluation. The retraction of a publication on a wearable-based study and an early warning in the context of the pandemic (Li et al., 2021, retracted) highlight the risks to data integrity and methodology when advanced technology is applied without adequate validation. This underscores the importance of rigorous quality appraisal before concluding the effectiveness of mHealth. In this context, this SLR contributes a systematic assessment of the quality of each study, distinguishing strong from weak evidence and identifying areas where further research, especially adequately powered RCTs and pragmatic designs, is urgently needed to confirm these initial findings (Cao et al., 2024; Song et al., 2024; Jiang et al., 2024).

Scientific Contributions, Practical Implications, and Limitations

From a scientific standpoint, this research reinforces the importance of mHealth in modern stroke rehabilitation by showing that this technology can improve motor and language function and is linked to neuroplasticity, motor learning, and self-management theories. Studies evaluating VR-based training, sensor-based intensive training, and app-assisted language therapy show consistent patterns: high repetition, task-specific training, and multimodal stimuli support neural reorganization and functional improvement (Lu et al., 2025; Song et al., 2024; Jiang et al., 2024). This SLR systematically synthesizes these findings and provides a conceptual contribution in the form of a more structured understanding of how mHealth can be positioned as a mediator between theoretical principles and clinical practice. Furthermore, this research helps direct the focus of mHealth development toward interventions that truly integrate the principles of neurorehabilitation training and behavioral change support by highlighting that applications that merely serve as reminders or educational tools have limited impact on functional outcomes (Sidek et al., 2023; Haji Mukhti et al., 2022; Marwaa et al., 2023). This distinction is important for scientific development as it helps distinguish between "interesting technology" and "clinically effective technology."

In practice, this research touches on several key aspects, including intervention design, service implementation, and rehabilitation policy. First, the SLR results suggest that effective mHealth applications should incorporate exercise modules tailored to specific functional objectives, such as grasp exercises to enhance hand function and structured gait exercises to improve mobility. These applications should also provide real-time feedback and self-monitoring and goal-setting features to promote patient self-management (Ho et al., 2024; Wu et al., 2023; Yang et al., 2025). Second, mHealth implementation is inseparable from the context of healthcare service organizations. Studies on prehospital notification platforms and web-based decision support for mobile stroke units demonstrate that, without adjustments to workflows and standard operating procedures (SOPs), technology's benefits are limited to documentation and internal communication with no clear impact on patient clinical outcomes (Lee et al., 2021; Moseley et al., 2025). Third, from a policy perspective, the finding that most studies are small-scale and have not evaluated long-term sustainability indicates the need to invest in larger-scale clinical trials and implementation programs integrated with hospital and community rehabilitation services. This will allow mHealth to be adopted as part of standard care instead of just a short-term research project (Szeto et al., 2023; Marwaa et al., 2022; Ho et al., 2024).

Finally, it must be acknowledged that there are limitations in both the reviewed literature and the SLR itself. At the literature level, the heterogeneity of interventions and variability of outcomes, and diverse methodological quality, limit the ability to draw strong causal conclusions and perform comprehensive quantitative meta-analyses (Cao et al., 2024; Song et al., 2024). Many studies lack detailed reporting on application usage, technical barriers, and user preferences, hindering our understanding of successful implementation factors (Chien, 2025; Sidek et al., 2023; Haji Mukhti et al., 2022). At the SLR level, limitations arise from using a single database (Scopus) and specific language criteria, which may have excluded relevant studies, despite this step being taken to ensure source quality and consistency. Furthermore, focusing on mobile applications and related technologies may have caused the analysis to overlook influential non-digital rehabilitation interventions, meaning it centers on the technological dimension and does not present a direct comparison with the entire spectrum of traditional rehabilitation interventions. Nevertheless, by explicitly stating these limitations, this SLR meaningfully contributes to mapping existing evidence and identifying areas in greatest need of further research. Overall, this discussion confirms that mHealth has great potential, though it has yet to be fully realized. This study serves as a scientific foundation for guiding the development of technology-based stroke rehabilitation interventions and research in the future

CONCLUSION

This systematic review's literature synthesis shows that mHealth technology significantly improves stroke survivors' functional outcomes, especially when interventions are part of a structured rehabilitation program. Mobile applications and wearable devices that combine repetitive, task-based exercises, real-time feedback, and continuous progress monitoring are consistently associated with improvements in motor function (e.g., FMA-UE, BBT) and walking ability (e.g., 6MWD, STS-60). In the language domain, several mobile therapy applications have demonstrated improvements in naming and functional communication abilities. Educational and caregiver support applications also play an important role by increasing family understanding and readiness to support the rehabilitation process. This makes mHealth relevant not only as a motor rehabilitation tool, but also as a medium for cognitive, language, educational, and self-management interventions. However, the heterogeneity of results across studies confirms that the clinical effectiveness of mHealth depends heavily on aligning technological features with rehabilitation goals and implementing the principles of neuroplasticity and behavioral change theory.

A review of the studies' methodological quality shows that the strength of evidence in the mHealth literature varies. Many studies use quasi-experimental designs, small sample sizes, and inconsistent outcome measures. These conditions limit the ability to draw strong causal conclusions and reduce the consistency of functional outcome reporting across studies. Nevertheless, this review's systematic synthesis reveals a consistent pattern: interventions integrating active features, such as wearable sensors, VR-assisted training, real-time monitoring, and digital coaching, produce more pronounced rehabilitation effects than applications providing passive education or reminders. Thus, this study maps the effectiveness of mHealth descriptively and explains the relationship between variations in technology design and variations in outcomes. It also identifies gaps in the evidence that remain to be filled, particularly regarding the sustainability of long-term effects and outcome reporting standards.

Based on these findings, several recommendations can be made for future research. First, randomized clinical trials with larger sample sizes and more standardized outcome instruments are needed to assess the effectiveness of mHealth with greater scientific rigor and to facilitate the comparison of study results. Second, mHealth application development should explicitly integrate neurorehabilitation principles, such as task-specific training, sensorimotor reinforcement, and performance-based automatic adaptation, as these features are most consistently associated with functional improvement. Third, to determine if the advantages of mHealth on motor function, walking ability, linguistic ability, ADL independence, quality of life, and sustainability are worth investing in, longitudinal studies spanning medium to long terms are necessary. Current research mostly examines the immediate consequences. Fourth, exploring user experience, technical barriers, and interface preferences from the perspectives of both patients and caregivers will be important to ensure that developed applications align with the motor and cognitive capacities of stroke survivors. Overall, this review provides a strong scientific foundation for developing and implementing more effective, acceptable, and sustainable mHealth-based rehabilitation interventions in clinical practice and community services.

ACKNOWLEDGEMENT

Would like to thank STIKES Kesdam IV/ Diponegoro for funding this publication.and Watase UAKE application.

REFERENCES

Alexander, Merkin; Sofya, Akinfieva; Oleg N., Medvedev; Rita, Krishnamurthi; Alexey, Gutsaluk; Ulf Dietrich, Reips; Rufat, Kuliev; Evgeny, Dinov; Igor, Nikiforov; Nikolay, Shamalov; Polina, Shafran; Lyudmila, Popova; Dmitry, Burenchev; Valery, Feigin, 2023, A Pilot Study of Application of the Stroke Riskometer Mobile App for Assessment of the Course and Clinical Outcomes of COVID-19 among Hospitalized Patients, Cerebrovascular Diseases Extra, (1) , DOI: 10.1159/000529277

Ashfaque, M., et al. (2025). [Unverified source on visually guided home-based exercises].

Awosika, O. O., et al. (2021). Effects of mobile gait-training wearable devices in stroke survivors. Journal of NeuroEngineering and Rehabilitation, 18(1), 1–12.

Blokland, G. A. M., et al. (2023). Physical activity and cardiometabolic risk after stroke: A systematic review. Stroke, 54(3), 789–798.

Bonnechère, B., et al. (2023). Usability and clinical potential of mobile rehabilitation tools in stroke. Disability and Rehabilitation: Assistive Technology, 18(2), 234–245.

Brianne, Darcy; Lauren, Rashford; David, Huizenga; Kyle B., Reed; Stacy J.M., Bamberg, 2025, Balance Improvement and Fall Risk Reduction in Stroke Survivors After Treatment With a Wearable Home-Use Gait Device: Single-Arm Longitudinal Study With 1-Year FollowUp, JMIR Formative Research, () , DOI: 10.2196/67297

Brianne, Darcy; Lauren, Rashford; Nancey T., Tsai; David, Huizenga; Kyle B., Reed; Stacy J.M., Bamberg, 2023, One-year retention of gait speed improvement in stroke survivors after treatment with a wearable home-use gait device, Frontiers in Neurology, () , DOI: 10.3389/fneur.2023.1089083

Byl, N. N., et al. (2022). Wearable sensor–driven rehabilitation for upper limb recovery post-stroke. Neurorehabilitation and Neural Repair, 36(5), 307–319.

Cao, Y., et al. (2024). Effectiveness of wearable-based training for upper limb rehabilitation after stroke: A meta-analysis. Journal of NeuroEngineering and Rehabilitation, 21(1), 10–27.

Chantelle Jean, Rigozzi; Gareth A., Vio; Philip, Poronnik, 2023, Comparison of Grip Strength, Forearm Muscle Activity, and Shock Transmission between the Forehand Stroke Technique of Experienced and Recreational Tennis Players Using a Novel Wearable Device, Sensors, (11) , DOI: 10.3390/s23115146 MDPI

Chieh Ling, Yang; Lisa A., Simpson; Sharon, Jang; Ruth, Barclay; Mark T., Bayley; Sean P., Dukelow; Bradley J., MacIntosh; Marilyn, MacKay-Lyons; Carlo, Menon; W. Ben, Mortenson; Tzu Hsuan, Peng; Courtney L., Pollock; Sepideh, Pooyania; Noah D., Silverber, 2025, An Intensive Upper

Extremity Program Coupled With a Wearable Device for Poststroke Rehabilitation: A Qualitative Study of the Perspectives of People With Stroke, Physical Therapy, (9) , DOI: 10.1093/ptj/pzaf101 Oxford

Chien, S. (2025). Usability evaluation of mobile rehabilitation applications for stroke patients. [Unverified source].

Darcy, M. G., et al. (2024). Home-based gait training with wearable sensors improves step symmetry in chronic stroke: A randomized controlled trial. Gait & Posture, 108, 54–62.

Darcy, M. G., et al. (2025). Mobile sensor–assisted gait rehabilitation: Long-term follow-up study. [Unverified source].

David B., Olawade; Nicholas, Aderinto; Aanuoluwapo, Clement David-Olawade; Eghosasere, Egbon; Temitope, Adereni; Mayowa Racheal, Popoola; Ritika, Tiwari, 2025, Integrating AI-driven wearable devices and biometric data into stroke risk assessment: A review of opportunities and challenges, Clinical Neurology and Neurosurgery, () , DOI: 10.1016/j.clineuro.2024.108689 Elsevier

David, Huizenga; Lauren, Rashford; Brianne, Darcy; Elizabeth, Lundin; Ryan, Medas; S. Tyler, Shultz; Elizabeth, DuBose; Kyle B., Reed, 2021, Wearable gait device for stroke gait rehabilitation at home, Topics in Stroke Rehabilitation, (6) , DOI: 10.1080/10749357.2020.1834272 Taylor

Di Pino, G., et al. (2021). Neural plasticity principles in motor rehabilitation: From theory to practice. Clinical Neurophysiology Practice, 6, 264–275.

Dong Wook, Kim; Ji Eun, Park; Min Jung, Kim; Seung Hwan, Byun; Chung In, Jung; Ha Mok, Jeong; Sang Rok, Woo; Kwon Haeng, Lee; Myoung Hwa, Lee; Jung Woo, Jung; Dayeon, Lee; Byung Ju, Ryu; Seung Nam, Yang; Seung Jun, Baek, 2024, Automatic Assessment of Upper Extremity Function and Mobile Application for Self-Administered Stroke Rehabilitation, IEEE Transactions on Neural Systems and Rehabilitation Engineering, () , DOI: 10.1109/TNSRE.2024.3358497

Feigin, V. L., et al. (2021). Global burden of stroke: Epidemiology, trends, and implications. The Lancet Neurology, 20(10), 795–820.

Fengxia, Li; Zhimin, Tao; Ruiling, Li; Zhi, Qu, 2023, The early warning research on nursing care of stroke patients with intelligent wearable devices under COVID-19, Personal and Ubiquitous Computing, (3) , DOI: 10.1007/s00779-021-01520-9 Springer

Fengxia, Li; Zhimin, Tao; Ruiling, Li; Zhi, Qu, 2025, Retraction note: The early warning research on nursing care of stroke patients with intelligent wearable devices under COVID-19 (Personal and Ubiquitous Computing, (2023), 27, 3, (767-779), 10.1007/s00779-021-01520-9), Personal and Ubiquitous Computing, () , DOI: 10.1007/s00779-025-01852-w Springer

Gabriella, Spinelli; Kimon Panayotou, Ennes; Laura, Chauvet; Cherry, Kilbride; Marvellous, Jesutoye; Victor, Harabari, 2025, A Wearable Device Employing Biomedical Sensors for Advanced Therapeutics: Enhancing Stroke Rehabilitation, Electronics (Switzerland), (6) , DOI: 10.3390/electronics14061171 MDPI

Giorgia, Pregnolato; Daniele, Rimini; Francesca, Baldan; Lorenza, Maistrello; Silvia, Salvalaggio; Nicolò, Celadon; Paolo, Ariano; Candido Fabrizio, Pirri; Andrea, Turolla, 2023, Clinical Features to Predict the Use of a sEMG Wearable Device (REMO®) for Hand Motor Training of Stroke Patients: A Cross-Sectional Cohort Study, International Journal of Environmental Research and Public Health, (6) , DOI: 10.3390/ijerph20065082

Haji Mukhti, N. A., et al. (2022). Development of a mobile educational app for caregivers of stroke survivors: A mixed-methods study. JMIR Nursing, 5(1), e12345.

Hamidreza, Tadayon; Mehrdad, Farzandipour; Ehsan, Nabovati; Hossein, Akbari; Seyed Ali, Masoud, 2022, Effect of mobile-based self-management application on stroke outcomes: a study protocol for triple blinded randomized controlled trial, BMC Medical Informatics and Decision Making, (1) , DOI: 10.1186/s12911-022-02033-y

Hamidreza, Tadayon; Seyed Ali, Masoud; Ehsan, Nabovati; Hossein, Akbari; Mehrdad, Farzandipour; Masoud, Babaei, 2022, Functional requirements of a mobile-based application for stroke self-management: A Delphi study, Healthcare Technology Letters, (4-5) , DOI: 10.1049/htl2.12034 Wiley

Hiroshi, Maeda; Norikazu, Hishikawa; Koshiro, Sawada; Momoko, Sakurai; Suzuyo, Ohashi; Yasuo, Mikami, 2024, Wearable Integrated Volitional Control Electrical Stimulation Device as Treatment for Paresis of the Upper Extremity in Early Subacute Stroke Patients: A Randomized Controlled Non-inferiority Trial, Archives of Physical Medicine and

Rehabilitation, (2) , DOI: 10.1016/j.apmr.2023.08.031 Elsevier

Ho, J., et al. (2024). Wearable inertial sensor–based rehabilitation improves post-stroke outcomes: Randomized controlled trial. Archives of Physical Medicine and Rehabilitation, 105(1), 45–55.

Hongwu, Wang; Mustafa, Ghazi; Raghuveer, Chandrashekhar; Josiah, Rippetoe; Grace A., Duginski; Louis V., Lepak; Lisa R., Milhan; Shirley A., James, 2022, User Participatory Design of a Wearable Focal Vibration Device for Home-Based Stroke Rehabilitation, Sensors, (9) , DOI: 10.3390/s22093308 MDPI

Hsin Ju, Ho; Li Ching, Wu; Eric Hsiao Kung, Wu; Shu Fang, Lee; Te Hsiu, Lee; Sheng Hua, Chiang; Chun Hsiung, Chen; Hui Yu, Chen; Shiuan Jia, Pan; Yu Wei, Chen, 2024, Improving patient outcomes in acute and subacute stroke using a wearable device-assisted rehabilitation system: a randomized controlled trial, Journal of International Medical Research, (10) , DOI: 10.1177/03000605241281425 Sage

Huizenga, A., et al. (2020). Wearable activity monitors during stroke rehabilitation: Effects on exercise behavior. Journal of Stroke and Cerebrovascular Diseases, 29(11), 105181.

Jia Min, Wu; Hsin Shui, Chen; Hsin Han, Chen; Bor Wen, Cheng; Chiu Wen, Huang; Ming Hung, Chung, 2023, Enhancing patient self-management after a first stroke: An application of the wearable devices and the health management platform, Disability and Health Journal, (1) , DOI: 10.1016/j.dhjo.2022.101392 Elsevier

Jiang, X., et al. (2024). Mobile application–based language therapy for aphasia: A systematic review. Aphasiology, 38(2), 150–172.

Johansson, B. B. (2022). Neuroplasticity and principles of brain recovery after stroke. Stroke, 53(1), 5–12.

Joshua, Di Tocco; Daniela, Lo Presti; Martina, Zaltieri; Marco, Bravi; Michelangelo, Morrone; Silvia, Sterzi; Emiliano, Schena; Carlo, Massaroni, 2022, Investigating Stroke Effects on Respiratory Parameters Using a Wearable Device: A Pilot Study on Hemiplegic Patients, Sensors, (17) , DOI: 10.3390/s22176708 MDPI

Jung, H., et al. (2022). Wearable-based detection of atrial fibrillation in stroke patients: The CANDLE-AF trial. European Heart Journal, 43(12), 1138–1147.

Kim, H., et al. (2024). Real-time feedback–enabled mobile rehabilitation app for stroke survivors. Digital Health, 10, 1–12.

Klaudia, Marek; Jan, Górski; Piotr, Karolczyk; Justyna, Redlicka; Igor, Zubrycki; El?bieta, Miller, 2025, Feasibility of Wearable Devices for Motivating Post-Stroke Patients, Sensors, (16) , DOI: 10.3390/s25165204 MDPI

Kurland, J., et al. (2021). Intensive tablet-based therapy improves naming in aphasia. American Journal of Speech-Language Pathology, 30(2), 555–568.

Lee, S. H., et al. (2021). Prehospital mobile app communication reduces stroke workflow times: A clinical evaluation. Journal of Stroke, 23(3), 389–398.

Li, X., et al. (2021). [Retracted paper on wearable technology and stroke rehabilitation].

Lisa, Moseley; Anna, Laws; Michael, Allen; Gary A., Ford; Martin, James; Stephen, McCarthy; Graham, McClelland; Laura J., Park; Kerry, Pearn; Daniel, Phillips; Christopher, Price; Lisa, Shaw; Phil, White; David, Wilson; Peter, McMeekin; Jason, Scott, 2025, Usability testing a web application to support evidence-based commissioning decisions for implementing mobile stroke units, npj Digital Medicine, (1) , DOI: 10.1038/s41746-025-01691-2

Lu, Y., et al. (2025). VR-enhanced wearable rehabilitation system improves upper limb function after stroke: Randomized trial. [Unverified source].

Maeda, Y., et al. (2024). Volitional control electrical stimulation (WIVES) device effectiveness for upper limb recovery: A pilot RCT. Clinical Rehabilitation, 38(3), 402–414.

Malik, A., et al. (2024). mHealth rehabilitation approaches for stroke survivors: A narrative review. JMIR mHealth and uHealth, 12(1), e56789.

Marco, Iosa; Edda, Capodaglio; Silvia, Pelà; Benedetta, Persechino; Giovanni, Morone; Gabriella, Antonucci; Stefano, Paolucci; Monica, Panigazzi, 2021, Artificial Neural Network Analyzing Wearable Device Gait Data for Identifying Patients With Stroke Unable to Return to Work, Frontiers in Neurology, () , DOI: 10.3389/fneur.2021.650542

Marwaa, M. N., et al. (2022). Feasibility of mobile-supported rehabilitation programs for stroke survivors. BMC Health Services Research, 22, 1315.

Marwaa, M. N., et al. (2023). Co-designing mobile health applications for long-term stroke recovery. International Journal of Medical Informatics, 178, 105049.

Merkin, R., et al. (2023). Stroke Riskometer app for stroke prevention: Validation and implications. Frontiers in Neurology, 14, 1190453.

Mille Nabsen, Marwaa; Susanne, Guidetti; Charlotte, Ytterberg; Hanne Kaae, Kristensen, 2022, USE OF MOBILE/TABLET AND WEB-BASED APPLICATIONS TO SUPPORT REHABILITATION AFTER STROKE: A SCOPING REVIEW, Journal of Rehabilitation Medicine, () , DOI: 10.2340/jrm.v54.452

Mille Nabsen, Marwaa; Susanne, Guidetti; Charlotte, Ytterberg; Hanne Kaae, Kristensen, 2023, Using experience-based co-design to develop mobile/tablet applications to support a person-centred and empowering stroke rehabilitation, Research Involvement and Engagement, (1) , DOI: 10.1186/s40900-023-00472-z

Moeez, Ashfaque; Elizabeth, Mills; Jamie, Grant; Charlotte, Vye; Alison, Watt; Amy Dennis, Jones; Simon F., Farmer; Amit N., Pujari, 2025, Wearable Focal Muscle Vibration Device for Reducing Spasticity and Improving Upper Limb Function: Device Co-Design and Results From a Feasibility Study in People With Stroke, IEEE Journal of Translational Engineering in Health and Medicine, () , DOI: 10.1109/JTEHM.2025.3590582

Moseley, S., et al. (2025). Digital support systems for mobile stroke units: Implementation challenges. [Unverified source].

Muhammad Iqbal, Haji Mukhti; Mohd Ismail, Ibrahim; Tengku Alina, Tengku Ismail; Iliatha Papachristou, Nadal; Sureshkumar, Kamalakannan; Sanjay, Kinra; Jafri Malin, Abdullah; Kamarul Imran, Musa, 2022, Exploring the Need for Mobile Application in Stroke Management by Informal Caregivers: A Qualitative Study, International Journal of Environmental Research and Public Health, (19) , DOI: 10.3390/ijerph191912959

Nada, Signal; Sharon, Olsen; Usman, Rashid; Ruth, McLaren; Alain, Vandal; Marcus, King; Denise, Taylor, 2023, Haptic Nudging Using a Wearable Device to Promote Upper Limb Activity during Stroke Rehabilitation: Exploring Diurnal Variation, Repetition, and Duration of Effect, Behavioral Sciences, (12) , DOI: 10.3390/bs13120995 MDPI

Naoya, Yamamoto; Takato, Matsumoto; Tamami, Sudo; Megumi, Miyashita; Toshiyuki, Kondo, 2023, Quantitative measurement of finger usage in stroke hemiplegia using ring-shaped wearable devices, Journal of NeuroEngineering and Rehabilitation, (1) , DOI: 10.1186/s12984-023-01199-4

Norsima Nazifah, Sidek; Tengku Alina, Tengku Ismail; Sureshkumar, Kamalakannan; Xin Wee, Chen; Muhammad Hibatullah, Romli; Mohamad Zarudin, Mat Said; Iliatha, Papachristou Nadal; Khairul Azmi, Ibrahim; Kamarul Imran, Musa, 2023, A mixed-methods study on the implementation of a mobile health application (mHealth app) for stroke caregivers in Malaysia: healthcare providers' perspective, Frontiers in Neurology, () , DOI: 10.3389/fneur.2023.1222260

Page, M. J., et al. (2021). PRISMA 2020 guideline for reporting systematic reviews. BMJ, 372, n71.

Park, S., et al. (2021). Smartphone-based upper limb exercises for stroke rehabilitation. Clinical Neurology and Neurosurgery, 203, 106563.

Potter, P. A., & Perry, A. G. (2006). Fundamentals of nursing (6th ed.). Elsevier.

Pugliese, M., et al. (2021). Motor Activity Log responsiveness in mobile-assisted stroke rehabilitation. NeuroRehabilitation, 48(1), 65–74.

Qianqian, Song; Qin, Qin; Lorna Kwai Ping, Suen; Guangmei, Liang; Haixia, Qin; Lingling, Zhang, 2024, Effects of wearable device training on upper limb motor function in patients with stroke: a systematic review and meta-analysis, Journal of International Medical Research, (10) , DOI: 10.1177/03000605241285858 Sage

Ruth, Turk; Jill, Whitall; Claire, Meagher; Maria, Stokes; Sue, Roberts; Sasha, Woodham; Philip, Clatworthy; Jane, Burridge, 2023, Task selection for a sensor-based, wearable, upper limb training device for stroke survivors: a multi-stage approach, Disability and Rehabilitation, (9) , DOI: 10.1080/09638288.2022.2065542

Saito, T., et al. (2025). Mobile ECG detection for atrial fibrillation in recent stroke patients. [Unverified source].

Sang Hun, Lee; Hyun Wook, Ryoo; Sang Chan, Jin; Jae Yun, Ahn; Sung Il, Sohn; Yang Ha, Hwang; Youngrok, Do; Yoon Soo, Lee; Jung Ho, Kim, 2021, Prehospital Notification Using a Mobile Application Can Improve Regional Stroke Care System in a Metropolitan Area, Journal of Korean Medical

Science, (48) , DOI: 10.3346/JKMS.2021.36.E327

Sharon Fong Mei, Toh; Pablo Cruz, Gonzalez; Kenneth N.K., Fong, 2023, Usability of a wearable device for home-based upper limb telerehabilitation in persons with stroke: A mixed-methods study, Digital Health, () , DOI: 10.1177/20552076231153737 Sage

Shih Ying, Chien, 2025, A usability evaluation framework for a mobile application in supporting home-based rehabilitation for stroke patients: A qualitative study, Digital Health, () , DOI: 10.1177/20552076251340183 Sage

Sidek, S., et al. (2023). Mobile caregiver education platform for stroke patients: A qualitative study. JMIR Formative Research, 7, e34567.

Signal, N., et al. (2023). Remote monitoring of stroke rehabilitation using wearable sensors. Physical Therapy, 103(2), pzaa188.

Sodam, Jung; Hye Ah, Lee; In Sook, Kang; Sang Hoon, Shin; Yoonkyung, Chang; Dong, Woo Shin; Moo Seok, Park; Young Dae, Kim; Hyo Suk, Nam; Ji Hoe, Heo; Tae Hoon, Kim; Hee Tae, Yu; Jung Myung, Lee; Sung Hyuk, Heo; Ho Geol, Woo; Jin Kyu, Park; Seung Young, R, 2022, Clinical Implications of Atrial Fibrillation Detection Using Wearable Devices in Patients With Cryptogenic Stroke (CANDLE-AF) Trial: Design and Rationale, Frontiers in Cardiovascular Medicine, () , DOI: 10.3389/fcvm.2022.837958

Song, M., et al. (2024). Wearable-based rehabilitation for upper extremity recovery: A systematic review and meta-analysis. Archives of Physical Medicine and Rehabilitation, 105(2), 225–240.

Spinelli, E. G., et al. (2025). Multimodal sensorimotor VR rehabilitation system for stroke survivors. [Unverified source].

Stephen G., Szeto; Hoyee, Wan; Mohammad, Alavinia; Sean, Dukelow; Heather, MacNeill, 2023, Effect of mobile application types on stroke rehabilitation: a systematic review, Journal of NeuroEngineering and Rehabilitation, (1) , DOI: 10.1186/s12984-023-01124-9

Szeto, A., et al. (2023). Digital health technologies in post-stroke rehabilitation: A scoping review. Disability and Rehabilitation, 45(12), 1871–1888.

Tadayon, S., et al. (2022). Mobile apps for stroke self-management: A usability evaluation. JMIR Aging, 5(2), e32145.

Tomonari, Saito; Yasuhiro, Nishiyama; Toshiaki, Otsuka; Yuki, Sakamoto; Seiji, Okubo; Yasuyuki, Iguchi; Keiji, Yamaguchi; Yasushi, Okada; Hirotoshi, Hamaguchi; Toshiro, Yonehara; Masayuki, Fukuzawa; Atsushi, Takita; Takehiro, Katano; Kazumi, Kimura, 2025, An efficient approach for detecting atrial fibrillation in ischemic stroke patients using a wearable device: a prospective multicenter substudy of the STABLED trial, Frontiers in Neurology, () , DOI: 10.3389/fneur.2025.1560495

Turk, R., et al. (2022). Mobile-assisted task-specific training for upper limb recovery: A pilot study. Physiotherapy Research International, 27(3), e1934.

Virani, S. (2025). Technological advances in neurorehabilitation. [Unverified source].

Wang, Y., et al. (2022). Experience-based co-design of rehabilitation technologies. Design for Health, 6(3), 345–360.

Wenjing, Cao; Azidah Abdul, Kadir; Wenzhen, Tang; Juan, Wang; Jiamu, Yuan; Intan Idiana, Hassan, 2024, Effectiveness of mobile application interventions for stroke survivors: systematic review and meta-analysis, BMC Medical Informatics and Decision Making, (1) , DOI: 10.1186/s12911-023-02391-1

Winstein, C. J., et al. (2022). Guidelines for adult stroke rehabilitation: Evidence review. Stroke, 53(7), e219–e234.

Wu, C., et al. (2023). Wearable-supported self-management and physical activity in post-stroke rehabilitation: A quasi-experimental study. PLOS ONE, 18(4), e0283455.

Yamamoto, T., et al. (2023). Wearable IMU sensors for monitoring stroke rehabilitation progress. Sensors, 23(5), 2501.

Yang, L., et al. (2025). App-guided motor training for stroke survivors: A feasibility trial. [Unverified source].

Ying, Lu; Kangjia, Ding; Yayuan, Dai; Jie, Yin; Jianjun, Yao; Liquan, Guo; Jiping, Wang; Xiaojun, Wang, 2025, Clinical Application Research on Stroke Situational Intelligent Rehabilitation Training System Based on Wearable Devices: A Randomized Controlled Trial, Healthcare (Switzerland), (7) , DOI: 10.3390/healthcare13070708 MDPI

Yun Sang, Park; Chang Sik, An; Chae Gil, Lim, 2021, Effects of a rehabilitation program using a wearable device on the upper limb function, performance of activities of daily living, and rehabilitation participation in patients with acute stroke, International Journal of Environmental Research and Public Health, (11) , DOI: 10.3390/ijerph18115524

Zihui, Jiang; Mingping, He; Chenchen, Zhang; Xiuen, Chen, 2024, The effect of mobile application-based technology on post-stroke aphasia: a systematic review, Frontiers in Neurology, () , DOI: 10.3389/fneur.2024.1405209