Factors affecting user acceptance of MHealth interventions in Parkinson’s Disease: A systematic literature review.

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Abstract

Background: The widespread development of digital health technologies and mHealth apps has the potential to overcome some of the challenges of managing Parkinson's disease in practice. The majority of research in this area typically focuses on assessing the quantitative measures rather than the acceptance and perspectives of the patients.

Objective: A systematic review was conducted to identify studies exploring the barriers and facilitators of using mHealth apps to support the management of Parkinson's disease in practice and identify the factors that might affect the acceptance of these interventions from patients' and healthcare professionals' perspectives.

Methods: We searched MEDLINE, EMBASE, Scopus, and Google Scholar databases up to August 2022. We used search terms related to ‘mHealth intervention,’ ‘Parkinson’s disease, and ‘acceptability.’ Study participants were either people with Parkinson's (PwP) or healthcare professionals (HCPs) for PwP. Interventions had to be delivered by a smartphone or tablet iPad and being implemented for use in clinical practice. Data was analysed thematically and organized by common themes observed across studies.

Results: The initial literature search yielded 1,469 articles, of which 9 met the inclusion criteria included in this review. All interventions aimed to assess and track motor symptoms of Parkinson’s, 3 out 9 of the interventions had features to assess non-motor symptoms, and 4 out of 9 had a feature to monitor medication intake and adherence. Overall, mHealth interventions appeared to be acceptable to both PwP and HCPs, as they recognized their potential benefits in improving healthcare services with a few highlighted concerns. Several factors were identified that might be associated with mHealth acceptance and usability, including technological, individual, and organizational factors.

Conclusions: The review reinforces the reflect on end user needs (both PwP and HCPs) and requirements throughout the design process of the mHealth app for Parkinson's. The early involvement of end-users might lead to a more accurate understanding of needs and requirements when designing a mHealth intervention for PD, and ultimately influence the future acceptability and uptake of the mHealth intervention.

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Keywords: Parkinson's disease, mHealth, acceptance, disease management.

Introduction

Parkinson’s disease (PD) is a heterogeneous, progressive neurodegenerative disorder that is best identified by its cardinal motor symptoms of tremor, rigidity, postural instability, and bradykinesia (1). In addition people with Parkinson’s (PwP) experience a host of non-motor symptoms including sleep disturbances, anxiety, constipation, and depression, which significantly impact on the quality of life of (2).

Early detection/diagnosis, monitoring and management of PD is key for maintaining good quality of life, but each has its challenges (3). This has stimulated the search for digital solutions, including apps and wearable sensors with cloud computing to facilitate data storage ultimately aiming to improve the healthcare provided to PwP (3,4). MHealth is defined by the WHO as ‘medical and public health practice supported by mobile devices, such as mobile phones, patient monitoring devices, personal digital assistants, and other wireless devices’ (5). Several mHealth app interventions have been developed for the detection and management of PD and have the potential to monitor and track PD symptoms, transmit data to healthcare professionals (HCPs), and promote self-management of the disease (6,7) ultiamtely leading to improved care.

Several studies have rigorously evaluated the feasibility, effectiveness, and usability of mHealth interventions in PD (8–14). Most have placed emphasis on quantitative measures to evaluate the utility of these interventions, such as rates of adoption and enrolment, feasibility and clinical outcomes, and have largely excluded the user perspectives (PwP and/or HCPs). The adoption and acceptance of mHealth in PD is still at an early stage, which, given that mHealth interventions for PD will not be of any value or benefit unless accepted and adopted by their target users, means further investigation into this is needed (4,12). Most mHealth research did not capture the complexity of PD to satisfy the diagnostic needs of HCPs as well as the therapeutic needs of PwP (3). Reasons for this include mHealth research failing to capture the demographic and socioeconomic data of target users (e.g., age and digital literacy skills), mHealth tools not being utilised as anticipated in clinical settings (have limited clinical application), and insufficient engagement and acceptance of stakeholders (PwP, carers of PwP, HCPs, and healthcare regulators) (3,4,12)·. This final component is key, and the early recognition of the user’s perceptions, attitude, and experience of mHealth app interventions is essential to understand the factors that might impact its future acceptability and usability.

Previously, technological, social, and financial factors were found to enhance the acceptability and usability of mHealth interventions by PwP in non-clinical settings (15). A focus on clinical settings is timely and commonalities and new factors identified across different studies performed to date may inform how the future mHealth interventions for PD will be designed based on the perceptions of users, and factors that might impact the acceptability of these interventions. We performed a systematic review of the existing literature that addresses the perceptions of users and factors that impact the acceptability of mHealth interventions for PwP. The analysed interventions aim to support PwP during clinical encounters in relation to disease and medicine management. This review could contribute to the development and design of a more acceptable mHealth intervention for PwP.

Methods

The review was performed according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines (16). The review was conducted by one researcher (AK), with findings reviewed and conclusions validated by the rest of the research team (LH and EL) in order to reduce potential bias. At all stages of this review, including the search, data extraction, data syntheses, and quality appraisal, 20% of studies were double-checked for consistency. All inconsistencies were resolved through discussion.

Search strategies

The search (fig 1) was developed according to the participants, intervention, and context (PICo) framework (17). Using the PICo framework to develop the review research question facilitates the search strategy by identifying the main concepts of the research question that need to be answered

(18). The search was limited to Parkinson’s disease with no restrictions on the study design: both qualitative and quantitative studies were included.

The following search strategy was used:

1. Population (P): studies focusing on PwP and/or HCPs as target users.
2. Intervention (I): mHealth use (smartphone/tablet/iPad) for clinical management.
3. Context (Co): users’ perceptions of mHealth technology acceptance or use.

A systematic search of titles and abstracts was conducted in MEDLINE, EMBASE, Scopus, and other sources, such as Google Scholar, in August 2022. Search terms focused on the three concepts of the review question: (‘mHealth’, ‘smart devices (smartphone/tablet)’), ‘Parkinson’s disease’, and ‘acceptability’ (Multimedia Appendix 1). Alternate terms relating to the same concepts were combined using the Boolean operator ‘OR’, and different concepts were combined using ‘AND’.

Duplicates were removed, and a preliminary screening of titles and abstracts of citations was conducted for appropriate studies to include in this review based on relevance to the search terms. Full-text articles were then reviewed against the inclusion/exclusion criteria. Additionally, references of included studies were searched manually, but no additional studies were identified.

Eligibility criteria

The study screening was conducted by one researcher (AK) following a four-stage process of identification, screening, eligibility, and inclusion (16) (Figure 1). The first reference related to the development of a mHealth app interventions for PD was published in 2011, so 2010 was selected as the start of the search window up to August 2022. Inclusion and exclusion criteria are set out in Table 1 and outcomes in figure 1.

Table 1: Inclusion and exclusion criteria.

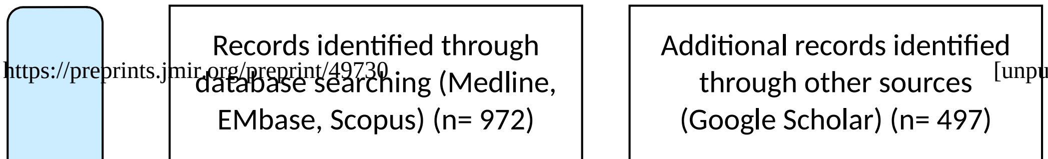
Inclusion Criteria	Exclusion Criteria
Participants were PwP (any disease stage) and/or HCPs for PwP.	Studies that did not include participants with PD.
The intervention was a mHealth app intervention (smartphone/ tablet) by itself or as part of a system.	Insufficient information on the mHealth intervention/data type/users' perspective to be adequately reviewed.
Intervention outcomes that included the user's perspective (i.e., users' satisfaction, users' feedback, acceptability, or usability) included: a) PD medication adherence or management, disease management, and promotion of self-management. b) Type of data collected via intervention: Objective or Subjective. c) Intervention with clinical value in PD clinical practice that may support patients during clinical consultation.	mHealth interventions outside clinical practice (e.g., in home settings) only or were a method of data collection only and were not interactive (e.g., they did not support patients' clinical consultations).
Qualitative, quantitative, or mixed-methods.	Evaluations of the efficacy of an mHealth intervention without determination of user perceptions.
	Studies not written in English.

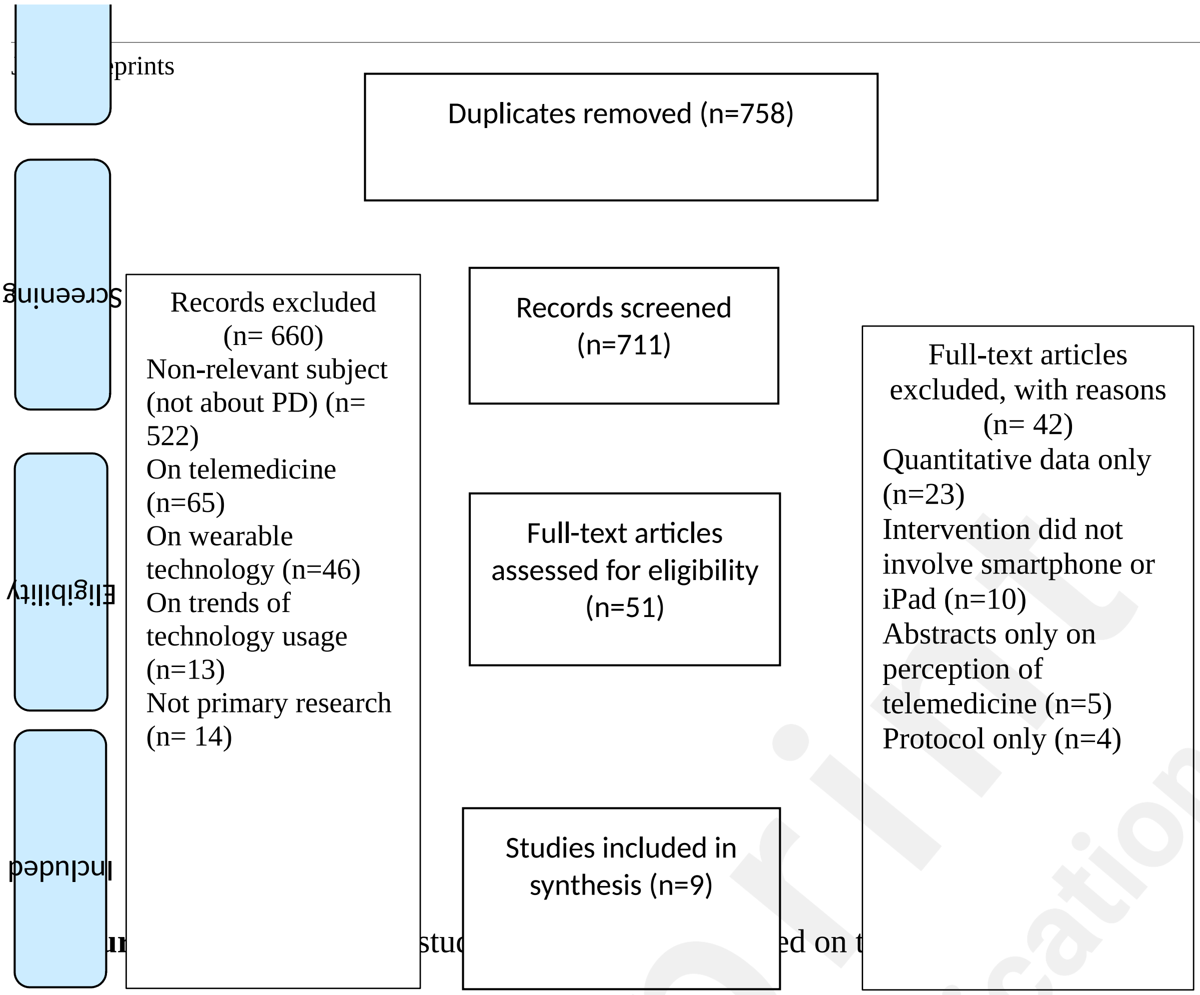
Data Extraction and Synthesis

Data were collected and extracted from each study under the following headings: research identification (authors, year of publication, country of study sample, study focus, study population), intervention (intervention type, mHealth type, feature of the intervention), research methods (study design, method, outcome measures, length of intervention use), and main findings. A qualitative approach (content analysis) (19) was performed to synthesise the results in relation to the motivators for, and concerns about, mHealth intervention use from the perspectives of PwP and/or their HCPs.

Quality Appraisal

The methodological quality of the quantitative research studies was assessed using the Effective Public Health Practice Project (EPHPP) checklist (20). Studies were rated 'good' (if all sections were rated strong), 'moderate' (if one section was rated weak), and 'poor' (if two or more sections were rated weak); however, the final rating of the study was based on the authors' judgement (21). The Critical Appraisal Skills Programme (CASP) checklist was used for the qualitative research studies (22,23). The rating of the 10 sections of the CASP tool was considered as follows: 'good' (if all questions were answered Yes), 'moderate' (if questions between 1–5 were answered No) and 'poor' (if there is > 5 questions were answered No). This review focused on the findings of studies that were appraised as 'good' or 'moderate' quality (24). However, studies that were appraised as 'poor' quality were included and referenced where appropriate.





Results and discussion

A total of 9 studies met the inclusion criteria, Table 2 describes the relevant characteristics of the articles included in this rapid review.

Study characteristics

There were considerable differences in the methodology and sample size of the included studies. The number of participants (PwP) ranged from n = 7 (25) to n = 204 (26). All studies included PwP who were in their early stages and excluded those in advanced stages (Hoehn and Yahr scale (H&Y) 4 and 5), PwP with dementia, and those with severe physical disability. Additionally, two of these studies included the views of HCPs (25,27). Studies recruited participants from the USA (27,28), Spain, Italy, Ireland, and Israel (29), Portugal, Germany, and Norway (30), Australia (31), Japan (11), Sweden (25), China (26), and the UK (32).

Three were feasibility studies, the others included an RCT, a randomised crossover study, a prospective pilot study, a validation observational study, a surveillance study, and a qualitative study (focus group discussion then questionnaire) (see Table 1). Four studies specified the length of time that participants were required to use the mHealth app interventions, ranging from 3 to 180 days, averaging 75 days, the mode being 3 days.

Two studies reported user opinions and attitudes as their primary aim (25,26) whilst this was a secondary aim of the other 7 studies. The majority collected the perceptions of the user (PwP), one collected data only from neurologists (27), and one from both PwP and HCPs, which included neurologists, parkinson's disease nurse specialist (PDNS), and physiotherapists (25). Methods applied for data collection included user satisfaction and/or intervention ease of use questionnaire (7 studies) and focus groups (2 studies). Eight of the nine studies evaluated the user perceptions after the development of the interventions, while one evaluated the user perceptions during the development stage of the intervention, which resulted in intervention updates and improvement in the acceptance and usability of the intervention (27).

Interventions were on a smartphone (26,31,32), or tablet (11,28), and one on both forms of device (25). A further three included wearable sensors (27,29,30). Almost all interventions included features to assess and track the motor and non-motor symptoms (NMS) of PD (27,30,32). Monitoring medication intake and adherence was included in 4 apps (11,27,29,32). Two interventions were for use in clinical settings (25,28), while six were for home-based settings which enabled users to generate reports for their HCPs (11,27,29–32).

Almost all of the included studies in this review evaluated the users' perceptions of their intervention as a secondary outcome through a follow-up questionnaire that was conducted at the end of the study (e.g., system usability scale (33) and IBM post-study usability scale (34)). Of note was the insufficient reporting of the findings from the user perceptions questionnaire in eight of the included studies (11,26–32).

Table 1: Detailed summary of included studies

Author (year) and country	Study focus	Study population	Intervention	Methods	Outcome measure	Main findings
Ferreira et al. (2015)	To explore feasibility and usability of SENSE-PARK system that aimed to collect PD symptoms including gait, hypokinesia, dyskinesia, tremors, sleep, and cognitive symptoms.	PwP (n = 11) **Inclusion criteria** 40–85-year-old PwP Stage 1 to 2 on H&Y scale Experience or interest in using digital devices. **Exclusion criteria** Illiteracy Inability to handle the device for any reason	SENSE-PARK system 3 Wearable sensors, Wii Balance Board, software, and smartphone app **Intervention focus** Motor symptoms (gait, hypokinesia, dyskinesia, tremors) NMSs (sleep and cognition)	Multicentre, feasibility and usability study, open-label study, two period study (1) with no feedback to the participants then 2) participants provided with the feedback about their performance), Qualitative (interview) Descriptive analysis **Study Period** 12 weeks	Frequency of dropouts, willingness to use system, users' satisfaction. Surveys on usability	Participants reported good acceptance levels and were willing to use the system even after the study ended. All participants completed the study. Providing feedback to the participants motivated them to continue using it. Additionally, participants found the system useful and simple to use, especially the users' interface of the system and the instructions provided to complete the task. Participant liked that the system helped to monitor changes in their condition.
Lee et al. (2016)	To validate a smartphone app against the gold standard tool in the clinical practice (MD-UPDRS-III), and to assess the practicality, compliance, and user	PwP (n = 103) **Inclusion criteria** Patient diagnosed with PD. **Exclusion criteria** Stage 4 and 5 H&Y PwP. Patients with physical or cognitive impairments	Smartphone app included four tests: Timed tapping test, rapid alternating movements, tremor tracker, and cognitive interference test. **Intervention**	Quantitative, validation and observational study, descriptive statistics, Pearson's or Spearman's correlation **Study period** 18 months	MD-UPDRS-III, two target tapping test, Montreal cognitive assessment, Victoria Stroop test. Surveys on compliance and user satisfaction	A strong correlation reported between data obtained from the app and MD-UPDRS (P<0.001). 96% had positive experiences of participation, 4 dropped out because of the difficulties using smartphones, 40% (n = 36) of participants experienced difficulties with apps. 83% felt comfortable using the

Author (year) and country	Study focus	Study population	Intervention	Methods	Outcome measure	Main findings
	satisfaction of the app.		**focus** Motor symptoms (hand dexterity)			app and mobile technology. 8% of participants perceived cost of mobile apps a limitation for future use.
Lalshminarayana et al. (2017)	The impact of a smartphone app to improve medication adherence, promote patient self-management, and quality of clinical consultation.	PwP (n = 158) **Inclusion criteria** Idiopathic PD patient older than 21 years Prescribed one or more Parkinson's medications and had a stable medication regime. Access to a smartphone and/or tablet or internet at home **Exclusion criteria** People diagnosed with dementia, cognitive impairment, or psychiatric illness	Parkinson's Tracker App included: 10 self-monitoring measures (e.g., sleep, exercise, and mood). Medication reminder Optional data reports to aid clinical consultation. Games to assess physical activities (finger tapping test) Information about PD **Intervention focus** Motor symptoms NMSs (cognition, mood, and sleep) Medication management	Quantitative, Multicentre, RCTs, 7 centres across UK (England and Scotland). **Study period** 16 weeks	MMAS-8, PDQ-39, patient-centred questionnaire for PD, NMSQ, hospital anxiety and depression scale Questionnaire and interviews to assess acceptability and ease of use of the app.	App significantly improved medication adherence ($p = 0.0304$), and patient's perceptions of the quality of clinical consultation ($p = 0.011$). Benefits of the app recognised, such as sharing valuable information with HCPs and participating in decision making during consultation. Additionally, the simple design of the app's user interface and user experience with technology use improved the acceptability and usability of the app.
Mitsi et al. (2017)	To evaluate the	PwP (n = 19)	iMotor app	Single centre,	Tapping	Significant difference in

Author (year) and country	Study focus	Study population	Intervention	Methods	Outcome measure	Main findings
	feasibility, potential benefit, and user satisfaction of using a tablet-based app to assess motor function.	Healthy volunteers (n = 17) **Inclusion criteria** Healthy people or PwP 17–75 years old H&Y stages I–IV **Exclusion criteria** Atypical Parkinsonism Other CNS disorders Physical inability to perform tasks on app	(tablet-based app) including 3 different tapping tests and a report generator section (summarising tests results) **Intervention focus** Motor - hand movement)	Cross-sectional, feasibility and exploratory study **Study Period** NA	variables (total number of taps, velocity, interval, duration, and accuracy of tap), and Questionnaire on users' satisfaction	almost all tapping variables were reported on PwP compared to healthy volunteers, except accuracy. A high rate of user satisfaction was reported by participants; 79% of participants found the app very easy to use, 63% were very willing to continue using the app, and all participants reported that they would use the app if their HCPs recommended it.
Bayés et al. (2018)	To assess the accuracy of the REMPARK system in recognising the motor fluctuations during ON and OFF states	PwP (n = 33) **Inclusion Criteria** 50–80-year-old PD patients with severe motor conditions (freezing of gait and/or dyskinesia) **Exclusion criteria** dementia	REMPARK system included: Wearable sensors (to monitor motor fluctuations) Smartphone app (inc medication management, visualisation of the detected symptoms, specific questionnaire and scales sent to HCPs) **Intervention focus**	Multicentre, A prospective, pilot study in home of PwP (Spain, Italy, Israel, and Ireland). **Study period** 5 days	Recording motor status in diary while using the system, UPDRS-III Surveys on usability and user satisfaction	The system is able to detect the motor fluctuations, demonstrated 97% (sensitivity) in detecting OFF state and 88% specificity in detecting ON state. Participants found the system acceptable and were satisfied. User-friendly systems with high security levels were considered by participants.

Author (year) and country	Study focus	Study population	Intervention	Methods	Outcome measure	Main findings
			Motor - on-off fluctuations			
Sekimoto et al. (2019)	To assess the feasibility and safety of using a tablet device video-based telemedicine systems as part of patient care in PD To assess user satisfaction with the use of telemedicine system	PwP (n = 10) **Inclusion criteria** 20–75 years old PD patients Access to Wi-Fi at home **Exclusion criteria** Not mentioned	Video-based telemedicine call on FaceTime app on a tablet. Telemedicine to supplement clinical visits. **Intervention focus:** Motor examination Medication review	Randomised, crossover, pilot study. Comparing the regular visit every 2 months with an intermediate video call to a control period regular visit only **Study period** 12 months	PDQ-39, H&Y staging scale, UPDRS, Beck depression inventory. Surveys on user satisfaction	No significant difference was reported in outcomes measures between two periods (P > 0.05). Participants found the tablet-based telemedicine system easy to use, useful to reduce anxiety level regarding medication and disease progression. Participants also agreed that the system made it easier to communicate with their HCPs.
Elm et al. (2019)	To evaluate feasibility and usability of mHealth app-derived data to inform clinical decision making.	PwP (n = 51) HCPs (n = 14 neurologists) **Inclusion criteria** 18 years and older PwP. Stage 1 to 3 on H&Y scale. Access to WiFi at home **Exclusion criteria** cognitive impairment	Smartwatch + Fox Wearable companion mobile app (To collect e-PROMs and medication reminders) **Intervention focus** Motor - tremor, rigidity, dyskinesia, gait problem, bradykinesia NMSs (constipation,	Feasibility and observational, exploratory study focus group **Study Period** 6 months	Retention of PwP, number of hours of data streamed, and HCPs' feedback	39/51 participants completed the study. The reasons for drop-out were fatigue, and system specific and technical issues. HCPs perceived that the medication compliance and severity of e-PROMs were the most beneficial components of the system that support clinical care.

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			voice problems) Medication management			
Wannheden and Revenäs., (2020)	To explore the expectation and desired of PwP and HCPs' about features of e-Health to support co-care in PD practice	**Stage I**: PwP (n = 7), HCPs (n = 9 (4 neurologists, 3 PDNS, 2 physiotherapists)) **Stage II**: PwP (n = 31), Carers for PwP (n = 6)	**The co-care prototype app (smartphone or tablet)** included: Pre-visit form, Patient self-tracking, graphical overview, clinical decision support, self-care recommendations, and asynchronous communication **Intervention focus** None mentioned	Qualitative, workshop, focus group discussion, thematic analysis, Descriptive analysis. **Study period** 4 half-day workshops	**Stage I:** important features of the app porotype and its impact on care **Stage II:** Survey on usability and acceptance of the prototype	Co-care design prototype app perceived to have potential to improve quality of care - effectiveness, timeliness, and patient-centredness. Patients' digital literacy, acceptance, and extra workload on HCPs were the main constraints. 31 (84%) of participant benefits of the app and all features of the prototype app were rated as important or very important, especially features related to communication, graphical overview, or summary of the inputted data.
Hu et al. (2020)	To explore acceptability and practicality of a smartphone app for PD self-management among PwP.	PwP (n = 204) **Inclusion criteria** Diagnosed with PD Physically and cognitively able to complete the questionnaire. **Exclusion criteria** Not mentioned	PD self-management smartphone app **Intervention focus** None mentioned	Quantitative, surveillance study Descriptive statistics, Chi-squared test	Attitude toward mHealth use and PD self-management app	Participants had positive attitudes toward the intervention, 82.84% reported willingness to use self-management app. Cost-free app reportedly easy to use with a medication reminder system and help to manage their PD condition is preferable. PD education section, ability to communicate with HCPs,

Author (year) and country	Study focus	Study population	Intervention	Methods	Outcome measure	Main findings
						and ability to record symptoms were the most interesting features reported by participants (80.88%, 77.46%, and 65.69% respectively).

Themes

Findings from the qualitative content analysis were categorised into two main themes: (1) motivators to accept and use a mHealth intervention, which included the subthemes of perceived usefulness, perceived usability, interactivity, design, and users' engagement, and (2) barriers to acceptance and use, including the subthemes of trust, long-term use, PD-related status, financial factors, and workload.

Theme 1: Motivators

1. Perceived usefulness

The mHealth interventions were largely perceived as useful by PwP. In an observational study 93% of PwP reported the usefulness of the mHealth app, designed to support the patients' physical examination during clinical encounters with their HCPs (by giving indications of motor symptoms progress) (31). Similarly participants in an RCT found the PD Tracker app significantly improved collaboration and patient involvement in the decision-making process during clinical encounters (32). this was echoed in a crossover RCT , with 90% of participants indicating that an iPad app based tool had the potential to improve communication between PwP and their HCPs (11). Benefits also included enable tracking of the impact of PD medication and improving medication adherence (25). Questionnaire findings from a cross-sectional study showed that 204 PwP reported their willingness to use mHealth apps for PD if the apps were found to have the potential to improve the management of PD (69%, 141/204) and communication with HCPs (74 %, 151/204), facilitate the findings of PD-related information (61%, 124/204), reduce the psychological burden of PD (78 %, 160/204), and help HCPs to track the impact of PD medications and make changes based on that (71%, 145/204) (26).

2. Perceived usability (ease of use)

Six studies (11,26,28–31) discussed the usability of smart device app interventions focusing on: ease of use (11,26,28) and user-friendliness (29,30). Both concepts serve a practical purpose, which is simplicity and lack of effort required for the intervention system. Several studies found their device easy to use (11,26,28). However this was not consistent across all apps which actually led to 4 PwP dropping out at early in the study (31). The reasons for the reported difficulties were attributed to NMSs of PD, such as poor hand dexterity (50%), fear of new technology use (33%), poor vision (11%) and reduced clarity of thoughts (31%).

3. Training/technical support

Where technical support was offered it provided through personalised contact (27,29) or providing users with training to improve their performance and deal with troubleshooting themselves (28,30,31). One study reported that training significantly improved the comfort of using the device (31).

4. Interactivity

The ability to generate feedback summaries of user performance, progress reports and provide access to the collected data were valued by users. Three studies (25,27,32) had this feature although limited data were provided to follow this through to the impact of this on the clinical encounter.

Three studies showed the importance of integrating the mHealth intervention with the electronic health records (EHRs) indicated by both patients and HCPs (25,27,29). For example, in a prospective pilot study, PwP were requested to send their collected data from the intervention system to a specific server in order to allow HCPs to act on it (29). Similarly, in another study, the mHealth intervention (which included four sections as follows: medication intake, patients' diaries (e-PROMS), and two sections that were related to hourly symptoms and daily displays) was integrated with the patients' database in order to support the clinical practice (27). The information related to NMSs (constipation), the medication intake section, and the e-PROMs diary section were the most valued and beneficial sections in supporting and informing clinical practice according to HCPs (neurologists) (88%, 85%, and 85% respectively) (33).

5. **Design**

Two studies discussed the need for user friendly interfaces and desired functionality (25,26). In a China based surveillance study, PwP rated the most important features and contents as: PD education section (81%), features that enable communication with HCPs (78%), recording of PD symptoms (66%), provision of PD-related information (60%), and medication recommendations (55%) (26). Similarly, a qualitative study suggested key features were graphical display of the collected data, general information about PD (symptoms, treatment, and possible ongoing research), and a feature for users to flag symptoms to support clinical encounters and requests for recommendations regarding medications and activities (25).

6. **User engagement**

End user engagement was found to be highly informative in the early stages of development to improve acceptance and usability of the intervention (25,27). Wannheden and Revenäs study involved both HCPs and PwP in guiding the design and development of their prototype app (Mini Fair app) to support the concept of co-care in PD. This the desired functionality by both HCPs and PwP including a pre-visit form for PwP, graphical overview of the data, option to flag or request advice, and option for direct communication. Subsequently, 84% of PwP liked the app and perceived the value of the prototype app; they also rated the functionality of the app as either important or very important (86% vs 97%) (25). A feasibility study reported that the involvement of neurologists resulted in improvement of their intervention (e.g., addition of separate display for each section within the intervention and addition of markers for medication intake across e-PROMs section). Subsequently, this improved the usability of the intervention system to support clinical practice (27).

Theme 2: Barriers

1. **Trust**

Trust factors, such as perceived privacy and security and their impact on the user intention to accept and use it (26,29). In Bayés et al study, security was reported with the highest score on the QUEST-questionnaire (35), which is used to assess satisfaction with wearing the sensors and the potential concerns about adverse events (29). Hu et al study, reported a majority of participants willing to use a smart device intervention if they felt that their privacy was protected (26).

2. **Long-term use of the intervention.**

High attrition rates were reported by two longer term studies (27,32). No specific measures were used in these studies to determine the reasons behind the discontinuation of the intervention use, however in these studies the PwP were asked to stream data from a wearable sensor then report it using an app. High task load could increase the cognitive burden on users, and tasks may not have met the participant needs at that time.

3. **PD-related health status**

Surprisingly few studies (25,31) detailed user concerns about the impact of their PD symptoms (such as physical and cognitive ability) on the usability of the mHealth intervention. Lee et al study reported 40% (36/91) of PwP experiencing difficulty using a smartphone app due to poor hand dexterity (18/36), poor vision (4/36), and decreased clarity of thoughts (11/36) (31). Fatigue was also noted as a symptom of concern that would impact use (25). Whilst HCPs noted that symptoms of advanced disease and PD medication-related symptoms, such as hallucination and impulse control issues, would negatively impact PwP ability to use the intervention in an effective manner (31). The importance of this is highlighted by Li and Chang study, users avoiding tasks that required either cognitive or fine motor skills (12). In addition to technical issues, symptoms such as fatigue and cognitive impairment could explain the high attrition rates in studies that involve multiple elements, failing to account for the specific accommodations required for PwP (29,35). Detailed understanding of this lacking though, as there is a tendency to exclude individuals with these characteristics from studies at the outset.

4. Financial factors

The cost of the mHealth app intervention was reported as a potential concern for acceptance and use (26,31). Hu et al study, 136/204 of the PwP showed interest in using an mHealth app intervention if no financial outlay was required. In a similar vein, 7 out of 36 PwP who expressed concerns that the cost of the mHealth app intervention would impact their future intention to use it (26). Interestingly, a quarter of PwP were willing to purchase a mobile device in order to use an mHealth app in the future (31).

5. Workload

In one study (25), concerns regarding the additional workload for HCPs when using a smart device app intervention were reported from both HCPs themselves and PwP. Poor integration risks increasing the administrative workload for HCPs and doubling their documentation burden. Overuse of the intervention to report multiple issues, could also increase HCP workload, concerns which would need to be countenanced. Therefore, adequate integration of mHealth interventions within routine care is essential to improve acceptance and usability. It would be essential to explain the purpose behind the use of intervention and clarify the roles of each member of the clinical staff in order for them to make essential adjustments to their new responsibilities and ways of working. This result is in line with the study by Jacob et al, in which workload factors were among the organisational factors that most impacted HCPs' willingness to accept and use mHealth (29).

Principle findings:

Consistent with previous studies, technological and organisational factors were critical to the success of the apps and heavily influenced user perceptions (15). Learnability and familiarity increased usage, the more frequently end users utilised the mHealth app, the more understandable and operable it became, the more likely they were to continue using the app (31,32). However this was further impacted by the availability of technical support, the provision of which improved user confidence and compliance (27,31). As seen in apps for the management of obesity, technical support and training offered great value in improving usability (15,37). Whilst there are benefits to engaging with the apps, the sustained requirement for support to achieve that stable, integral level of usage needs to be considered at implementation.

In terms of design features, interface, content, and user-friendly elements have been identified as important influencing factors in several studies (25–27,30–32). The priority being not just ease of use but that by keeping it simple and clear the cognitive load is manageable, particularly relevant in Parkinson's where cognition might be impaired (27,30,32). Importantly there is limited insight into these issues as trial exclusion criteria have excluded those with specific cognitive impairment. Key content included an education section about PD, the capability to record and flag the most concerning symptoms to HCPs, and features to aid medication intake and adherence (25–27,30,32). Patients value the usability and visualisation of their own data serving the dual purpose of aiding the clinical encounter and maintaining user motivation to use and engage with it (25–27). This finding is supported by several previous studies that highlighted the significant impact of user-friendly design on stimulating users' acceptance and usability of interventions (15,36,38).

The successful integration of mHealth with clinical practice and a sharing of information with the patient were both deemed essential for successful adoption by HCPs but is also similarly highly valued by the PwP users mirroring findings from previous reviews (40,41). Benefits included enhancing the quality of patient care, improvement of disease control, and the ability to personalise treatment plans whilst minimising the impact on HCP workload (25,27,29). Features that supported medication adherence (alert users about medication use) and flagging symptoms for both PwP and HCPs were also valued (25,30,32). This aligns with the International Parkinson and Movement Disorders Society Task Force on Technology, which emphasised the need to develop an intervention that can be easily integrated into PD clinical practice to facilitate its adoption and better inform clinical practice (3).

Privacy and data security played an essential role in acceptability (42–45), yet only two of nine studies highlighted the importance of and relationship between privacy and security variables and willingness to use mHealth interventions (26,29). Users may be more reluctant to use an mHealth intervention if they perceive that it invades their privacy (46) although it is possible that this will evolve with time as data sharing becomes more part of everyday life. Spann and Stewart reported that there was a thin line between mHealth apps collecting enough data to serve their purpose, and becoming intrusive (e.g., feeling being watched or collecting non-medical data) (44). In contrast though Peek et al study suggested that privacy concerns were not a significant issue, as participants reported their willingness to relinquish some of their privacy if the mHealth app would be beneficial to them (42). Therefore, future researchers and developers should examine and evaluate users trust (privacy and security of the data), address their needs against the cons of mHealth interventions, and capitalise on the influence of potential facilitators, such as perceived usefulness, to promote mHealth acceptance and use.

According to the Technology Acceptance Model and other studies, attitudes towards the tech are impacted by two main factors: perceived usefulness and perceived ease of use (44,47-48). People with Parkinson’s are receptive to the idea of using the mHealth app, assessed as user satisfaction, preference, and level of comfort with the tools (11,26,28–31). Whilst perceived, or experienced usefulness depends on understanding and recognising its benefits, to improve communication with HCPs, reduce physiological burden, improve management of PD and support decision-making processes, allow individual adjustment of treatment, and empower PwP (11,25,26,29,31,32). Ease of use in reality equates here to being user friendly and intuitive, including those unfamiliar with technology. The importance of ease of use was also emphasised in previous reviews by Spann and Stewart and Kaium et al studies.

Social environment can also be influential; motivation or endorsement by key figures within their own social environment, for example, their HCPs may be critical to uptake (49). Recommendations by reliable people, such as HCPs, may foster acceptance and usability of the intervention (28), which could be a reflection of the trust that PwP tend to put on their HCPs. Therefore, active promotion of an intervention and its impact on users’ outcomes may encourage their use.

According to the Person-Based Approach the early involvement of end users during the development stages is crucial for user acceptance of technology (50). The data in the current review showed that involving both PwP and HCPs at the early development stage in the Wannheden and Revenäs study facilitated the development of the intervention (mini fair prototype app) to support the co-care approach in PD clinical practice (25). Therefore, future research should consider engaging target users when designing the mHealth intervention for PD to ensure that the intervention addresses the target users’ needs, capabilities, operability, and preferences, which may contribute to the acceptance and use of the mHealth app for PD.

The final factor that might have an ambivalent role in whether older people used or intended to use the mHealth app was the cost of the device and the app. Cost-saving is one of the self-service technology aspects that has a positive impact on users’ satisfaction (51). Cost was identified as an important determining factor in accepting and using mHealth interventions in two studies (26,31).

However, this does not mean that users are unwilling to pay for an mHealth app intervention. In the Lee et al study of mHealth apps for hand dexterity, they found that participants reported their willingness to purchase a mobile device to be able to use such an app after trying it out (31). This may indicate that the financial cost associated with purchasing mobile devices or mHealth apps is not a big concern for PwP if the mHealth app proved to be beneficial for them. This finding echoes previous research on the factors that influence the adoption of mHealth among people with heart failure (52) in which perceived financial cost was not significantly associated with the intention to adopt and use mHealth. Further study is needed to investigate whether mHealth apps for PD are cost effective, and if so, recommendations to subsidise the cost of these interventions by researchers should be considered to facilitate mHealth acceptance and use. Costs could also add to the growing disparities in healthcare based on socioeconomics.

Quality of Studies

Most of the included studies were critically appraised as being of moderate or poor quality. Limitations of some studies included in this review were small sample sizes (11,30), short study periods (25,29,30), and underreporting of reasons for participant drop-out (27,32). In addition, the study population was often limited to those in early to moderate stages of PD with no severe physical or cognitive abnormality or diagnosis of dementia (27,29,30-32). It might be very challenging to consider including these subgroups of PwP in the use of an mHealth intervention without seeking support from the patients' carers, so carer input is another area that needs to be considered when designing an mHealth app for PD. Further research is needed to investigate this consideration and mHealth app-related characteristics to provide a more granular view of the factors that might influence the acceptance and use of mHealth for PD.

Identifying the reasons for the study drop-out may give insight into the further clues for the potential concerns and barriers to the usability and acceptance of mHealth interventions for PD. Response or completion rates of the user perception questionnaires were not always reported, and therefore, it is hard to confirm whether participants avoided giving feedback due to poor levels of satisfaction or negative experiences with the intervention. Additional limitations included that some studies only included participants who had access to their own device, who had WiFi access at home or who already had experience with technology use. However, these criteria may have biased findings, as those who participated in these studies may have expressed more favourable perceptions towards mHealth intervention use than those who were unable to participate.

Nevertheless, the findings, especially the user perspectives, were generally comparable across studies of good, moderate, and poor quality, so the conclusions of this rapid review were drawn from all included studies. Finally, many of the included studies in this review relied on self-completed questionnaires (to assess users' satisfaction or attitudes) or self-reported data collection. Findings may have been affected by recall bias or the Hawthorne effect (53), where participants may have changed their attitudes and perceptions due to knowingly being observed or awareness of being part of the experiment.

Strengths and limitations

This review set out to include of all kinds of available evidence, regardless of the type of research method (qualitative, quantitative, or mixed-methods). This is a challenging approach but with technology evolving so rapidly covering all research methodologies enabled the most comprehensive evaluation of the current status of the field. While this review contributes to the understanding of the factors that might impact acceptance and usability of mHealth intervention from the user perspective, much of this information is not in academic context and including a wider breadth of non-peer-reviewed grey literature such as blogs, may provide a more granular view of a wider range of factors, beyond those raised in peer-review studies might provide greater insights, although the additional resources required to do this robustly were not available in this instance (54).

Implications

Multiple factors, across technological, social (individual), and organisational levels, are associated with mHealth intervention acceptance. We further develop the concepts identified by Grosjean et al, who focused on designing a socially acceptable mHealth app for PD self-management (15) reinforcing the need for substantial exploration of user perspectives towards usability, acceptance, and adoption of mHealth intervention in PD clinical settings. Acceptability appears to be high to both PwP and HCPs, recognising the potential benefits in improving healthcare services, specifically that real-time data collection, medication adherence, and symptom-monitoring interventions have the potential to improve self-management of PD and provide HCPs with improved insight into the symptoms, while improving the communication and relationship between PwP and HCPs. However, the challenge in application is in that validation of clinical use and the paucity of data on user experience. The real time monitoring of Parkinson's include should provide a more balanced and objective insight than the subjective rating and snapshot in time captured currently in a clinical consultation. This can help to limit recall bias whilst enabling prioritisation of the healthcare needs that the patient needs addressing. Usable dashboards enabling HCP's to readily visualise the relevant data and to trust in the data interpretation is critical to ensure this can be done efficiently. Following approval of the Personal Kinetigraph devices, FDA have recently approved the use of a device not considered here (because data is not available on the user experience) from Rune Labs, a kinematic smart watch-based system. These approvals demonstrate the progress towards recognising the value of real-world data collection in clinical practise. However, whilst many apps publish their data validation, what is lacking is the data on preference, adherence and usability to support further design improvements and independently inform clinicians on what to implement or recommend. That they are currently not approved for use as primary or secondary endpoints in clinical trials is a further limitation which may change if patients increasingly move towards them.

Conclusion

In summary, understanding the factors behind the acceptance and usability of smart device intervention for PD can only enhance the rapidly developing landscape. mHealth interventions appear to be an acceptable platform for delivering interventions in PD but there is limited depth to determining what may pose specific barriers to individuals using these tools. We highlight the potential clinical benefits resulting from the use of mHealth interventions, such as improving communication and supporting the decision-making process. However, there is a perceived lack of evidence base and proof of concept of clinical benefit on their use in PD management. Further research in this area is still needed, with a focus on feedback from all stakeholders in PD clinical settings, including both PwP and HCPs, in the design and development of mHealth interventions to support the transfer of interventions into clinical practice.

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Abbreviations

PD	Parkinson's Disease
PwP	People with Parkinson's
HCPs	Healthcare professional
PRISMA	Preferred Reporting Items for Systematic Reviews and Meta-Analysis
RCT	Randomized controlled trial.
NMSs	Non motor symptoms
EPHPP	Effective Public Health Practice Project
CASP	Critical Appraisal Skills Programme

Footnotes

Authors' Contributions: AK, LH, and EL were responsible for the concept, design, and conduct of the study. AK was responsible for collection of data and manuscript preparation. LH and EL were responsible for double checking all stages of the search and reviewed and edited the manuscript drafts. All authors were involved in interpretation of results and approved the final version of the manuscript.

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Supplementary Files

Multimedia Appendixes

Search strategy.
URL: http://asset.jmir.pub/assets/21820dced0d593ca8d50741d08a4f3e8.docx

Findings and quality appraisal of some of included studies.
URL: http://asset.jmir.pub/assets/0897e1ad7b36eec2407b94c6c0235a3d.docx