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Mobile health interventions in Parkinson's Disease: A Paradigm shift in patient Care: A review

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Abstract

Introduction: Parkinson's disease (PD) is a progressive neurological condition that affects both motor and non-motor skills. The emergence of mHealth paradigm provides "freshwaters" to Parkinson's disease care by allowing for remote monitoring, self-management, patient education, among others. This study does an evaluation of the available literature on mHealth therapies for Parkinson's disease, focusing on their efficacy, usability, and research gaps.

Results: The review revealed a variety of mHealth therapies for Parkinson's disease, including symptom tracking, medication adherence, and rehabilitation tools. The SpiroGym app increased self-efficacy and exercise adherence, and mKinetikos demonstrated good feasibility for continuous symptom monitoring. Study indicated that virtual reality is helpful in improving mobility and balance. Studies by Memedi et al among others identified limitations in cost-effectiveness, user uptake, and healthcare integration.

Discussion: While mHealth therapies show potential for improving Parkinson's disease management, further large-scale RCTs are needed to evaluate their effectiveness and provide implementation frameworks. Direct comparisons are limited due to the variability of study designs and outcome measures.

Conclusion
mHealth therapies offer novel approaches to PD management, but their inclusion into routine practice necessitates additional study to create standardized recommendations and solve existing constraints. Future research should look into long-term efficacy, user acceptability, and economic feasibility to enable widespread use in clinical settings.

Keywords: M-Health; Digital Health; Neurology; Public Health; Primary Care; Parkinson's Disease

1. Introduction

Parkinson's disease (PD) is essentially a broad spectrum of PND (progressive neurodegenerative disorder) characterized by motor symptoms such as, rigidity, tremor, bradykinesia and other gait abnormalities, alongside a spectrum of non-motor manifestations including cognitive impairment, mood disorders, and autonomic dysfunction significantly affecting DALYs and quality of life. The complexity and chronicity of PD necessitate continuous monitoring and comprehensive management strategies to optimize patient outcomes.(1)

In recent years, m-Health interventions have emerged as promising tools to enhance the management of chronic diseases, including PD especially after the COVID pandemic that highlighted structural and non-structural bottlenecks

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of traditional care and treatment delivery systems(2). These interventions leverage mobile technologies to facilitate remote monitoring, patient education, and self-management support, thereby potentially improving clinical outcomes and quality of life. Technological tools used for the reduction of modifiable risk factors and better symptomatic management could be valuable for patient health and QoL In this context, mobile applications (or mobile apps) have been used extensively to support CNSD patients with the regular monitoring or management of their disease, which is largely possible because of their sensing and communication capabilities and the fact that they are accessible, acceptable, and easily adopted.(3). Despite the proliferation of mHealth applications targeting PD management, the scientific validation of their efficacy remains limited as there is paucity of literature regarding the use of this app in neuro-degenerative disorders and Parkinsons disease per se(2).

The barriers encountered with the use of m-health as an intervention significantly affect the adoption of these technologies. These may be briefly categorized in the following: physical pain/discomfort associated with the regimen, associated non-motor symptoms, poor accessibility of location and infrastructure for interventions, transportation costs and arrangement issues, discomfort in crowded public spaces, and the associated disproportionate financial burden and bottlenecks.(4) The integration of mHealth interventions into PD care pathways holds immense potential for enhancing patient engagement, treatment adherence and compliance and facilitating tailored management approaches. However, further research is imperative to substantiate their clinical benefits and to establish standardized guidelines for their implementation in routine practice as there is current absence of consensus on any guidelines and standard operating procedures for treatment.(5)

2. Materials and methods

A literature review was performed using medical databases like Scopus, MEDLINE, and PubMed to identify recent and relevant studies on mobile health (mHealth) interventions in Parkinson's disease. The search incorporated MeSH terms and free-text keywords related to mHealth, Parkinson's disease, and digital health, focusing on peer-reviewed articles published in the past few years as a particular timeline is not specified. Studies were selected based on the relevancy of the topic, prioritizing randomized controlled trials, systematic reviews, and observational studies assessing the efficacy and feasibility of mHealth interventions. Data extraction captured key study characteristics, interventions, and outcomes, with quality assessment. This review synthesizes current evidence, highlighting gaps and future research directions in digital health for Parkinson's disease management.

3. Results

the findings are given in the following table with information classified into relevant columns.

Table 1: Studies Review of Studies on Mobile Health Interventions for Parkinson's Disease: Advancements and Impact on Patient Care

Author (Year)	Methodology	Findings	Tool Used	Limitations, Research gaps and future directions
Martin Srp et.al. (2025) (6)	Proof-of-concept study, single-group, multicenter, 63 PD patients across four centers; two intervention durations: 1-week (n=35) and 24-week (n=28)	The study found that both the 1-week and 24-week EMST groups had substantial increases in self-efficacy for home exercise programs (SEHEPS), which resulted in more confidence in exercising. The 24-week group showed high adherence	SpiroGym app for monitoring expiratory muscle strength training (EMST)	Lack of control group, small sample size, limited to tertiary PD centers Need for comparative studies to validate the effectiveness of SpiroGym; exploration of long-term sustainability

		rates, suggesting that improved exercise routine adherence is correlated with higher levels of self-efficacy.		
Mevludin memedi et. al. (2024) (7)	In order to find studies on the use of mobile health devices in evaluating the cardinal motor aspects of Parkinson's disease, a literature search was carried out utilising databases such as IEEE Xplore, PubMed, and Scopus. 138 pertinent publications out of 2364 papers published between October and November 2023 were analysed.	The use of mobile health devices (MHDs) for Parkinson's disease monitoring was found to be extremely prevalent among 138 relevant publications in research that examined 2364 papers. Even though MHDs are mostly used to test bradykinesia and gait, many research concentrate on patient outcomes rather than cost-effectiveness, user acceptance, and integration into healthcare processes.	Not specified	• The study identified a gap in the literature because the majority of research focused on patient outcomes while ignoring important elements that are necessary for the long-term management of Parkinson's disease, such as user adoption, cost-effectiveness, and the integration of MHDs into healthcare workflows.
Amani Khardali et. al.(2024) (8)	A systematic review of mHealth interventions for Parkinson's disease was conducted using databases like MEDLINE, EMBASE, Scopus, and Google Scholar up to August 2022. 9 studies have assessed mHealth interventions for PD primarily on tracking moto and non-motor symptoms.	Both patients and healthcare professionals found these interventions acceptable, but acknowledged concerns about technological, individual, and organizational factors affecting acceptance and usability.	Not specified	The review primarily relied on self-reported data and user satisfaction questionnaires, which may be affected by recall bias and the Hawthorne effect, potentially skewing the true perceptions of users. Future research should incorporate a broader range of study designs,

				including qualitative and mixed-methods approaches, to gain deeper insights into user experiences and acceptance of mHealth interventions.
Sigrid Ryeng Alnes et. al. (2023) (9)	The study evaluates the efficacy of a mobile health intervention for people with idiopathic Parkinson's disease (PD) who are at least 40 years old using a single-blinded, two-group RCT. After finishing a 4–5-week multidisciplinary rehabilitation program, participants are selected and randomised to either the intervention group, which receives a six-month mobile health follow-up that focusses on self-management of exercise and nutrition, or the control group, which receives standard care. At baseline, three months later, and six months later, measurements are made.	The RCT focuses on evaluating a 6-month m-health intervention, emphasizing self-management in exercise and nutrition. Recruitment is ongoing, with completion expected in January 2023, and no results are available yet. Data will be analysed using linear mixed models for repeated measurements, and results will adhere to the CONSORT reporting guidelines. The article primarily contributes a detailed protocol of the intervention and study design.	The study measures physical capacity via the 6-minute walk test (6MWT) as the primary outcome, and secondary outcomes include nutritional status, health-related quality of life (HRQOL) using the Parkinson's Disease Questionnaire (PDQ39), physical function, and exercise adherence.	
JuHee Lee et. al. (2024) (10)	The research created a complete symptom management app and assessed its viability and usefulness. The experimental design employed was a single-group repeated measurement. The software was used for six weeks by twenty-two individuals. The app included medication management, games to treat motor symptoms, and nonmotor symptom monitoring.	In addition to conducting one-on-one telephone interviews to get insight into the user's perspective, quantitative results were self-assessed via an online questionnaire. Participants' self-efficacy ($Z = -3.634$, $p < .001$)	Not specified	The preliminary effects on self-efficacy and medication adherence will guide future nursing interventions using mobile health.

		and medication adherence (Z = −3.371, *p* =.001) were both enhanced by the effective self-monitoring experience. Facilitators provided prescription assistance, interesting material, and an easy-to-use interface. Simple forgetfulness and a lack of digital literacy, including not knowing how to operate a cell phone, were obstacles.		
Chun En Yau et. al. (2024) (11)	Medline, Embase, Cochrane CENTRAL, and Clinicaltrials.gov databases were searched until 2 April 2024 and only included randomized controlled trials. Outcomes included changes in UPDRS-III/MDS-UPDRS-III score, stride length, 10-meter walk test (10MWT), timed up-and-go (TUG) test, balance scale scores and quality-of-life (QoL) scores. Results were reported as mean differences (MD) or standardized mean differences (SMD), with 95% credible intervals (95% CrI)	There were 51 RCTs with 2095 subjects. The effectiveness of each intervention was comparable for UPDRS (motor outcome). VR outperformed robotic, exercise, and proprioceptive therapies in terms of improving TUG when compared to control (MD: −4.36, 95% CrI: −8.57, −0.35). Proprioceptive intervention outperformed VR, robotic, and exercise therapies in terms of stride length, surpassing control intervention by a substantial margin (MD: 0.11 m, 95% CrI: 0.03, 0.19). In comparison to the exercise intervention (SMD: 0.75, 95% CrI: 0.12, 1.39), and the control	UPDRS	There are few non-proprioceptive studies that utilize inactive controls. The number of data points that may be combined for each outcome is decreased since included studies with the same intervention do not necessarily employ the same set of outcome measures. Because the included studies' end timepoints and follow-up periods varied, heterogeneity was introduced. It was shown in several research that the effects of the treatments fade over an

		intervention (SMD: 1.42, 95% CrI: 0.06, 2.77), virtual reality considerably increased balance scale scores. The virtual reality intervention outperformed Internet-based therapies and significantly improved QoL ratings when compared to the control intervention (SMD: −0.95, 95% CrI: −1.43, −0.52).		extended period of time, resulting in negligible effect sizes. To examine how the impact magnitude varies over time, further cohort studies can be conducted. Patients were aware of the intervention that they received in most studies, and this could have led them to adopt behaviors (health-related or otherwise) that could influence the relatively subjective measurements of QoL
Beattriz Alves (2024) (12)	This study used a mixed methods technique to gather input, evaluate the usability of the Web Platform and the Mobile App, and determine whether they were acceptable. Descriptive statistics, heatmaps, and correlation matrices were used to analyze quantitative data, which comprised questionnaire answers and System Usability Scale (SUS) ratings. An inductive theme analysis was performed on qualitative data, which included transcripts of semi-structured and thinking-aloud interviews. Twenty physiotherapists (average age: 34.50 ± 10.4) and eight PwPD (average age: 65.75 ± 8.63; mean Hoehn & Yahr: 2.0 (± 0.76)) made up the study's 28 participants.	The thematic analysis of the interviews revealed three primary themes: recommendations (Theme 3), user engagement (Theme 2), and self-management (Theme 1). According to the evaluation of the CA and the Mobile App (mean score: 4.42/5.0 ± 0.79), PwPD appeared to have no trouble navigating this interface. Good usability is indicated by the mean SUS score of 79.50 (±12.40%) with a 95% confidence range between 73.70 and 85.30.	MoveONParkinson	Purposive sampling method may influence the generalizability of results, as participants could have a predisposition towards mHealth solutions, potentially skewing the findings. A limited number of participants may decrease diversity representation and increase the potential for bias from outliers, affecting the generalization of the findings.

Luis Sigcha et al (2023) (13)	7 healthy controls and 21 early-stage Parkinson's disease patients participated in an experimental procedure using Monipar installed in commercially available smartphones and smartwatches. Relevant digital indications (features) were extracted from movement data gathered by the integrated acceleration sensors. The MDS-UPDRS scale was then used to compare these findings with clinical assessments.	The clinical assessments (MDS-UPDRS scale) and features taken from the movement data used to measure resting tremor (i.e., the standard deviation of the time series: $r = 0.772$, $p < 0.001$) and data from the pronation and supination movements (i.e., power in the band of 1–4 Hz: $r = -0.662$, $p < 0.001$) were found to have moderate to strong (significant) correlations.	Monipar, UPDRS	Limitations include the small sample size of healthy controls compared to participants with PD (21 PD and 7 HC).
Özden et al. (2023) (14)	Systematic review and meta-analysis of 5 studies; PEDro scores ranged from 4 to 7 (median: 6)	A systematic review screened 2,175 articles, resulting in 5 eligible studies. Two were included in a meta-analysis. PEDro scores ranged from 4 to 7 (median: 6), indicating good quality but with "some concerns." Mobile app-based interventions improved quality of life and adherence but did not surpass standard treatments for balance (MiniBESTest: ES=0.15, 95% CI: -0.33 to 0.26) or disease severity (UPDRS III: ES=0.86, 95% CI: -0.94 to 2.46).	MiniBESTest and UPDRS III	Limited number of studies and low sample sizes; heterogeneity among interventions
Ellis et al. (2019)	This was a 12-month comparative-effectiveness, randomised	Both groups increased daily	Not Specified	Small sample size

(15)	controlled trial that was single-blind (assessor). Over the course of a year, an active control condition (walking with a pedometer and exercise only) was contrasted with a mHealth-mediated exercise program (walking with a pedometer + participation in scheduled exercise supported by a mobile health application). 51 people with mild-to-moderately severe (Hoehn and Yahr stages 1–3) idiopathic Parkinson's disease participated in a community setting. Using a step activity monitor, daily steps and moderate-intensity minutes were recorded for one week at baseline and again at one year. The 6-Minute Walk Test, the mobility component of the Parkinson Disease Questionnaire 39, safety, acceptability, and adherence were examples of secondary outcomes.	steps, moderate-intensity minutes, and 6-Minute Walk Test, with no statistically significant between-group differences observed. In the less active subgroup, changes in daily steps and moderate-intensity minutes were clinically meaningful. An improvement in the Parkinson Disease Questionnaire 39 mobility score favored mHealth in the overall comparison and was statistically and clinically meaningful in the less active subgroup		
Raquel Bouça-Machado(2021) (16)	Patients with a clinical diagnosis of PD, who were able to walk unassisted, and had an Android smartphone were included. Patients were asked to answer a daily survey, to perform three weekly active tests, and to perform a monthly in-person clinical assessment. Feasibility and usability were explored as primary and secondary outcomes. An exploratory analysis was performed to investigate the correlation between data from the mKinetikos app and clinical assessments.	The study demonstrated that the mKinetikos system is feasible for continuous and objective real-life measures of health and functional mobility in Parkinson's disease patients, with 85% of participants completing the study and 94.1% showing medium-to-high compliance with the system. Additionally, a strong correlation was found between mKinetikos metrics and clinical assessments, suggesting its potential utility in	mKinetikos system	Small sample size. Interruption of monthly in-person assessment between months 4 and 6, due to the COVID-19 pandemic.

		supporting clinical decisions. Despite a 6-point drop in the total score of the Post-Study System Usability Questionnaire, participants maintained a high level of satisfaction and compliance throughout the 7-month study period. The analysis indicated that users complied more with certain active tests, such as fingertapping and balance tests, compared to walk tests, which may require more effort and be challenging for some patients to perform at home.		

4. Conclusion

Finally, this review emphasizes the emerging importance of mobile health (mHealth) interventions in Parkinson's disease care, which provide potential opportunities for remote monitoring, symptom management, and patient engagement. While previous research shows the potential benefits of these digital health solutions, issues like as technology accessibility, user adherence, and the need for standardized clinical recommendations persist. More high-quality research, particularly large-scale randomized controlled trials, is required to establish their long-term efficacy and implementation into standard clinical practice. Expanding the evidence base is critical for optimizing mHealth techniques to improve patient outcomes and healthcare delivery in Parkinson's disease management.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

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