

BMJ Open Digital health technologies and self-efficacy in Parkinson's: a scoping review

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ABSTRACT

Objective Prior research has identified that people with Parkinson's reporting lower levels of self-efficacy exhibit worsening motor and non-motor symptomology, reduced quality of life, and self-management. Our key objective was to conduct a scoping review examining the impact of digital health technologies on self-efficacy in people with Parkinson's.

Design A scoping review using Arksey and O'Malley's (2005) framework was undertaken.

Data sources MEDLINE, Embase, PsychINFO, CINAHL, Web of Science, IEEE Xplore, and Google Scholar principally for grey literature were searched from 1 January 2008 to the 24th of July 2024.

Eligibility criteria for selecting studies Primary studies which incorporated digital health technologies, measured self-efficacy and had a sample population of people with Parkinson's were searched.

Data extraction and synthesis Following identification of potentially eligible records, two independent reviewers undertook title and abstract screening, followed by full-text screening. Data was extracted using our earlier published data extraction sheet which incorporated the Practical Reviews in Self-Management Support (PRISMS) taxonomy, and the template for intervention description and replication (TIDieR) checklist. Data was extracted from a Microsoft Excel spreadsheet and synthesised by describing themes, demographic data and numerical data.

Results From 33 165 unique records following screening and independent review by two reviewers, 11 eligible records were found. Of these five elevated self-efficacy to a statistically significant level, five did not and one lowered self-efficacy. Of the studies which raised self-efficacy to a statistically significant level, all adopted a multimodal approach with a variety of devices. Thematically, these devices were focused on physical activity, falls/falls prevention, or both. The level of heterogeneity precluded comparisons between studies.

Conclusions This scoping review identified significant knowledge and evidence gaps in the literature, and the limited number of eligible studies make these findings not generalisable. Future self-management research might benefit from also considering self-efficacy.

INTRODUCTION

Background

Parkinson's disease (PD) is a progressive neurodegenerative disorder with no known cure.¹ It causes both motor symptoms (MS)

STRENGTHS AND LIMITATIONS OF THIS STUDY

- ⇒ This study followed the six steps for conducting a scoping review reported by Arksey and O'Malley (2005), making it replicable and methodologically robust.
- ⇒ A diverse collection of bibliographic databases were used to ensure the literature was scoped broadly and included qualitative, quantitative and mixed methods studies.
- ⇒ This review did not include studies which were not published in English limiting the number of records which could be identified during the review.
- ⇒ A broad definition of outcomes measured was used in this review, widening its scope.
- ⇒ An assessment of the quality of the included studies was not undertaken.

and non-motor symptoms (NMS), resulting in significant morbidity and mortality.^{1–3} The number of people with Parkinson's (PwP) is predicted to rise significantly in the coming years.^{4 5} This predicted increase in PwP will place increased burden on already stretched healthcare systems which have limited resources available.^{6–8} Key to attenuating this impact relies on PwP being able to effectively self-manage their condition, for which digital solutions have been proposed to play a key role.^{9 10} Reviews exploring self-management interventions to support PwP have identified that the strength of evidence to support their use is weak, and that better designed and more robust studies are needed.¹¹ In contrast, other reviewers suggest there are currently some promising self-management interventions to support PwP.¹² Interventions which incorporate digital health technologies (DHT) have been proposed as an approach to enable effective self-management for PwP, with a growing body of evidence to support this view.^{10 13 14} Studies investigating home-based care have discovered that it has clinical outcomes equal to usual care in PwP; however, the strength of evidence needed for this to be scaled up has potentially not yet been reached.¹⁵ Advantages of using DHT

to deliver PD care remotely include care which is more accessible, convenient, comfortable and reduces the risks of contracting nosocomial infections.^{16 17} A cross-sectional observation study investigating the determinants of self-efficacy in PwP found that those with lower self-efficacy had worse MS and NMS, reduced quality of life, and that it negatively impacted on their mood/apathy and ability to self-management.¹⁸ These observations regarding the determinants of self-efficacy in PwP are significant as this psychological construct has been identified as an important mediator of self-management in the other fields.^{19 20} In focusing on self-efficacy, it is important to first define it and then differentiate it from self-management. In line with the published protocol, Bandura's definition of self-efficacy is used which is:

The belief in one's capabilities to organise and execute the courses of action required to manage prospective situations.^{21 22}

In contrast, self-management is defined as:

training, skill acquisition and intervention by which an individual with a specific morbidity is able to care for themselves so that they can manage their illness,^{23 24}

As this scoping review would be searching for self-management interventions which incorporated DHT to support PwP, defining what a DHT is, was vital. The Food and Drug Administration (FDA) define a DHT as the:

Use computing platforms, connectivity, software, and sensors for healthcare and related use. These technologies span a range of uses, from applications in general wellness to applications as medical devices.²⁵

In line with the published scoping review protocol, a broad definition of DHT was chosen,²² while categorising the types of DHT used in included studies was thought might be beneficial using this review framework.^{26–28} The National Institute for Health and Care Excellence (NICE) have produced three DHT tiers:

Tier C DHT for treating and diagnosing medical conditions or guiding care choices.

Tier B DHT for helping citizens and patients to manage their own health and wellness.

Tier A DHT intended to save costs or release staff time, no direct patient, health, or care outcomes.²⁹

Thus far, evidence regarding self-management interventions to support PwP is largely weak, with only a few exceptions showing promise,^{11 12} while digitally enabled self-management interventions have been proposed as potential solutions to enabling home-based PD care.^{10 15–17} Finally, low levels of self-efficacy have been associated with a negative impact on self-management in PwP, while self-efficacy has been proposed as a potential mediator of self-management.^{18–20} Collectively, these observations indicate that there is potential gap in the literature relating to the impact of DHT on self-efficacy in PwP and form the rationale for undertaking this scoping review. Placing

this review into context, a recent systematic review has focused specifically on behaviour change interventions to raise exercise self-efficacy and adherences in PwP.³⁰ Complementing that review, this scoping review also has unique features in that it focuses specifically on digitally enabled self-management interventions to support PwP and does not restrict which type of self-efficacy or outcome measure used. It is hoped this scoping review might enhance our understanding of the role of DHT in self-management in PwP. It is also hoped this review could potentially determine if self-efficacy acts as a mediator for self-management in PwP, and in doing so, filling an important and potentially sizeable gap in the literature.³¹

METHODS

Framework

This scoping review was based on the framework first described by Arksey and O'Malley (2005) in conjunction with the PRISMA ScR framework and checklist.^{26–28 32} The aim, objectives, eligibility criteria and methods used in this review are also described fully in the published protocol.²²

Stakeholder Involvement and expert opinion

In keeping with the scoping review framework used here at both the protocol stage and beginning in the early stages of this review, stakeholder involvement from a Parkinson's UK advocate was sought. This stakeholder provided valuable insight into how well PwP might engage with interventions which used DHT, barriers to using them and their insight into how PwP self-manage on a day to day basis.^{22 26 28 32} In line with the scoping review framework used here, expert opinion was sought from a neurologist with expertise in PD care, and a subject specialist librarian, providing both clinical and methodological perspectives relevant to conducting this review.^{22 26 28 32}

Search strategy and literature sources

Embase, PsychINFO, CINAHL, Web of Science, MEDLINE and IEEE Xplore were searched from 1 January 2008 to 24 July 2024, while Google Scholar was principally used to search the grey literature shown in online supplemental file 1.

Choosing which bibliographic databases to use in this review was carefully considered, and comparisons between similar databases were made to see how well their performance aligned with the scoping review framework used here.^{26 28 32} For example, PubMed is an excellent database to use when executing a simple scoping search, or when attempting to identify a limited number of specific key references,³³ while MEDLINE via Ovid is more appropriate when the reviewer seeks to perform a comprehensive, structured and systematic review of the literature.³³ Based on Arksey and O'Malley's (2005) framework and its subsequent iterations which describe the broadness of search as a key feature of scoping reviews, MEDLINE via

Table 1 Population Intervention Comparator Outcome Study design (PICOS) framework³⁴

PICOS	Detail	Keywords	MeSH* terms when used
Population	People with Parkinson's	Parkinson's disease OR Parkinson disease	Parkinsonian disorders OR Parkin* OR Neurodegenerative disorders
Intervention	Digital health technologies	Health technology OR Wearables OR Sensors OR Home-based care	Telemedicine OR Telehealth OR Telecare OR Digital Health OR eHealth
Comparator	None or usual care		
Outcomes	Self-efficacy	Self-monitoring OR Self-rehabilitation OR Resilience OR Behaviour change OR Behaviour modification	Self-efficacy OR Self Concept OR Self* OR Self-Care
Study design	Quantitative Qualitative Mixed methods		

*MeSH Medical Subject Headings. This PICOS shown above is in line with the published scoping review protocol.²²

Ovid was felt more appropriate than PubMed to use in this review.^{26 27 32}

Rationale for deviation from protocol

Due to unforeseen circumstances, it was not possible to complete the review in the planned time period stated in the protocol,²² so the review was updated to end on 24 July 2024 to ensure it was current.

Search strategy and literature sources

The search terms were developed from a Population Intervention Comparator Outcome Study design (PICOS) framework shown in table 1.³⁴

Keywords

Some databases used MeSH terms, while others required different controlled vocabulary to be used. Combinations of keywords derived from the PICOS framework, search term combinations, Boolean operators, databases used, and records retrieved can be found in (dataset) online supplemental file 1. The search terms developed were optimised through an iterative process which included expert consultation with subject and information specialist librarians in line with the PRISMA ScR framework, checklist and updated methodological guidance.^{26 28 35}

Searching the grey literature

The grey literature was searched using Google Scholar, which although limited in terms of sensitivity, broadness of coverage and inferior performance when compared with more extensively validated databases, does have some benefits.³⁶ These include complementing searches of the grey literature by identifying records which the more extensively validated databases do not always do, due to listing, cataloguing or controlled vocabulary used in Google Scholar.^{36–39}

Eligibility criteria

Inclusion criteria

Studies were eligible for inclusion if they evaluated self-efficacy as an outcome using any measure, in all genders,

aged 18+ yearsold with no upper age limit, participants came from any ethnic group and must have been diagnosed with PD or be the care partner (CP) of PwP* (* The rationale for including CP was that some studies might have PwP and their CP and that excluding these might exclude important studies especially given the important role CP play in supporting PwP and is consistent with this reviews published protocol.²²). The definition of digitally enabled was kept broad to encompass the potential variety of DHT used. Interventions must have had a digital element to be considered for inclusion, this must be more than electronic data capture and must have had a degree of interactivity and user engagement. Eligible studies must have stated that participants were either PwP or CP of PwP or both. Qualitative, quantitative and mixed methods studies were all considered eligible, in line with the published scoping review protocol.²²

Exclusion criteria

Studies were ineligible if they included participants with parkinsonism rather than PD. For the purposes of this review, studies in which the intervention group did not exclusively contain PwP, or their CPs were ineligible. Studies not published in English, or where no full text was available were ineligible. Digitally enabled interventions which only involved electronic data capture were excluded. Reviews or other forms of secondary research or service evaluations were not directly included in the review, but their bibliographies were hand searched in line with the scoping review protocol and supporting literature.^{22 40}

Hand searching

Hand searching was undertaken by reviewer one in line with the scoping review protocol.²² Backward and forward citation checking was undertaken to ensure no eligible studies were omitted from the final review. The scoping review was reported using the PRISMA ScR extension guidelines and checklist, and a PRISMA ScR flowchart was produced.^{28 41}

Data management

Potentially eligible records from each database were exported into an EndNote version 20.1 library for the purposes of de-duplication, study screening by automation, record retrieval and management.

Identification and screening

Records were exported into Rayyan a web-based literature reviewing tool (<https://www.rayyan.ai/>), where title and abstract screening by reviewers one and two was undertaken. Full texts were retrieved by reviewer one, and screening was undertaken by reviewers one and two.

Data extraction, synthesis, and analysis

Data extraction of included studies was done using a previously developed data extraction sheet in line with the published scoping review protocol.²² Extracted data was transferred into a Microsoft Excel spreadsheet which replicated the data extraction sheet to ensure standardisation data extraction and facilitate synthesis. Two fields included the Template for Intervention Description and Replication (TIDieR) and the Practical systematic Reviews in Self-Management Support for people with long-term conditions taxonomy (PRISMS) checklists to provide greater depth of extraction.^{42 43} Data extraction was conducted by reviewer one due to the limited number of records and this extraction was checked by reviewer two.

Patient and public involvement

Patient and public involvement came from two sources. First, the Parkinson's UK advocate who was consulted on this scoping review protocol provided feedback and insight from the perspective of a PwP which was invaluable in shaping the search strategy of this review.²² Additionally, their involvement influenced the interpretation of this reviews results, particularly in terms of the appropriateness of the self-efficacy measures used.²² A second newly diagnosed PwP spoke about their experiences of having PD particularly around self-efficacy, they also talked about capability and goal setting and how DHT might support this. This input certainly enabled the reviewers to explore this review from the perspective of a PwP.

RESULTS

This scoping review is presented in a PRISMA ScR flowchart shown in [figure 1](#).⁴¹ A total of 36 887 records were exported into EndNote version 20.1 and after initial de-duplication, 3429 records were removed and following customised de-duplication, a further 293 records were removed leaving 33 165 unique records. 32919 records were marked as ineligible by automation using the advanced search function in EndNote version 20.1 using the search fields from the PICOS. This resulted in 246 records to be screened. Having reached the limits of marking records as ineligible by automation using the advanced search function in EndNote version 20.1,

reviewer one title and abstract screened these 246 records manually. 212 records were marked as ineligible and 35 records were included for full-text screening. Full texts were screened for eligibility independently by reviewers one and two and 24 records were marked as ineligible and 11 records were included in the final review. 10 of these records were identified from bibliographic databases and one from other sources (citation checking) (shown in [table 2](#)). The 11 records which were included in the final review are summarised in [table 2](#). The search process is presented in a PRISMA 2020 flowchart and shown in [figure 1](#).⁴¹

Description of included studies

A summary of the included studies and key findings are shown in [table 2](#), with the full extracted dataset in (dataset) online supplemental file 2.

All eligible studies included both male and female participants.^{44–54} Study designs included randomised controlled trials (RCTs),^{49 50 53 54} feasibility,^{47 48 52} mixed methods pilot,⁵¹ cohort,⁴⁵ a cross-sectional study,⁴⁴ and one case report.⁴⁶ Sample sizes ranged from 5 and 474 participants. Included studies were geographically distributed widely, reflecting the ubiquity of PD and PD research found in (dataset) online supplemental file 2.

Self-efficacy was a primary outcome in two studies^{45 54} and a secondary outcome in the remainder. Several self-efficacy measures were used in line with the protocol eligibility criteria.²² These included the Falls Efficacy Scale International (FES-I),⁵⁵ Exercise Self-efficacy Scale (ESE),⁵⁶ the Self-efficacy for Exercise Scale (SEE),⁵⁷ Physical Activity Assessment Inventory (PAAI),⁵⁸ Norman Exercise Self-efficacy Scale,⁵⁹ Self-efficacy for Management of Chronic Disease 6-item scale (SEMCD-6),⁶⁰ the self-efficacy for walking duration 10-item questionnaire (SEW_Dur),⁴⁷ and finally, the result of a qualitative thematic analysis (shown in [table 2](#)).

DHT used included smartphones,^{52 54} telehealth/telecoaching,^{45–47 51} instructional videos,⁵⁰ video conferencing,⁵¹ online modules and social media platforms,^{48 53} virtual physical therapy sessions,^{44 49 53} tablet devices,^{48 50} physical activity trackers/sensors,^{45–48} smartwatches,⁵⁴ videogame technology,⁴⁹ all focusing on either falls, physical activity, or both.

Key intervention components across studies were education, training and coaching. In five studies, the interventions focused on physical activity^{45–47 51 53} one explored physical activity and falls,⁵⁰ and one mixed methods pilot study considered self-efficacy more broadly.⁵⁴ Approaches included virtual physical therapy and physiotherapy online discussion groups,^{44 53} mobile phone interventions,^{52 54} telehealth, tele-monitoring of exercise and telecoaching^{45–47 51} exergaming,⁴⁹ physical exercise and falls prevention using instructional physiotherapy material,⁵⁰ remote monitored physical exercise, instructional material and access to a social media platform and online modules.^{48 53}

PRISMA ScR Filtering Process

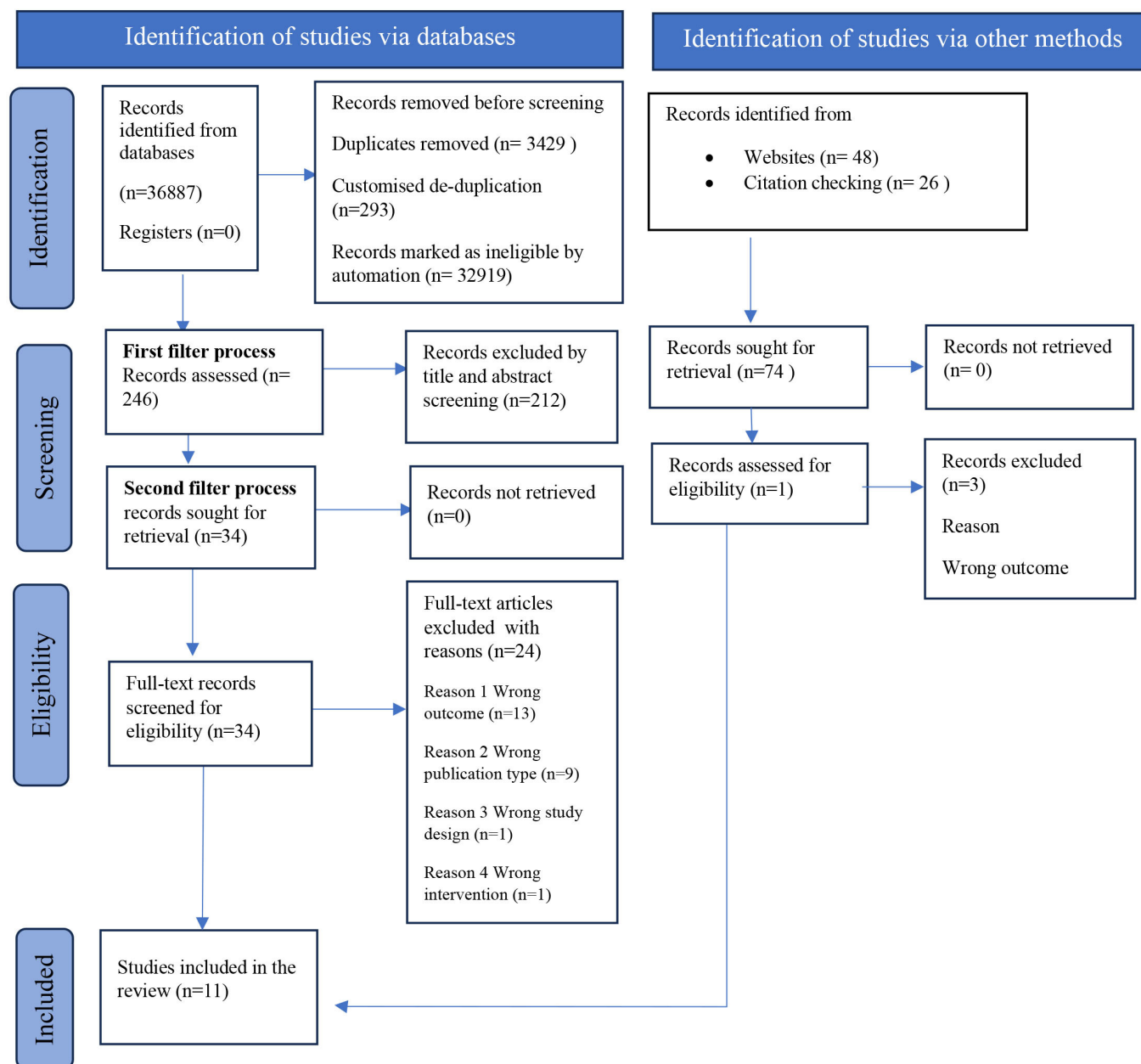


Figure 1 PRISMA ScR flowchart.

Participant safety was a consideration in six of the 11 studies, while digital literacy was not specially described in any of the included studies.^{45–47 49–51}

Included studies

Scoping reviews traditionally involve the identification, presentation and description of the characteristics of included studies, in keeping with Arksey and O'Malley's (2005) scoping review framework.³² This type of review does not usually involve combining and synthesising quantitative and qualitative results.⁶¹ Here, we present the statistical and qualitative results of the included studies, not to determine their validity or effectiveness,⁶² but

simply as a fuller description of the studies methodology, and the results simply presented how they are reported by the authors.^{32 61} In deviating from the traditional scoping framework, we are taking advantage of the iterative and flexible characteristics of the scoping review methodology to enhance this review.^{26 35} Table 2 summarises the 11 studies included in this review.

Five studies showed statistically significant findings in terms of improving self-efficacy.^{45 46 50 51 54} Shih *et al* (2018) was a particularly interesting study as it involved physical activity telecoaching that increased physical activity and strengthening posture, thus, traversing the approaches

Table 2 Summary of included studies

Authors and year	Study design and sample size	Self-efficacy measure	Results as reported by the authors
Interventions which raised self-efficacy to a statistically significant level for the given measure			
Chivers Seymour, K <i>et al</i> 2019 ⁵⁰	RCT Sample size n=474	Falls Self-efficacy Scale International (FES-I). ⁵⁵	Between-group difference 1.60 points, 95% CI 3.00 to 0.19, p=0.026 for the intervention at 6 months. Themes: The study intervention predominantly focused MS symptoms (falls prevention). However, the impact of PD (MS and NMS) on fear of falling and falls self-efficacy were secondary outcomes.
Lai, B <i>et al</i> 2020 ⁵¹	Mixed methods pilot Sample size n=20	Qualitative thematic analysis.	Perceived increased exercise motivation, and self-efficacy in the intervention group identified using qualitative thematic analysis. Themes: MS were objectively measured using different walking tests. NMS were explored using qualitative research methods and thematic analysis of data.
Park, Y <i>et al</i> 2022 ⁵⁴	RCT Sample size n=20	Self-efficacy for Managing Chronic Disease 6-item (SEMCD-6-item). ⁶⁰	The intervention group improved self-efficacy to a statistically significant level when compared with the control group (t=2.33, p=0.025). Intervention pre-post score (t=2.85 p=0.011) compared with the control pre-post test score (t=0.26 p=0.796). Themes: This was a complex multimodal intervention which focused on the effects of self-efficacy and self-management using mobile phone technology. Outcomes focused on the impact of PD (MS and NMS) and their management. The impact of PD symptoms on the QoL was measured separately and was considered.
Quinn, L <i>et al</i> 2020 ⁴⁶	Case report Sample size n=27	Norman Self-efficacy Scale for Exercise. ⁵⁹	Pre/post scores showed a statistically significant increase in self-efficacy (d=0.95, p<0.001). Theme: This was a physical activity telehealth intervention which predominantly focused on MS, including measuring self-efficacy using the Norman Self-efficacy Scale for Exercise. NMS were not explicitly mentioned.
Shih, S <i>et al</i> 2022 ⁴⁵	A single cohort study with no control group or blinding of participants Sample size n=62	Exercise Self-efficacy Scale (ESE). ⁵⁶	ESE pre and post-intervention rose with a large effect size Cohens d 1.20. Participants with lower baseline ESE showed the greatest rise in self-efficacy. Theme: This was a physical activity telehealth intervention which predominantly focused on MS, including measuring self-efficacy using the Exercise Self-efficacy Scale for exercise. NMS were not explicitly mentioned.
Interventions which did not raise self-efficacy to a statistically significant level for the given measure			
Agle <i>et al</i> 2024 ⁵³	An assessor blinded, randomised controlled feasibility study Sample size n=30	Self-efficacy for Exercise (SEE). ⁵³	Intervention group baseline 56 (49–68), post-intervention 40 (37.5–63.5) and 6 months post follow-up 65 (53.75–78.25). Control group baseline 64 (52.5–74), and post-intervention 56 (51.5–69.5) and 66 (50–76). Interpretation, self-efficacy dropped post-intervention in the intervention group, rose to above baseline at 6 months, but lower than the control at this time point using the SEE measure. Theme: This study predominantly focused on physical activity with self-efficacy measured using the self-efficacy for exercise measure.
Colón-Semenza <i>et al</i> 2018 ⁴⁷	Feasibility study Sample size n=10 (5 dyads)	Self-efficacy for walking duration 10-item questionnaire (SEW_Dur). ¹⁰³	The mean self-efficacy for peer mentees increased from 66.8 (SD 24.7) points at baseline to 70 (SD 25.9) points post-intervention. The authors of this study describe these findings as failing to establish clinically important differences using the SEW_Dur measure. Theme: Physical activity in regard to walking using the SEW_Dur measure, therefore, predominantly focused on MS.

Continued

Table 2 Continued

Authors and year	Study design and sample size	Self-efficacy measure	Results as reported by the authors
Ginis, P <i>et al</i> 2016 ⁵²	Pilot RCT Sample size n=40	Falls Self-efficacy Scale International (FES-I) ⁵⁵	Self-efficacy was measured using the FES-I measure. ¹⁰⁴ Effects at 6 weeks (time (p=0.91) × group (p=0.84 equals p=0.89) and was not raised to a statistically significant level. Themes: Primarily MS based in regarding to gait, walking and FoG. A second theme was NMS focusing on health and well-being looking at the impact of disability, cognition and other symptoms. QoL was measured separately using the SF-36 physical and mental health scales.
Mango <i>et al</i> 2021 ⁴⁴	Cross-sectional study Sample size n=87	Self-efficacy for Exercise (SEE). ⁵⁷	While SEE was measured at baseline, authors report it could not be measured as an outcome measure at another time point due to the cross-sectional design of the study. Themes: This study focused on the impact of PD (MS and NMS) on how PwP used their leisure time. In addition, this study also considered the impact of PD on PwP overcoming barriers to physical activity and socialisation (particularly during the height of the COVID-19 pandemic)
Song, J <i>et al</i> 2018 ⁴⁹	A two-arm, parallel, single-blinded RCT Sample size n=60	Falls Efficacy Scale-International (FES-I). ⁵⁵	Self-efficacy was measured using the FES-I week 12 minus week 0 intervention minus control p value 2.8 (−0.8 to 6.5) p=0.13. The p value indicates that the intervention did not raise self-efficacy to a statistically significant level. Themes: MS related to stepping reaction time test and Functional Gait Assessment and Timed Up and Go test and overall falls prevention. NMS measures included cognition using the mini-mental state exam and Montreal Cognitive Assessment in relation to risk of falling.
Interventions which lowered self-efficacy from baseline for the given measure			
Hermanns, M, Haas, BK, Lisk, J 2019 ⁴⁸	Longitudinal pre-test and post-test design Sample size n=5	Physical Activity Assessment Inventory (PAAI). ⁵⁸	Statistical analysis involved pre-scores and post-scores at baseline and 12 weeks. Simple pre-test and post score comparisons indicated a reduction in self-efficacy from baseline. PAAI total scores measuring self-efficacy using Wilcoxon signed-rank tests maintained non-significant changes (p>0.05) Themes: MS included physical activity measured using a physical activity tracker. The impact of PD (MS and NMS) on engagement with a social media platform was explored. Well-being and QoL were measured using a number of different scales cited in the paper. The PAAI has 13 items which measure confidence and was used as the Self-efficacy Scale.
MS, motor symptoms; NMS, non-motor symptoms; PD, Parkinson's disease; PwP, people with Parkinson's; RCT, randomised controlled trial.			

used across the 11 studies and describing the behavioural theory underpinning the intervention.⁴⁵ Grounded in self-determination theory, this intervention enhanced motivation resulting in increased physical activity and ESE.⁴⁵ The adaptability of the Engage-PD approach to accommodate different contexts was demonstrated when it was deployed as part of an alternative mode of service delivery at the height of the COVID-19 pandemic.⁴⁶ This study allowed progress to be measured which appears to be key to reinforcing participant belief in their own capabilities.^{21 45} A substudy of the Engage-PD study described above and included in this review improved self-efficacy using a telecoaching approach.⁴⁶ Park *et al* (2022) described a promising study which improved the level of self-efficacy in the measure used.⁵⁴ This intervention is based on the information-motivation-behaviour (IMB) skills model used: smartphones, mobile applications, smartwatches, smartphone-based short text messages, information, and

telephone counselling.^{54 63 64} One telecoaching mixed methods pilot study identified a perceived improvement self-efficacy in participants as a result of a qualitative thematic analysis.⁵¹ Another approach involving physiotherapy and instructional material improved self-efficacy as a secondary outcome, while not improving the primary outcome of the study.⁵⁰

Five studies showed no statistically significant improvement in self-efficacy, two were RCTs,^{49 52} two were feasibility studies^{47 53} while one was a cross-sectional study.⁴⁴ It is unclear on examining these studies why this was the case but may have been due to the level of heterogeneity between the studies in terms of study design, DHT employed and self-efficacy measures used. Two studies lowered the level of self-efficacy post-intervention. One of these studies transiently lowered self-efficacy post-intervention when compared with baseline.⁵³ However at 6 months post-intervention, this had risen above baseline

but was below the level of the control at this time point, the reason for this observation is unclear.⁵³ The one study which only lowered self-efficacy had two distinct features which may explain what was observed.⁴⁸ First, the self-efficacy measure used was the PAAI and was the only study which used this self-efficacy measure.⁵⁸ While confidence is a realistic sense of one's capabilities, it does not completely explain why self-efficacy dropped across all 13 activities of the PAAI measure.^{48 65} The study's authors postulate that a shift to the intervention having a positive impact on self-efficacy might have been seen with a larger sample size than the $n=5$ in this study.⁴⁸ The authors acknowledged that the small sample size minimised power and reduced confidence in the use of non-parametric Wilcoxon signed-rank tests.⁴⁸ These tests were used to compare the difference between pre-test survey and post-test survey scores.⁴⁸ Despite this test findings, these were still evaluated to lend support to the percentage of change findings which might be considered a limitation. While this prediction might prove correct, it would need to overcome the significant negative impact this intervention had on self-efficacy which increasing the sample size alone might not be sufficient to do. It might be that a small sample size ($n=5$) and an online social media support group might be an unhelpful combination due to participants potentially influencing each other's responses to complete the PAAI, driven by a desire to conform with others.^{48 58}

A fuller description of study interventions can be found in (dataset) online supplemental file 3.

Unlike systematic reviews which appraise study quality, for scoping reviews, this is optional and in this review, this has not been undertaken.^{32 66} However, some important differences between the studies were identified in particular the use of surveys and qualitative research methods. The use of validated PD scales such as the PDQ-39 presented as surveys is not a recent one,⁶⁷ indeed all of the 11 eligible studies were reliant on surveys and questionnaires to collect various types of data, in addition to analytical objective instrumental recordings of physical movement.⁴⁴⁻⁵⁴ Surveys were explicitly described as being used to measure/determine acceptability using satisfaction surveys and online surveys,^{47 53} custom-designed electronic and paper questionnaires to examine preference,^{44 46} and Likert scales to explore participant perception.⁴⁵ Three studies used established PD and QoL scales including SF36, PD-39 or a Self-efficacy Scale.^{49 50 52} Two studies used surveys to explore intervention participant perceptions of their experiences on it using open-ended questions.^{48 51} The latter of these studies used these open-ended questions to initiate the conduction of semi-structured interviews, which through thematic analysis identified a perception of raised self-efficacy.⁵¹

DISCUSSION

This scoping review has scoped the literature to bring together primary studies which have explored the impact

of DHT on self-efficacy in PwP. 11 studies met the eligibility criteria,⁴⁴⁻⁵⁴ of which five improved self-efficacy,^{45 46 50 51 54} five did not^{44 47 49 52 53} and one lowered the level of self-efficacy,⁴⁸ and another did so transiently, before returning to a level which did not improve self-efficacy.⁵³ This suggests that the use of DHT could possibly improve self-efficacy, and hence, improve self-management by potentially acting as a mediator.^{31 68} All 11 eligible studies primarily focused on physical activity, falls prevention or a combination of the two, and by inference predominately the impact of the intervention on MS (see table 2), with the exception of one study which extensively focused on NMS in addition to MS.⁴⁸ However, self-efficacy in PwP is determined by both MS and NMS which is lower when these symptoms worsen; therefore, this review is not showing the whole picture highlighting this as a potential limitation.¹⁸ While self-efficacy has been strongly associated as a mediator of self-management in areas such as schizophrenia, this has not yet been examined in relation to PD despite determinants of self-efficacy in this patient population having been undertaken.^{18 69} Studies exploring the perceived usefulness, self-efficacy, and privacy concerns of using information communication technologies (ICT) on which the DHT identified in this review are underpinned, found that demographic factors played an important role with higher age associated with greater perceived usefulness and lower self-efficacy and need for family support.⁷⁰

While evidence standards for DHT exist, they have not been created to explicitly encompass self-efficacy which highlights the challenges researchers face when interpreting the results in reviews such as this one.^{25 29} One possibility is that self-efficacy is a psychological construct which is challenging to identify and interpret and is potentially hampered by publication bias or under-reporting of psychometric studies.^{71 72}

To date, DHT have provided good support of MS for PwP used in conjunction with pharmacological management.⁷³ However, the use of DHT in the management of NMS has been lacking, prompting non-pharmacological approaches at an early stage of PD development before they fully manifest themselves.⁷³ One such DHT approach is a mobile app for NMS symptom management (NMS Assist) which has incorporated validated scales such as the NMSQuest (non-motor symptoms questionnaire).^{73 74} NMS digital solutions differ from MS digital solutions in that the former is proactive and the latter reactive.⁷³ The use of DHT to proactively manage NMS aligns with the NHS long-term plan which states that digitally enabled care should be first choice over the next decade.⁷⁵ This new model of care will be predictive and personalised, enabling care which reduces CP burden through preventative and participatory strategies.⁷⁵ In terms of how the findings of this review relate to the wider literature, this review has shown that research into self-management in PwP would benefit from developing research which focuses on self-efficacy as a primary outcome, something this review has identified as lacking up to now.

Self-management interventions which have been ineffective might benefit from integrating elements of interventions which improve self-efficacy to see if this then improves self-management. This review in the context of the wider literature shows there is a sizeable gap in terms of primary studies which have explored the impact of DHT on self-efficacy in PwP, despite this being examined in other chronic diseases in published reviews.⁷⁶ These gaps are seemingly related to the strength of evidence and knowledge on this important topic. Khalil *et al* (2016) propose that an evidence-based approach to conducting scoping reviews is of great importance to maximising its value.^{77 78}

This review has the potential to inform primary studies in other specialities who have explored home-based/remote monitoring, telemedicine and self-efficacy and/or self-management as an outcome in the paediatrics, and diabetes in adults,^{79–81} and also in the management of chronic obstructive pulmonary disease (COPD) and lung transplant recipients.^{82–84} Of course, the reciprocal may also be potentially true with examples such as these primary studies in paediatrics and respiratory medicine informing future primary studies in the topic area on which this scoping review has focused.

As described earlier, acceptability and satisfaction and inferences of these from study descriptions identified this was an important consideration.

Pleasingly, acceptability and satisfaction were determined in a number of ways including direct measurement of satisfaction/acceptability,^{45 47 53} barriers and opportunities to use,^{44 46 51} being user-friendly,⁵² participant likes and dislikes⁴⁸ with the remaining studies describing this more subtly or in general terms in the context of other measures.^{49 50 54} It is clear that there are pros and cons to using surveys, case studies, and direct objective measurements. The use of these methods is reliant on the research question posed and the desired outcome(s). Surveys can reveal perception and experience in broad terms, case studies in a constrained focused manner and while both are subjective, that does not diminish their merit. Meanwhile, direct objective measure is more precise but does not measure perception or personal experience.

Despite the limited evidence identified in this review, it has begun to characterise evidence and knowledge gaps in research. For example, the included studies focused on only two aspects related to Parkinson's, falls, and falls prevention, and physical activity while seemingly neglecting NMS for the most part (shown in [table 2](#)).

This review identified that a potential reason for gaps in the literature related to NMS in regard to self-efficacy is that the technology to remotely monitor these symptoms is still in its infancy.⁷³ This review has also identified that barriers to synthesis to better characterise gaps in the literature potentially stem from, first, a lack of consensus on which self-efficacy measure to use, second, variation in the DHT used in each study, and poor reporting with only one study using the TIDieR guidelines.^{42 53} To facilitate the readers understanding of these gaps and how to

evaluate them the framework proposed by Robinson *et al* (2013) is an excellent source to reference.⁸⁵

This review might also inform other clinical specialities which focus on long-term chronic conditions that are moving towards a self-management care model. Published examples have involved behaviour change strategies to raise self-efficacy across a number of specialities.^{86–91} An integrative review of behaviour change strategies that promote self-efficacy found that they are either self-management programmes, telehealth, mobile applications, gaming and social media which is helpful to be aware of.⁹¹

Strengths and limitations

The limited number of studies identified, their different study designs, small samples sizes, and range of self-efficacy measures used made the findings of this review not generalisable due to the level of heterogeneity between them. For these same reasons, direct comparisons between interventions were not possible. The review provided insufficient strong evidence to explain why some interventions raised self-efficacy to a statistically significant level, and why some did not. The eligibility criteria failed to include a potentially important study as it was a doctoral thesis and the original source could not be retrieved.⁹²

Review synthesis was hampered by fragmentary and incomplete study reporting and the limited number of studies identified. Incomplete study descriptions and reporting made mapping them to the TIDieR and PRISMS taxonomy checklists potentially less valuable than had they been more complete with the exception of one study.^{42 43 53} In addition, had the number of the included studies been greater and more fully described, the synthesis might have better explained the evidence which was found and its significance. Assessment of the quality of studies was not undertaken as this was a scoping review which some may consider a limitation, but adequately answered the aim, and was consistent with the PRISMA ScR framework and checklist on which this review was based.^{26 28}

This review is the first of its type to scope the literature for primary studies which have explored the impact of DHT on self-efficacy in PwP following an already published protocol.²² This has complemented a series of literature reviews that have focused on self-management interventions to support PwP.^{11 12 93 94} Additionally, this review has identified substantial knowledge and evidence gaps in the literature which future research must address to strengthen the evidence on this topic which has previously been identified as weak.^{11 77 78}

Five interventions produced statistically significant improvements in self-efficacy compared with controls, two being RCTs, one being a case report, one a mixed methods pilot and one being a cohort study.^{45 46 50 51 54} This review has also identified the potential benefits of underpinning interventions with either self-determination theory or the information-motivation-behaviour (IMB)

skills model to elicit positive behaviour changes which improve self-efficacy.^{45 54 95 96} Acceptance and satisfaction of DHT by users could be explored more deeply, which is important when considering user engagement, themes which have been explored by other researchers looking at information communication technologies.⁷⁰

Some researchers have considered the implementation of telemedicine interventions to support self-management in PwP as not 'the panacea for all'.^{17 97} Physical activity and self-efficacy behaviour change have been a common themes researchers have explored in a recent review.³⁰ Strategies to achieve this include persuasion graded mastery, identification of barriers, considering intervention best practice, and organisational contextual nuances.^{98–100} Researchers have also considered the pros and cons of DHT in Parkinson's care, seeking solutions to the challenges of implementing conventional outcomes measures (COM).¹⁰¹

Lee *et al* (2024) explored the usability, feasibility and acceptance of a mobile app to comprehensively manage PD symptoms; this was something lacking in the eligible studies described in this review and could be perceived as a weakness.¹⁰²

With greater resources and time, a broader search of the literature could have been undertaken, potentially identifying more eligible studies. This review only searched for records published in English which meant potentially eligible records not published in English could have been excluded from the review. This review did not include records for which full texts were not available, meaning these were potentially omitted from the review but may have been eligible. While database filters were carefully considered, their selection might have negatively influenced the records retrieved, but this is potentially speculative. Finally, the year parameter was limited to 2008–2024, with 2008 coinciding with the release of the first smartphone and similar DHT developed from it. However, when the date parameter was widened, many of the DHT identified were now obsolete.

CONCLUSIONS

This scoping review presents for the first time the currently available literature on the impact of DHT on self-efficacy in PwP, which was limited, with high heterogeneity between studies and was not generalisable. This literature was extensively surveyed using an established and recognised framework making it methodologically robust and replicable. One weakness of this review pertained to data extraction from included studies. The data extraction tool developed was based on two assumptions: good quality and complete study reporting, and a sufficient number of studies to enable meaningful synthesis of findings, both were incorrect. The scoping review was unable to reasonably determine the true impact of DHT on self-efficacy in PwP based on the evidence identified. This review has negligible implications for clinicians and policymakers based on the conclusions of some of the

included studies. However, the findings of this scoping review remain of epistemic worth to other researchers interested in this area of Parkinson's research.

Unanswered questions and future research

This scoping review set out to answer through surveying the literature the impact of DHT on self-efficacy in PwP. After completing this review, this question remains largely unanswered, though a sizeable gap in the literature has been identified supporting the continued need for this to be answered. Future research may wish to determine if a literature review is the best methodological approach to answering this question, and, if not proposing alternative approaches to solving this important question.

Study dissemination

The findings of this scoping review will be disseminated via peer-reviewed journals, conference presentations and symposia. It is expected that the outcome of this review will be shared with service users, providers and other interested stakeholders. The implications of this review's findings for the potential development of clinical interventions and outcomes for PwP, their CP and the wider community will be shared locally and nationally through newsletters and PD research networks.

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