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The impact of digital health technologies on self-efficacy in People with Parkinson's: a scoping review of the literature.

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Title page

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The impact of digital health technologies on self-efficacy in People with Parkinson's: a scoping review of the literature.

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ABSTRACT

Background The use of digital health technologies to support self-management in people with Parkinson's is beginning to be better understood. Meanwhile, the impact of these technologies on self-efficacy in this patient group is less well understood and has not been formally reviewed. This scoping review aims to address this important topic.

Objective To conduct a scoping review of the literature on the impact of digital health technologies on self-efficacy in people with Parkinson's.

Methods MEDLINE, Embase, PsychINFO, CINAHL, Web of Science, IEEE Xplore and Google Scholar™ were searched from 1st January 2008 to 23rd March 2023 with an updated search taking place covering the period between the 24th of March 2023 and the 9th of February 2024. Google Scholar™ was principally used to search the grey literature. This review included peer-reviewed primary studies meeting the eligibility criteria.

Results From 26183 unique records, 9 were included in the final review. A variety of study designs were used, 4 being randomised controlled trials the remainder being a mixed-methods pilot, feasibility, cohort, cross-sectional studies and a case report. Several digital health technologies were used including; smartphones, tablets, online platforms, telehealth and physical activity trackers. These interventions typically focused on falls, fear of falling, and

physical activity, incorporating; educational resources, training, and telecoaching. 5 studies improved self-efficacy the remainder did not, with one lowering self-efficacy.

Conclusion This scoping review identified a limited number of eligible studies. There was heterogeneity between the studies including a range of study designs and differing digital health technologies. More research on this topic is needed to determine the effectiveness of these technologies on improving self-efficacy in People with Parkinson's.

Strengths and limitations of this study
This scoping review is the first to examine the role of digital health technologies on raising self-efficacy in People with Parkinson's
The review used a Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) framework and followed a published scoping review protocol (1).
This scoping review excluded studies not published in English, meaning that eligible studies not published in English might have been omitted from the review.
This review did not consider the cost-effectiveness of the digital health technologies trialled.
An assessment of the quality of the included studies was not undertaken, however, evidence of effectiveness was examined.

INTRODUCTION

Background

Parkinson's disease (PD) is a progressive neurodegenerative disorder with no known cure. It causes both motor symptoms (MS) and non-motor symptoms (NMS), resulting in significant morbidity and mortality (2-4). The number of People with Parkinson's (PwP) is predicted to rise significantly in the coming years (5, 6). This predicted increase in PwP will place increased burden on already stretched healthcare systems which have limited resources available (7-9). 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 an important role (10, 11).

Currently no scoping reviews have been published which have sought to search the literature to identify primary studies which have explored the potential impact of Digital Health Technologies (DHT) on self-efficacy in PwP. Current literature reviews have attempted to identify primary studies which have assessed the impact of digital, non-digital or hybrid interventions on self-management in PwP, using a variety of different research designs (12-16). This scoping review has focused on self-efficacy rather than self-management, and exclusively DHT. The rationale for choosing self-efficacy as an outcome is that it has been found to be a crucial mediator of self-management in diabetes research and might have applicability to this topic (17, 18). Differentiating between self-management and self-efficacy is important in the context of the review. 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 (19, 20). In line with the protocol Bandura's definition of self-efficacy is used which is;

"The belief in one's capabilities to organize and execute the courses of action required to manage prospective situations"(1, 21).

Focussing exclusively on DHT was decided upon based on the growing body of evidence on their impact on self-management, but not self-efficacy making this scoping review novel (22-24).

Pigott et al, (2022) suggested that there are insufficient well designed, robust studies such as Randomised Control Trials (RCT) to evaluate the effectiveness of self-management interventions for PwP fully (14). More recent reviews have challenged this having identified some self-management interventions which show promise (14, 25). It has been suggested that such interventions have focused predominantly on MS, neglecting NMS or holistic approaches and have inadequately evaluated for cost effectiveness (25). Thematically, several reviews have identified that more personalised, holistic, tailored, self-management interventions are required which can overcome contextual barriers (12, 15, 16, 25). Some researchers have begun to explore the role of DHT to support self-management, identifying barriers and enablers to engaging and accepting such interventions (26, 27). Early studies have begun to explore the roles of empowerment and motivation in self-management by utilising DHT (28, 29).

Whilst researchers have rightly focussed on self-management interventions, the role of self-efficacy has remained largely on the periphery. Only two recent literature review protocols have been published intending to explore the role of self-efficacy in PwP in the context of self-management (1, 30).

This scoping review uniquely unites three current areas of PD research; assessing the impact of self-management interventions for PwP, the potential role of DHT to support self-management in PwP, and the transformation of how and where PD care is delivered. It is plausible that self-efficacy might act as a mediator in all three areas of PD research (1, 12, 16, 30, 31).

PD care has traditionally taken place in either primary or secondary care settings, however innovative research strategies have sought to relocate it to the home (31). Some authors caution that DHT approaches such as telemedicine are 'not the panacea for all' in terms of PD care, whilst conceding that these approaches have some advantages over the traditional model of care (32). 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 (33). Home-based care has been shown to be beneficial to the care recipient due to it taking place in a natural setting; has also been found to have clinical outcomes equal to standard care (34).

Effective home-based care for PwP is reliant on the appropriate integration of DHT to enable remote, and safe self-management of both MS and NMS to deliver holistic care (35-43). Accumulated evidence has informed our understanding of self-management interventions and identifies the reasons why they are promising (14, 25). However, our understanding of self-efficacy in PwP remains limited, and should be considered when designing and implementing DHT to support self-management in PwP (44). This scoping review enables a better understanding of the role of self-efficacy as a potential mediator in self-management in PwP, filling an important and sizable gap in the literature (45).

This scoping review aimed to identify studies in the literature which have looked at the impact of digital health technology (DHT) interventions on self-efficacy in PwP

METHODS

Framework This scoping review used the PRISMA ScR framework (46-49). The aim, objectives, eligibility criteria and methods used in this review are described fully in the protocol (1).

Search strategy and literature sources

Embase, PsychINFO, CINAHL, Web of Science, MEDLINE and IEEE Xplore were searched from 1st January 2008 to 22nd March 2023, with the review updated to cover the period of the 23rd of March 2023 to the 9th of February 2024, while Google Scholar™ was principally used to search the grey literature shown in appendix i.

Rationale for deviation from protocol

Due to unforeseen circumstances, it was not possible to complete the review in the planned timeframe (1), so the review was updated in February 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 (50).

Table 1 Population Intervention Comparator Outcome Study design (PICOS) Framework (50).

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 scoping review protocol (1).

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 are found in appendix ii The search terms developed were optimised through an iterative process which included expert consultation with subject and information specialist librarians.

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 to more extensively validated databases, does have some benefits (51). These include complementing searches of the grey literature which the validated databases do not always identify, due to listing, cataloguing or controlled vocabulary used (51-54).

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+ years old 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 a PwP. 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 scoping review protocol (1).

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 (1, 55).

Hand searching

Hand searching was undertaken by reviewer one in line with the scoping review protocol (1). 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 flowchart was produced (49, 56).

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 ones 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 scoping review protocol (see appendix iii) (1). Extracted data was transferred into a Microsoft Excel™ spreadsheet which replicated the data extraction sheet to ensure standardisation 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 of self-management support (PRISMS) checklists to provide greater depth of extraction (57, 58). 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 public involvement came from two sources. Firstly, the Parkinson's 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 (1). Additionally, their involvement influenced the interpretation of this reviews results, particularly in terms of the appropriateness of the self-efficacy measures used (1). 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 flowchart shown in Figure 1 (56). A total of 27499 records were exported into EndNote™ version 20.1 and after de-duplication 1266

records were removed leaving 26183 unique records. 25793 were marked as ineligible by automation using the advanced search function in EndNote™ version 20.1 This automated search function used the fields predefined in the PICOS. Having completed title and abstract screening 33 records were included for full text screening. Full texts were screened for eligibility by reviewers one and two and 24 records were marked as ineligible (see Supplement 1). Nine records were included in the final review and are summarised in Table 2. **Figure 1 PRISMA 2020 Flow chart (56).**

Description of included studies

A summary of the included studies and key findings are shown in Table 2, with the full extracted dataset available (see Supplement 2).

All eligible studies included both male and female participants (59). Study designs included; RCT, and feasibility, mixed methods pilot, cohort, and cross-sectional studies, with sample sizes between 5 and 474. Included studies were geographically widely distributed reflecting the ubiquity of PD and PD research (see Supplement 2).

Self-efficacy was a primary outcome in two studies and a secondary outcome in the remainder. Several self-efficacy measures were used in line with the protocol eligibility criteria (1). These included; the Falls Efficacy Scale International (FES-I) (60), Exercise Self Efficacy Scale (ESE) (61), the Self-efficacy for Exercise Scale (SEE) (62), Physical Activity Assessment Inventory (PAAI) (63), Norman Exercise Self-efficacy Scale (64), Self-efficacy for Management of Chronic Disease 6-item scale (SEMCD-6) (65) and the result of a qualitative thematic analysis (See Table 2).

DHT included; smartphones (66, 67), telehealth/telecoaching (68-70), instructional videos (71), video conferencing (68), online social media platforms (72), virtual physical therapy

sessions (59, 73), tablet devices (71, 72), physical activity trackers/sensors (70, 72, 74), smartwatches (67), videogame technology (73), focusing on falls, physical activity, or both.

Key intervention components across studies were education, training, and coaching. In three studies the interventions focused on physical activity (68, 70, 74) one explored physical activity and falls (71), and one mixed methods pilot study considered self-efficacy more broadly (67). Approaches included; virtual physical therapy (59), mobile phone interventions (66, 67), telehealth, tele-monitoring of exercise and telecoaching (68, 70, 74) exergaming (73), physical exercise and falls prevention using instructional physiotherapy material (71), remote monitored physical exercise, instructional material and a access to a social media platform (72).

Participant safety was a consideration in five of the nine studies, while digital literacy was not specially described in any of the included studies (68, 70, 71, 73, 74).

Effectiveness

Table 2 summarises the nine studies included in this review.

Five studies showed statistically significant findings in terms of improving self-efficacy (59, 66-74).Shih et al. (2018) was particular interesting study as it involved physical activity telecoaching that increased physical activity and strengthen posture (74).Grounded in self-determination theory this intervention enhanced motivation resulting in increased physical activity and ESE (74).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 (70). This study allowed progress to be measured which appears to be key to reinforcing participant belief in their own capabilities (21, 74). A sub-study of the Engage-PD study described above and included in this review improved self-efficacy using a telecoaching approach (70). Park et al. (2022) described a promising study which improved the level of self-efficacy in the measure used (67). This intervention based on

the information-motivation-behaviour (IMB) skills model used; smartphones, mobile applications, smartwatches, smartphone-based short text messages and information, and telephone counselling (67, 75, 76). One telecoaching mixed methods pilot study identified a perceived improvement self-efficacy in participants as a result of a qualitative thematic analysis (68). Another approach involving physiotherapy and instructional material improved self-efficacy as a secondary outcome, while not improving the primary outcome of the study (71).

Three studies showed no statistically significant improvement in self-efficacy, two were RCT's (66, 73), while one was a cross-sectional study (59). It is unclear on examining these studies why this was the case but may have been due to heterogeneity between the studies in terms of study design, DHT employed and self-efficacy measures used. The study which lowered the level of self-efficacy post-intervention had two distinct features which may explain what was observed (72). Firstly, the self-efficacy measure used was the PAAI, and was the only included study to use this (63). Whilst 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 (72, 77) 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 (72). The authors acknowledged that the small sample size minimised power and reduced confidence in the use of use non-parametric Wilcoxon signed-rank tests. These tests were used to compare the difference between pre-test survey and post-test survey scores (72). Despite this test findings were still evaluated to lend support to the percentage of change findings which might be considered a limitation. Whilst 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. 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.

Table 2 Summary of included studies

Studies which showed a statistically significant improvement in the self-efficacy measure		
Authors year Title	Study design, sample size and self-efficacy measure	Intervention description and key findings
Chivers Seymour, K., Pickering, R., Rochester, L. et al. (2019) Multicentre, randomised controlled trial of PDSAFE, a physiotherapist-delivered fall prevention programme for people with Parkinson's (71)	**Study design:** Randomised controlled trial using a pragmatic approach. **Sample size:** n=474 **Self-efficacy measure:** Falls Self-efficacy Scale International (FES-I) (60).	**Intervention:** Videos were recorded by physiotherapists using a tablet engaged in activities of the participant with or without strategies. Tailored video vignettes of strategies were given to participants on a DVD to remind/reinforce between face-to-face sessions (71). **Primary outcome:** No reduction in falling. **Secondary outcome:** Self-efficacy as a secondary sub-group analysis found that falls self-efficacy measured using the Falls-self-efficacy scale international (FES-I) showed a statistically improved compared to control at 6 months. Between-group difference 1.60 points, 95% CI 3.00 to 0.19, p=0.026 for the intervention at at 6-months.
Lai, B., Bond, K., Kim, Y. et al. (2020) Exploring the uptake and implementation of tele-monitored home-exercise programmes in adults with Parkinson's disease: A mixed methods pilot study (68)	**Study design:** Mixed methods pilot study **Sample size:** n=20 **Self-efficacy measure:** Thematic analysis of qualitative data	**Intervention:** telecoach-assisted exercise eight-week exercise prescription comprised of strength and aerobic exercise a telehealth system streamed and recorded vital signs and exercise data. Participants exercised under a telecoach's supervision via videoconferencing. Control group performed self-regulated exercise. **Outcomes:** The intervention group demonstrated greater exercise motivation. Qualitative thematic analysis identified participant reported increase in perceived self-efficacy
Park, Y., Kim, R.S., So, H. Y., et al. (2022) Effects of mobile phone intervention for self-management on self-efficacy, motor and non-motor symptoms, self-management, and quality of life in people with Parkinson's disease: Randomised controlled trial (67)	**Study design:** Randomised controlled trial compliant with the CONSORT statement **Sample size:** n=20 **Self-efficacy measure:** Self Efficacy for managing Chronic Disease 6-Item (SEMCD-6-item) (65).	**Intervention:** A mobile phone device, mobile applications, smartwatches, smartphone-based short text messages and information, and telephone counselling for 16 weeks. Based on the Information-motivation-behaviour (IMB) skills model (75, 76). **Outcome:** The self-efficacy score in the intervention group significantly improved compared to that in the control group (t=2.33, p=0.025). Intervention Pre-Post score (t=2.85 p=0.011) Compared to the control Pre-post test score (t=0.26 p=0.796). A statistically significant finding.
Quinn, L., Macpherson, C., Long, K. et al (2020) Promoting physical activity via telehealth in people with Parkinson disease: The path forward after the COVID-19 pandemic (70)	**Study design:** Case description: **Sample Size:** n=27 **Self-efficacy measure:** Norman Self-efficacy Scale for Exercise (64).	**Intervention**: 4 coaching sessions, delivered via a telehealth platform, incorporated 1:1 coaching, goal-setting, physical activity monitoring, and use of a disease-specific workbook resources aimed at promoting physical activity. **Outcome:** Pre/post scores showed a significant increase in self-efficacy (d=0.95 p<0.001). Study design does not have a control or blinding. Suggests Engage PD as an intervention is adaptable.
Shih, S. H-J., Macpherson, C.E., King, M., et al. (2018) Physical activity coaching via telehealth for people with Parkinson disease: A cohort study (74)	**Study design:** A single cohort study with no control group and no blinding of the participants **Sample Size:** n=62 **Self-efficacy measure:** Exercise Self-efficacy Scale (61)	**Intervention;** Engage-PD consists of up to 5 personal coaching sessions delivered via telehealth, over a 3-month period. Number and frequency of coaching sessions is based on the individuals' needs and progress. Time periods between sessions are tapered. The coaching intervention was led by licensed physical therapists using Zoom™ video communication

		Outcome: Exercise self-efficacy pre to post intervention rose with a large effect size Cohens *d* 1.20. Participants with lower baseline ESE showed the greatest rise.
Studies which did not raise self-efficacy to a statistically significant level in the measure used		
Authors Year Title	Study design, sample size and self-efficacy measure	Intervention description and key findings
Ginis P., Nieuwboer, A., Dorfman, M., et al (2016) Feasibility and effects of home-based smart-phone delivered automated feedback training for gait in people with Parkinson's. A pilot randomised controlled trial (66),	**Study design:** Pilot Randomised controlled trial **Sample size:** n=40 **Self-efficacy measure:** Falls Self-efficacy Scale International (FES-I) (60).	**Intervention**: The CuPiD, used a smartphone application that offered positive and corrective feedback on gait Two applications were used in this study: the audio biofeedback (ABF-gait app) and the instrumented cueing for Freezing of gait (FOG) training (FOG-cue app). Feedback and cues were provided via earphones or the smartphone's speaker. In terms and frequency gait training was undertaken 30 minutes 3 times a week for 6 week period. **Outcome**: Self-efficacy was measured using the FES-I (78) Effects at 6 weeks (Time (p=0.91) X Group (p=0.84 equals p=0.89) Not clinically significant over time.
Manãgo M.M., Swink, L.A., Hager, E.R. (2021) The impact of COVID-19 pandemic on community based exercise classes for people with Parkinson disease (59)	**Study design:** Cross-sectional Study **Sample Size:** n=87 **Self-efficacy measure:** Self-efficacy for Exercise (SEE) (62).	**Intervention** Data were collected via custom-designed electronic surveys for people with PD and class instructors who reported attending or teaching PD-specific exercise class ≥1 time/week for ≥3 months prior to pandemic restrictions. Self-efficacy was measured using the Self-efficacy for exercise scale (SEE). **Outcome:** Whilst SEE was measured at baseline authors report it could not be measured as an outcome at another time point due to the cross-sectional design of the study
Song, J., Paul, S.S., Caetano, M.J.D., et al (2018) Home-based step training using videogame technology in people with Parkinson's a single-blinded randomised controlled study (73)	**Study design** A two-arm, parallel, single-blinded randomised controlled trial **Sample size**: n=60 **Self-efficacy scale:** Falls Efficacy Scale-International (FES-I) (60).	**Intervention:** step pad training, taught by experienced physiotherapists to perform the exergame in their home by an experienced physiotherapist. In terms of duration and intensity participants were encouraged to perform the exergame for a minimum of 15 minutes, three times a week for 12 weeks. The exergame was an adapted version of dance mania Stepmania™ game(79). **Outcomes**: Secondary Falls efficacy scale I Week 12 minus Week 0 Intervention minus control p value 2.8 (-0.8 to 6.5) p=0.13. P value indicates no statistical significance in terms of the intervention
Studies which statistically lowered self-efficacy in the measure.		
Authors Year Title	Study design, sample size and self-efficacy measure	Intervention description and key findings
Hermanns, M., Haas, B.K., Lisk, J (2019) Engaging older adults with Parkinson's physical activity: A feasibility study (72)	**Study design:** Longitudinal Pre-test Post-test design **Sample size:** n=5 **Self-efficacy measure**: Physical Activity Assessment inventory (PAAI) (63).	**Intervention**: Devices used were Fitbits ™ and iPads given to PwP. In addition, participants had access to a private social media support group. via an electronic tablet, exercise compliance was measured using the Fitbit device. Participants also received instructional videos. In terms of frequency and duration this was 3 times a week for 12 weeks There was No control group **Outcome:** PAAI measure at 12 weeks was pre-test total score 4585.00 minus post test scores 2620.00 percentage of change in sum score -42% . PAAI total scores using Wilcoxon signed-rank tests maintained nonsignificant ($p > .05$). Full breakdown of PAAI in appendix iv.

Physical Activity Assessment Inventory-PAAI* Self-efficacy scales- FES-I: - Falls Self-efficacy Scale-International; -FES SEMCD-6: - Self-Efficacy for Managing Chronic Diseases 6-item Scale ESE: - Exercise Self-Efficacy Scale *SEE Self-efficacy for exercise scale.

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. Nine studies met the eligibility criteria

(59, 66-68, 70-74), of which five improved self-efficacy (67, 68, 70, 71, 74), three did not (59, 66, 73) and one lowered the level of self-efficacy (72).This suggests that the use of DHT has potential to improve self-efficacy, and hence improve self-management by acting as a mediator.

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 focusses on self-efficacy as a primary outcome. 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 sizable gap in terms of primary studies which have explored the impact of DHT on self-efficacy in PwP. 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 (80-84).

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 studies. For these same reasons direct comparisons between interventions was 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.

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 (57, 58). 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.

This review is this first of its type .to scope the literature for primary studies which have explored the impact of DHT on self-efficacy in PwP (1). It complements research which as explored to the role of interventions to raise self-management in PwP (12, 14, 16, 25). It has demonstrated the opportunities and challenges of reviewing the literature on this topic present, particularly around how self-efficacy as an outcome is reported in the literature. Additionally, this review has identified a substantial gap in the literature which future research may address. Three interventions produced statistically significant improvements in self-efficacy compared to controls, two being RCT's and one being a cohort study (67, 71, 74). 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 postive behaviour changes which improve self-efficacy (74, 85).

With greater resources and time, a broader search of the literature could have been undertaken, potentially identifying more eligible studies. Optimising the number and type of databases was an iterative process, and while increasing the number of databases from six to eight, the number of records identified was too large and unmanageable. 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 omitted from the review but may have been eligible. Whilst 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 obsolete.

Given the limited number of eligible studies included in this review, future research might focus on designing and performing high-quality primary studies which explore the role of DHT on self-efficacy for PwP. Alternatively, future research might take the form of literature reviews which use different frameworks or address the limitations of this review to coalesce the available primary studies in a more effective way. None of the studies included in this review considered cost, or CP of PwP as study participants, identifying two avenues of research which be worth pursuing.

CONCLUSIONS

Overall, this review identified a limited number of studies which explored the role of DHT to improve self-efficacy in PwP. Included studies used a variety of study designs, DHT, and self-efficacy measures. The findings of this review are insufficient to be generalisable but have identified potential gaps in the literature. Primary research is needed to better understand the potential role of DHT in elevating self-efficacy in PwP.

Patient and public involvement statement

This study utilised patient and public involvement as outlined in the methods section of this review.

ETHICS AND DISSEMINATION

As this is a piece of secondary research which has used retrospectively retrieved pre-exiting primary research studies which are published and in the public domain ethical approval was not required.

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 reviews 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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Contributors

AMH was involved in study design, development of scoping review search strategy, data collection, data analysis, data interpretation, production of figures and writing of the manuscript and contributed meaningfully to the drafting and editing. AMH has approved the final manuscript. VA was involved in title and abstract and full text screening and data extraction checking and has approved the final manuscript. CBC, VA, and EM were involved with revisions to manuscript, scrutiny of the data analysis, presentation of findings and their interpretation. CBC, VA, and EM have all approved the final manuscript.

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Patient consent for publication Not applicable

Patient and public involvement statement This scoping review included patient and public involvement which is described full in the methods section.

Patient consent for publication Not applicable.

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Data availability statement All data relevant to the study are included in the article or uploaded as supplementary information. This review does not contain patient identifiable data

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Appendix i

Updated literature search results

Records identified from databases		
Bibliographic database	**Dates searched**	**Number of records**
Embase	24/03/2023 to 09/02/2024	n=4361
Medline	24/03/2023 to 09/02/2024	n=200
Web of Science	24/03/2023 to 09/02/2024	n=842
CINAHL	24/03/2023 to 09/02/2024	n=1423
PsychINFO	24/03/2023 to 09/02/2024	n=144
IEEE Xplore	24/03/2023 to 09/02/2024	n=65
Google Scholar	2023-2024	n=22
Records identified from registers		n=0
Records identified from other sources		n=0
		Total number of records n=7057
		Total number of records after de-duplication
		n=5082

Records marked as ineligible by automation			
Boolean operator	**Field**	**Parameter**	**Term**
	Title	Contains	Parkin*
OR	Title	Contains	Parkinson's disease
AND	Title	Contains	Digital*
OR	Title	Contains	Technology
OR	Title	Contains	Tele*
OR	Title	Contains	Health Technology
AND	Title	Contains	Self*
OR	Title	Contains	Self-efficacy
NOT	Title	Contains	Review
AND	Year	Greater than or equal to	2023
			n=136 records

Title and abstract screening in Rayyan	
Exclusion reasons	Number of records*
Wrong population	n=134
Wrong outcome	n=61
Wrong study design	n=31
Wrong publication type	n=1
Foreign Language	n=1
Total number of eligible records	n=0

*The number of records exceeds 136 as some records were excluded for more than 1 reason.

Appendix ii

Search terms combinations and Boolean operators for each database used

Database	Search terms to be used and Boolean operators	Number of records identified in the initial search
Medline (EBSCO host)	Parkinsonian disorders **AND** Tele* OR Telemedicine OR Telehealth OR Telemonitoring OR Telepractice OR Telenursing OR Telecare **AND** Self* OR Behavior change OR Behavior Modification[t]	**9, 875**
PsycINFO	((Parkin* AND PEER (yes)) OR ((Parkinson disease) AND PEER (yes) OR ((Parkinsons disease) AND PEER (yes)) OR ((Parkinson's disease) AND PEER (yes)) OR ((Movement disorders) AND PEER (yes)) OR ((alpha synuclein) AND PEER (yes)) **AND** Technology AND PEER ((yes) OR ((Health technology) AND PEER ((yes) OR (Tele*AND PEER ((yes) OR (Telehealth AND PEER (yes)) OR (Telemedicine AND PEER ((yes) OR (Telemetry AND PEER (yes)) OR Sensors AND PEER (yes)) OR Wearables AND PEER (yes)) OR ((Assistive technology) AND PEER (yes)) OR ((Home based care) AND PEER (Yes)) OR ((Home-based care) AND PEER (yes)) OR ((IoT AND PEER (yes)) OR ((Internet of things) AND PEER (yes)) OR ((Virtual consultations) AND PEER (yes)) OR ((Video Consultations) AND PEER (yes))) **AND** ((Behav* AND PEER (yes)) OR Behavior AND PEER (Yes)) OR Behaviour AND PEER (yes)) OR ((Behavior Change) AND PEER (yes)) OR ((Behavior modification) AND PEER (yes)) OR (Self* AND PEER (yes)) OR ((Self Concept) AND PEER (yes)) OR ((Self efficacy) AND PEER (yes)) OR (AND PEER (yes)) OR (Self-efficacy AND PEER (yes)) OR (Self-management AND PEER (yes)) OR Rehabilitation AND PEER (yes)) OR (Resilience AND PEER (yes)) AND (La.exact(ENG*) AND PEER (yes))	**1, 576**
CINAHL	MW (Parkinson's disease or Parkinson disease or pd or parkinsonism) **OR** SU Movement disorders **OR** MW Parkinsonian disorders **OR** TI Parkinson disease **AND** (telehealth or telemedicine or telemonitoring or telepractice or telecare) **OR** MW technology in healthcare **OR** MW digital technology **AND** TX (Self-efficacy or self efficacy or confidence or self esteem) **OR** TX self concept **OR** (self-	**3, 891**

	management or self-care or self-regulation or self-monitoring) **OR** MW (Behavior change or Behavior modification)	
Web of Science	((((((((((((((((((TI=(Parkinson disease)) OR TI=(Parkinson's disease)) OR TS=(Movement disorders)) OR ALL=(Parkin*)) AND ALL=(Tele*)) OR TS=(Digital health)) OR TS=(Mobile health)) OR TS=(eHealth)) OR TS=(Sensors)) OR TS=(Home based care)) OR TS=(Telemetry)) OR TI=(Virtual consultations)) AND TI=(self-efficacy)) OR TI=(self-efficacy)) OR TI=(self management)) OR TI=(self-management)) OR TS=(Patient activation level)) OR TS=(Behavior change)) OR TS=(Behaviour change)) OR TS=(Behaviour modification)) OR TS=(Behavior modification)	**2,651**
Embase	#1 Parkinson disease/or Parkin/or Parkin*.mp. #2 Parkinson's disease.mp. or exp Parkinson disease/ #3 controlled study/exp Parkinson disease/ or exp levodopa/or Parkinson disease*.mp. #4 Movement disorders.mp. exp motor dysfunction/ #5 1 or 2 or 3 or 4 **AND** #6 telecommunication/or Tele*.mp. or telemedicine/ #7 telemedicine.mp. or telemedicine robot/ or telecommunication/or telemedicine/ or healthcare delivery /or patient/ #8 telehealth.mp.or telecommunication/ or telehealth/or health care/or telemedicine #9 telecare.mp. or exp telecare/ #10 exp medical informatics/ or digital health.mp. #11 eHealth.mp./exp telehealth/ #12 mHealth.mp.or mobile health application/ #13 6 or 7 or 8 or 9 or 10 or 11 or 12 **AND** #14 exp self care / or self medication/or exp self concept/exp self-testing/ or self evaluation/ exp self-monitoring/or General self-efficacy scale/ or exp self help/ or self*mp. or exp self report/ or self esteem/ or self-help device/ or Self-rating Depression Scale/ #15 self management.mp. or exp self care/ #16 self-efficacy.mp. or exp self concept #17 behavior*.mp. or exp behaviour modification/or exp care behavior #18 14 or 15 or 16 or 17 #19 5 **AND** 13 **AND** 18	**3, 136**
IEEE Xplore	("Mesh_Terms":Parkin*) OR ("All Metadata":Parkinson's disease) OR ("All Metadata":Neurodegenerative disorders) OR ("All	**3195**

	Metadata":Idiopathic Parkinson's Disease) **AND** ("Mesh_Terms":Tele*) OR ("All Metadata":Digital Health) OR ("All Metadata":Mobile Health) **AND** ("Mesh_Terms":Self*) OR ("All Metadata":Self, concept) OR ("All Metadata":self, rehabilitation) OR ("All Metadata": Self-management)	
Google Scholar™	Parkinsonian disorders Telemedicine Self-efficacy Self-management No Boolean operators used Filtered by date-2012-2022	**2210**

Appendix iii

Data extraction sheet

Article Information	Data to be extracted	Additional comments
General Information		
	Year of Publication	
	Country of publication	
	Country study took place	
	Initial sample size	
	Analysed sample size	
	Study design	
Demographic data		
	Age	
	Sex	
	Ethnicity	
	Age of PD diagnosis	
	Marital status	
	PwP or Caregiver (and relationship between if known)	
	Hoehn and Yahr score at time of recruitment	
	Socio-economic status	
	Disease duration	

	Index of multiple deprivation (IMD)	
	Level of digital literacy	
	Excluded populations (if mentioned)	
Intervention description		
	Intervention type: e.g., Digital hybrid	
	Type of device: e.g., Smart phone, acceloreter, gyroscope, motion sensor	
	Duration of intervention and frequency	
	Length of intervention use overall	
	Level of intervention modification	
	Setting intervention took place	
	TIDieR guidelines if relevant	
	Mapping to PRISMS taxonomy of self-management	
Outcome/outcome measures		
	Scale used to measure self-efficacy	
	Self-efficacy measured as a primary or secondary outcome	
	Magnitude of change in level of self-efficacy	
	Outcomes measured in addition to self-efficacy	
	PD symptoms measured	
	Objective measurement (Yes/No)	
	Self-reported or CP reported outcomes	
	Effective (Yes/No/Not evaluated)	
	Safety assessed	

Appendix iv

The complete self-efficacy PAAI measure sum scores reported by Hermans, Haas and Lisk (2019) (72).

Confidence to perform usual physical activities when/during	Pre-test sum score	Post-test sum score	Percentage change in sum score	
Feeling tired	325	320	-1.54	
Feeling pressure from work/school	475	220	-53.68	
Bad weather	485	380	-21.65	
Experiencing personal problems	490	340	-30.62	
Feeling depressed	385	360	-6.49	
Feeling anxious	460	380	-17.39	
Physical discomfort with activity	395	250	-36.71	
Too much work at home	430	320	-25.38	
Having visitors	435	370	-14.94	
Other interesting things to do	440	320	-27.27	
Don't have support from family/friends	455	320	-29.6	
Have other time commitments	430	320	-25.58	
Do not feel well				
PAAI Total score sums pre-test, post-test and overall percentage change				
	4,585.00	2,620.00	-42.86	

Figure 1 PRISMA flowchart (56).

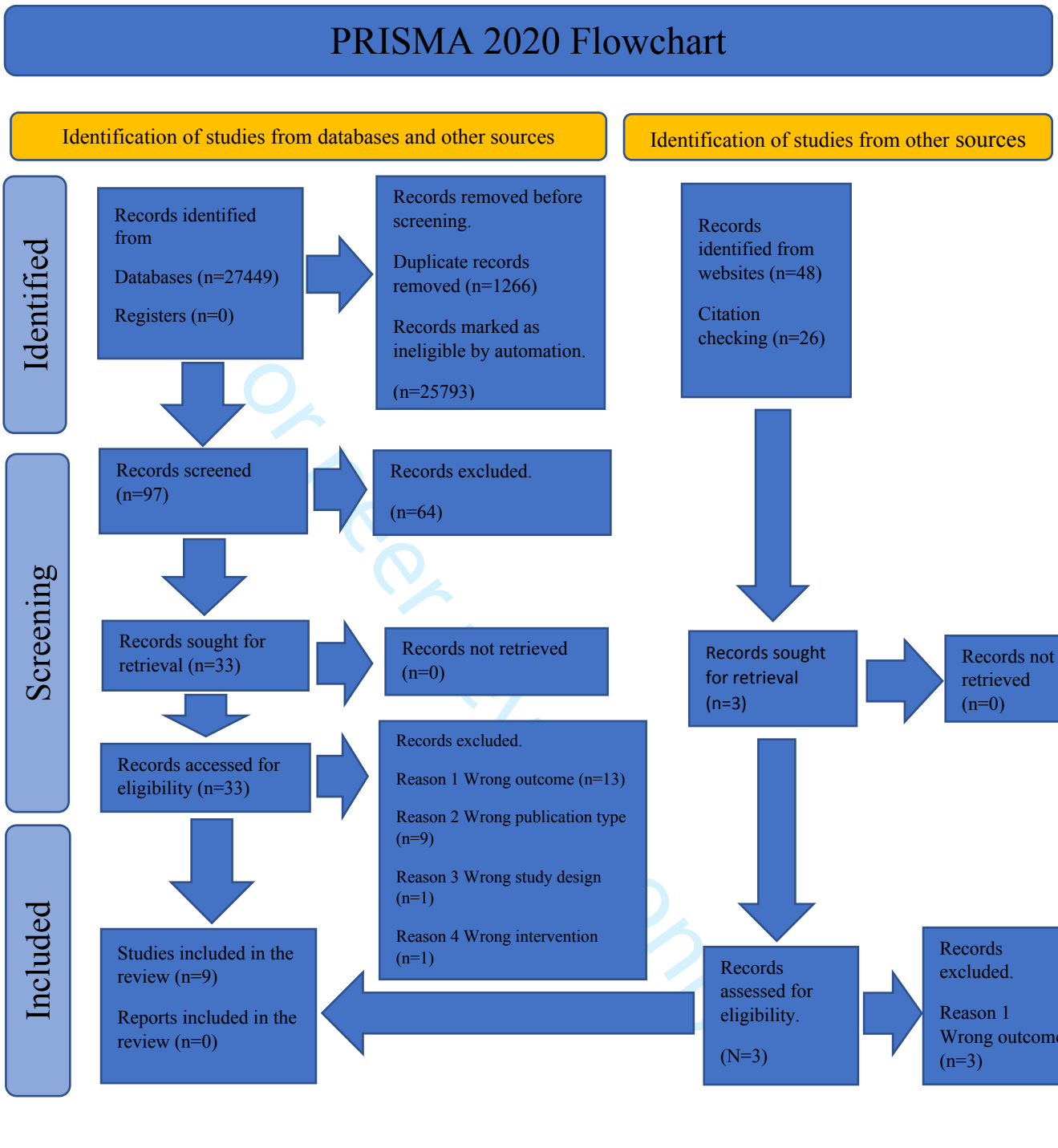

Table for excluded studies

No.	General information Author(s) title	Reject/not for data extraction and reason
1	Palliative Virtual Home Visits for Atypical Parkinsonian Disorders (PVH-Park Study) M. Afshari, A. Butala, J. Guenther, A. Pantelyat, N. Galifianakis.	Wrong Publication type: International Parkinson and movement disorder society Meeting abstract.
2	M. Armstrong, T. Rookes, A. Schrag, K. Walters A facilitated self-management toolkit for people with Parkinson's disease: A feasibility study of 'Live Well with Parkinson's.	Wrong Publication type: International Parkinson and movement disorder society Meeting abstract.
3	Butterfield, L. C.; Cimino, C. R.; Salazar, R.; Sanchez-Ramos, J.; Bowers, D.; Okun, M. SThe Parkinson's Active Living (PAL) Program: A Behavioral Intervention Targeting Apathy in Parkinsons Disease.	Wrong outcome.
4	Carvalho, L. P.; Decary, S.; Beaulieu-Boire, I.; Dostie, R.; Lalonde, I.; Texier, E.; Laprise, L.; Pepin, E.; Gilbert, M.; Corriveau, H.; Tousignant, M Baduanjin qigong intervention by telerehabilitation (Teleparkinson): A proof-of-concept study in parkinson's disease.	Wrong outcome.
5	Feasibility of large-scale deployment of multiple wearable sensors in Parkinson's disease. De Lima, A. L. S.; Hahn, T.; Evers, L. J. W.; De Vries, N. M.; Cohen, E.; Afek, M.; Bataille, L.; Daeschler, M.; Claes, K.; Boroojerdi, B.; Terricabras, D.; Little, M. A.; Baldus, H.; Bloem, B. R.; Faber, M. J.	Wrong outcome.
6	Telephone-administered cognitive behavioral therapy for depression in Parkinson's disease: A randomized controlled trial Dobkin, R. D.; Gara, M. A.; Rodriguez, K.; Interian, A.; Menza, M.	Wrong outcome.
7	Personalized Telemedicine for Depression in Parkinson's Disease: A Pilot Trial Dobkin, R. D.; Interian, A.; Durland, J. L.; Gara, M. A.; Menza, M. A.	Wrong outcome.
8	Need for personalized monitoring in Parkinson's Disease: The perspectives of patients and specialized healthcare providers Evers, L.; Bloem, B.; Meinders, M	Wrong Publication type: International Parkinson and movement disorder society Meeting abstract.
9	Usability of a patient-centered wearable system for continuous monitoring of Parkinson's disease. Fountas-Davis, N.; Daghstani, J.; Heldman, D.; Pulliam, C.; Giuffrida, J	Wrong Publication type: 4th World Parkinson Congress.
10	Home-based exercise monitored with telehealth is feasible and acceptable compared to centre-based exercise in Parkinson's disease: A randomised pilot study Flynn, A.; Preston, E.; Dennis, S.; Canning, C. G.; Allen, N. E.	Wrong outcome.
11	Sensor-Based and Patient-Based Assessment of Daily-Living Physical Activity in People with Parkinson's Disease: Do Motor Subtypes Play a Role? Galperin, I.; Herman, T.; Assad, M.; Ganz, N.; Mirelman, A.; Giladi, N.; Hausdorff, J. M.	Wrong outcome.
12	Acceptability and practicability of self-management for patients with Parkinson's disease based on smartphone applications in China Hu, J.; Yuan, D. Z.; Zhao, Q. Y.; Wang, X. F.; Zhang, X. T.; Jiang, Q. H.; Luo, H. R.; Li, J.; Ran, J. H.; Li, J. F.;	Wrong outcome.
13	A collaborative approach to exercise provision for people with Parkinson's - a feasibility and acceptability study of the PDConnect programme [version 2; peer review: 2	Wrong study design (protocol paper) no primary data full

	approved]Julie Jones, Lyndsay Alexander, Elizabeth Hancock, Kay Cooper	study will measure self-efficacy.
14	PKG Movement Recording System Use Shows Promise in Routine Clinical Care of Patients With Parkinson's Disease Joshi, R.; Bronstein, J. M.; Keener, A.; Alcazar, J.; Yang, D. D.; Joshi, M.; Hermanowicz, N	Wrong outcome.
15	Transition and Sustainability of an Online Care Model for People With Parkinson's Disease in Response to the COVID-19 Pandemic Ketigian, L.; Piniella, N.; McGivney, K.; Lui, S.; Dukat, A.; Jung, M. K.; Gallagher, R.; Leder, A.	Wrong outcome.
16	Digital biomarker sensor feature data reflect quality of life judgements (PDQ39) in recently diagnosed Parkinson's disease patients Lipsmeier, F.; Taylor, K.; Volkova-Volkmar, E.; Staunton, H.; Postuma, R.; Kilchenmann, T.; Wolf, D.; Zhang, Y.; Cheng, W. Y.; Scotland, A.; Schjodt-Eriksen, J.; Boess, F.; Ness, D.; Gossens, C.; Post, A.; Lindemann, M.	Wrong Publication type: International Parkinson and movement disorder society. Meeting abstract.
17	Engage-PD: A Physical Activity Coaching Program via Telehealth for people with Parkinson's Disease - Preliminary results a year after inception Macpherson, C.; King, M.; Shih, H.; Rieger, J.; Fineman, J.; Reid, J.; Pacheco, A.; Shah, H.; Alcalay, R.; Quinn, L.	Wrong Publication type: International Parkinson and movement disorder society. Meeting abstract.
18	Preliminary evaluation of the Integrated Parkinson's Care Network (IPCN): An integrated care model for complex needs. Mestre, T.; Kessler, D.; Cote, D.; Thavorn, K.; Liddy, C.; Taljaard, M.; Grimes, D	Wrong Publication type: International Parkinson and movement disorder society. Meeting abstract.
19	Pilot Evaluation of a Pragmatic Network for Integrated Care and Self-Management in Parkinson's Disease Mestre, T. A.; Kessler, D.; Cote, D.; Liddy, C.; Thavorn, K.; Taljaard, M.; Grimes, D.	Wrong outcome.
20	Exploring the experiences of people and family carers from under-represented groups in self-managing Parkinson's disease and their use of digital health to do this Nimmons, D.; Armstrong, M.; Pigott, J.; Walters, K.; Schrag, A.; Ogunleye, D.; Dowridge, W.; Read, J.; Davies, N.	Wrong outcome.
21	"You have to know why you're doing this": a mixed methods study of the benefits and burdens of self-tracking in Parkinson's disease Riggare, S.; Scott Duncan, T.; Hvitfeldt, H.; Hägglund, M.	Wrong outcome.
22	A randomized trial of individual versus group-format exercise and self-management in individuals with Parkinson's disease and comorbid depression Sajatovic, M.; Ridgel, A. L.; Walter, E. M.; Tatsuoka, C. M.; Colón-Zimmermann, K.; Ramsey, R. K.; Welter, E.; Gunzler, S. A.; Whitney, C. M.; Walter, B. L	Wrong intervention, correct outcome.
23	Supervised, home-based, real-time videoconferencing telerehabilitation preserves perception of some clinical aspects in people with Parkinson's disease: Preliminary data of a retrospective study Tardelli, E.; Okamoto, E.; Almeida, F.; Neto, A. M.; Barbosa, E.; Batista, C.	Wrong Publication type: International Parkinson and movement disorder society. Meeting abstract.
24	Passive monitored daily motor behavior significantly relates to quality of life in individuals with early Parkinson's disease. Thomann, A.; Taylor, K.; Lipsmeier, F.; Volkova-Volkmar, E.; Postuma, R.; Cheng, W. Y.; Van Lier, B.; Trundell, D.; Zago, W.; Boulay, A.; Pagano, G.; Gossens, C.; Lindemann, M.	Wrong Publication type: International Parkinson and movement disorder society. Meeting abstract.

General information Author(s) title	Reject/not for data extraction and reason	Year of Publication	Country of study	Country of Publication	Initial sample size	Analysed sample size	Study design	Demographic data	Age Range	Ethnicity	PwP or CG (and relationship between the two)
Feasability and effects of home-based smartphone-delivered automated feedback training for gait in People with Parkinson's diseaase: A pilot study Ginis, P.; Nieuwboer, A.; Dorfman, M.; Ferrari, A.; Gazit, E.; Canning, C. G.; Rocchi, L.; Chiari, L.; Hausdorff, J. M.;	Include?	2015	Belgium & Israel	Belgium	n=40 PwP Participants were included if they were able to walk for 10 minutes continuously; had a MoCA score higher than 24; were in a Hoehn and Yahr Stage II to III in the 'on'	35 PwP	Pilot study (Intervention and Control)	Not specifically described	Not specifically descrbed	Not specifically described	PwP
Engaging Older Adults With Parkinson's Disease in Physical Activity Using Technology: A Feasibility Study. Hermanns, M.; Haas, B. K.; Lisk, J.	Include?	2019	United States of America	United States of America	n=5 PwP	5 PwP	Longitudinal pretest/ posttest design	Demographic variables Gender Male 3 (60%) Female 2 (40%) Race/ethnicity Caucasian, non-	Age (years) M/Mdn 73.00/72.00 SD (4.95) Range 69-81 yrs	100% (5) Caucasian/ non-hispanic	PwP
Exploring the uptake and implementation of tele-monitored home-exercise programmes in adults with Parkinson's disease: A mixed-methods pilot study Lai, B.; Bond, K.; Kim, Y.; Barstow, B.; Jovanov, E.; Bickel, C. S.	Include?	2020	United States of America	United States of America	n=20 PwP	20 PwP	Mixed methods pilot study two interventions, telecoach assisted vs self-regulated home exercise.	Age years (I) n=10) 63.4+/-10.4(56-71) (c) n=10) 70.8 +/- 7.1 (66-76) BMI (Kg/m2) (I) 29.2 +/- 6.7 (24-34) (C) 27.2 +/- (22-32) Sex n Male/female (I) 7/3 (C) 7/3	Age years (I) n=10) 63.4+/- 10.4(56-71) (c) n=10) 70.8 +/- 7.1 (66-76)	Ethnicity n Non-hispanic White/Black (I) 9/1 (C) 10/0	PwP
The Impact of COVID-19 on Community-Based Exercise Classes for People With Parkinson Disease Manago, M. M.; Swink, L. A.; Hager, E. R.; Gisbert, R.; Earhart, G. M.; Christiansen, C. L.;	Include?	2021	United States of America	United States of America	n=87 PwP and 43 Instructors	n=87 PwP and 43 Instructors	Crossectional study Custom-designed electronic surveys	Participants (n=87)- Age y Mean (SD) 70.2 (7.3) Sex % female (n) 51.7% (45) Race % Caucasian (n) 93% (81) Ethnicity % non-Hispanic (n)	(n=87)- Age years Mean (SD) 70.2 (7.3) Sex % female (n) 51.7% (45)	Race % Caucasian (n) 93% (81) Ethnicity % non-Hispanic (n) 92% (80) H	PwP and Instructors
Effect of mobile health intervention for self-management on self-efficacy, motor and non-motor symptoms, self-management, and quality of life in people with Parkinson's disease: Randomized controlled trial Park, Y.; Kim, S. R.; So, H. Y.; Jo, S.; Lee, S. H.; Hwang, Y. S.; Kim, M. S.;	Include?	2022	South Korea	South Korea	n=50	43 PwP	Randomised, Controlled Trial	Demographic characteristics Gender Men (I) 5 (25.0) (C) 8 (34.8) Age yrs (I) 62.20 +/- 7.43 (c) 64.27 +/- 8.28 Education level (I) 5 (25.0) 2 (10.0) 9 (45.0) College or above 4 (20.0) (C) Elementary school	(I) 62.2 +/- 7.43 (c) 64.27 +/- 8.28	Not found in the demographic data	PwP

Promoting Physical Activity via Telehealth in People With Parkinson Disease: The Path Forward After the COVID-19 Pandemic? Quinn, L.; Macpherson, C.; Long, K.;	Include?	2020	United States of America	United States of America	n=27	n=27	Single cohort implementation study (Case description)	Age Mean (SD) age for the participants was 66.5 (8.6); Ethnicity 22 identifed as white, 1 Asian, 1 Hispanic, 1 Other 2 Declined	Age Mean (SD) age for the participants was 66.5 (8.6) (n=27);	Ethnicity 22 identifed as white, 1 Asian, 1 Hispanic, 1 Other 2 Declined	PwP and 12 PwP were accompanied by a caere partner.
Multicentre, randomised controlled trial of PDSAFE, a physiotherapist-delivered fall prevention programme for people with Parkinson's Seymour, Kim Chivers; Pickering, Ruth; Rochester, Lynn; Roberts, Helen C.; Ballinger, Claire; Hulbert, Sophia; Kunkel, Dorit; Marian, Ioana R.; Fitton, Carolyn; McIntosh, Emma; Goodwin, Victoria	Include?	2019	England	England	n=474 (I) 6 Months n=176 (C) n= 196	n=372	Multicentre, randomised controlled trial.	Baseline characteristics in the PDSAFE and control groups: figures are number (%) unless stated otherwise PDSAFE (n=238*) Control (n=236†) Gender Male Female 147 (62%) 91 (38%) 119 (50%) 117 (50%) Age (years) Mean (SD) Min to max 71	Age (years) Mean (SD) Min to max 71 (7.7) 51 to 91 73 (7.7) 46 to 88	Not recorded in baseline characteristics	PwP
Physical Activity Coaching via Telehealth for People With Parkinson Disease: A Cohort Study Shih, Hai-Jung Steffi Macpherson, Chelsea E King, Miriam Delaney, Elizabeth Gu, Yu Long, Katrina Reid, Jennifer Fineman, Julie Yu, Geraldine Rieger, Jamie Satchidanand, Ashrita Shah, Hiral	Include?	2022	United States of America	United States of America	n=62	Analysed for ESE n=52	Cohort study	Demographic data (n=62) (Mean and standard deviation) Age yrs 65.4 +/- 9.2 Sex Male 39 (62.9%) Female 23 (37.1%) Weight, Kg 73.6 +/- 14.2 Height, cm 172.0 +/- 8.9 Race/ethnicity White 53 (85.5%)	Age yrs 65.4 +/- 9.2	Race/ethnicity White 53 (85.5%) Black/African American 3 (4.8%) Hispanic 1 (1.6%) Asian 0 (0%) Other 2 (3.2%)	PwP

Home-based step training using videogame technology in people with Parkinson's disease: a single-blinded randomised controlled trial Song, J.; Paul, S. S.; Caetano, M. J. D.; Smith, S.; Dibble, L. E.; Love, R.; Schoene, D.; Menant, J. C.; Sherrington, C.; Lord, S. R.; Canning, C. G.; Allen, N. E.	Include?	2018	Australia	Australia	60 Community dwelling people with Parkinson's	Intervention group n=3 withdrew from study. N= 6 discontinued intervention. Control group Loss to follow-up n=3 withdrew from study n= 1 partial follow-up due to ankle injury	Two-arm parallel, single blinded randomised controlled trial.	Mean (SD) or number for participants' characteristics at baseline. Groups Intervention (n=31) (I) Control (n=29) (C) Age (I) 68 (7) (C) 65 (7) Gender (male) (I) 15 (48%) (C) 9 (31) Height (m) (I) 1.7 (0.1) (C) 1.7 (0.1) Weight (kg) (I) 76 (15) (C) 78 (18) Cognitive status (MMSE 0-30) (I) 28 (2) (C) 29 (1) Duration of disease (years) (I) 7 (4) (C) 9 (6) Disease severity "on" MDS-UDPRS part III (0-132) (I) 31 (11) (C) 33 (11) Fallen in past year (participants-yes) (I) 17 (55%) (C) 16 (55%) Freezing of gait (participants-	Interventio n (n=31) 68 (7) Control (n=29%) 65 (7)	Not recorded demograph ic data table	PwP

H&Y score at time of recruitment or other measure of disease severity	Socio-economic status	Disease duration	Index of multiple deprevation	Level of digital litracy	Excluded populations	Intervention description	Intervention type	Type of device	Duration of intervention and type	Length of intervention	Level of interventions modification
II-III in ON state	Not specified	Not stated	Not stated	Not recorded	People were excluded if they had secere medical conditions affecting gait other than PD, had hearing or visual problems predcluding benefiting from auditory feedback and were likely to change medication	Two applications were used in the study 1) The audio-biofeedback (AFB-Gait App) and the instrumented cueing for FOG-training (FOG-cue App) Feedback and cues were provided via earphones or the smartphones speaker.	mHealth Apps around gait and balance	Smartphone-Galaxy S3-mini, Samsung South Korea	CuPiD Smartphone App's and walk 3 times per week according to ACSM exercise guidelines.	6 weeks	Duration and frequency times specific, however some flexibility around timing and type of walking activity.
Stage of Parkinson's disease M/Mdn 1.70/1.50 (SD) 0.57 Range 1.00-2.50	Not specified	Not stated	Not stated	Not recorded	Exclusion criteria included inability to perform large muscle physical movements and cognitive impairments that	Fitbit and Ipads and online resources included preloaded videos. Exercise 3 times a week. Online participant a minimum	Fitbit (activity tracker), Ipad, pre-loaded videos, access to an online support group.	Physical activity tracker and an electronic table to engage with an online support group	Activity 3 times per week and a minimum of three sessions per week online support for a duration of 12 weeks.	12 weeks	No specified, however, exercise is unsupervised
Hoehn and Yahr scores (I) 2.15+/- 0.47 (1.5-3) (c) 2.3 +/- 0.63 (1-3)	No included in demographic data except employment status Employed/unemployed (I) 3/8 (C) 2/8	Duration of disease (years) (I) 6.55+/- 4.52 (1-16) (C) 7.55 +/- 4.78 (0.8-15.5)	Not included	Not recorded	Exclusion criteria included (a) performing > 150 min/week moderate intensity exercise (B) no wireless internet access at home (c) any orthopaedic, vascular, or cardiac	telecoach-assisted exercise, with an exercise prescription. Includes telecoach vision. Consists of three components; coach console PlayStation and the Internet via a	Online supervised telecoaching via the internet, exercise equipment, instrumental recording of physical activity via a bloodtooth	10.5 inch Android computer tablet with Bluetooth and wireless internet capability, mounted to an adjustable floor	Exercise prescription included eight weeks of exercise (three times per week:24 total sessions) with a goal of 165 min/week of combined aerobic and strength excercises.	Eight weeks	Intervention description appears to suggest standardised rather than tailored intervention
Not measured	Highest degree earned High School diploma/associates 14.9% (13)Degree % (n) 39.1% (34) Master,	Years since Diagnosis <1, % (n) 0% (0) 1-3% (n) 20.7% (18) 3-5% 21.8% (19) 5-10, % 29.9 (26) >10, % (n) 27.6	Not measured	Not measured however, Barriers, facilitators, and needs in PD and instructor groups explored	Those unable to answer survey questions either with or without someone to support. Participants were also required to be able to provide	tion of unity-based e classes to intervention for ur during the Covid-19 pandemic.	Face to face vs virtual class formats of usual care.	Online survey Virtual class format not very clearly described.	Survey closed February 2021	Single data capture point for both groups	N/A but the usual care face to face community-based care to virtual classes required significant levels of modification.
Modified H & Y stage On (I) 3.0 (2.625-3.0) (C) 3.0 (2.5-3.0) Modified H & Y Stage Off (I)3.0 (3.0-3.875) (C) 3.0 (3.0-4.0)	Marital status Married (I) 13 (65.0) (c) 8 (34.8) Not married (I) 7 (35.0) (c) 3 (13.0) Family income (10,000 won/Month) (I) <100 8(40) 100-199 4 (20) 200-299 3 (15)equal	Duration of PD years (I) 9.95 +/- 5.26 (c) 10.50 +/- 4.58	Not specfically IMD	No only educational level	Those with other serious diseaases that may affect QoL, Non-motor symptoms (such as depression and Pain) and self-management and those whose PD medication had been changed within the past month . In addition, participants	The mobile intervention in this study consisted of mobile applications, smartwatches, smartphone-based short text messages and information and telephone counselling for 16 weeks.	Mobile health Smartphone Smartwatch	Smartphone and Smartwatch	Complex 30 minute schedules based around activities and time of the day and diary prompts.	16 weeks	The design and data collection points seem very specific

Modified inclusion criteria from initially H&Y score I-II to H & Y score III	On in terms of general demographic data.	Not stated	No	No only level of education, however technology issues last more than 15 minutes were	PAR-Q as a screening tool and medical approval to participate.	Engage-PD is a Telecoaching intervention grounded in self-determination theory. Up to 4 coaching sessions all delivered via a	Single cohort implementation study	Mentions workbook on physical activity monitoring to support autonomy, which	Up to 4 telehealth coaching sessions over three months	3 months	Intervention was modified, however this was not unlimited.
Hoehn and Yahr stage 1 26 (11%) 78 (33%) 2 102 (43%) 32 (13%) 3 30 (13%) 56 (24%) 4 112 (48%) 38 (16%	Not recorded in baseline characteristics	Disease duration (years) Mean (SD) Min to max 8 (6.6) 0 to 36 8 (5.8)	Not stated	Not measured	People were eligible if they had a clinically confirmed diagnosis of PD in accordance with UK Brain Bank criteria were living in their own home; independently mobile with or without an aid; experienced one fall in the previous 12 months; score 24 or more on the MMSE	PDSAFE comprised individually tailored, progressive home-based exercise and strategies to avoid falls. Home visits with trained PT's 12 supervised sessions 1-1.5 duration over 6 months This was tapered Unsupervised exercise for about 30 mins. Participants were given a folder	Multimodal, Home-based, Physiotherapy, digital training videos, teleconferences	Audiovisual, digital images of excercises.		6 Months	Intervention is modified or tailored but there are limits and fidelity checks.
H & Y Stage I 16 (25.8%) Stage II 25 (40%) Stage III 21 (34%)	Education High school 2 (3.25%) College 25 (40.3%) Associates 2 (3.2%) Masters 15 (24.2%) Doctorate 5 (8.1%) Other advanced degree 7 (11.3%)	Time since diagnosis Yrs 4.7 +/- 4	Not measured	Not measured	Participants were excluded if they had coexisting neurological or musculoskeletal conditions that would restrict exercise. They were also excluded had more than 150 minutes of moderate vigorous physical activity per week. No	The Engage-PD intervention consists up to 5 personal coaching sessions delivered via telehealth over a 3-month period. Using Engage-PD© delivered by licensed Physical Therapists. Engage-PD grounded in self-determination theory	Telehealth	Telehealth via Zoom©	5 sessions over Three-months via Zoom ©	Three months	Some level of modification, described as advice on modified extensions based on functional ability

Not measured instead MDS-UPDRS part III (0-132) (I) 31 (11) (C) 33(13)	Not recorded in demographic data table	Duration of disease (years) (I) 7 (4) (C) 9 (6)	Not recorded	Not recorded	Participants were excluded if they had substantial cognitive impairment (MMSE <24) or a medical condition which would preclude or interfere with physical assessment or stepping training.	Exergame 15 minutes three times a week for 12 weeks while on usual medicinal treatment. The exergame was a modified version of the open source Dance Dance Revolution "stepmania game"	Exergame	Videogame	Stepping excersie 15 minutes three times a week for 12 weeks.	15 minutes per session	No specified, however, exercise is unsupervised

Setting intervention took place	TIDieR items	PRISMS taxonomic domains* listed full at foot of column	Outcome/Outcome measures	Scale used to measure self-efficacy	Magnitude of change in level of self-efficacy	Outcomes measured in addition to self-efficacy	PD symptoms measured	Objective measurement Y/N	Self-reporterd or CG reported outcomes	Effective Y/N/ Not measured	Safety assessed
Home with researcher home visits.	Brief name- CuPiD Why- Study investigated the CuPiD-system's feasiility and effectiveness compared to conventional gait training What-	A1 Not specifically, A2 Only in relation to gait and walking, A3 In part, A4 Yes, A5 Unclear A6 Yes Training , A7 Smartphone and Apps, A8 Unclear in terms of outside training visits, A9 Yes weekly training and instruction, A10 Only in terms of gait and walking, A11 Limited to intervention scope, A12 Not	Primary: Gait speed under dual conditions HR-QOL- 2 Minute walk test. MiniBESTTest, Four square step test (FSST) Falls Efficacy Scale International (FES-I)	FES-I	No statistically significant changes noted	Single and dual task gait speed, MiniBESTest, Quality of Life (SF-36 physical health) Balance, Endurance, Disease severity, FOG, Cognition	Comfortable gait, Dual task gait, Balance, Endurance and Physical Activity	Comfortable gait, Dual task gait, Balance, Endurance and Physical Activity, MiniBESTest	Self-reported	Not in terms of self-efficacy	Not specifically mentioned
Home setting	Brief name- Physical activity using technology: A feasibility study Why- The	A1 Some information but mainly about movement, A2 Signposting to online resources and support group, A3 not mentioned, A4 not mentioned, A5 Indirectly A6	Self-efficacy via PAAI, The funcational Assessment of Cancer Therapy-General (FACT-G) -	Physical Activity Assessment Inventory (PAAI)	No statistically significant changes noted but authors mention small sample size (n=5)	QoL, Wellbeing, PWB, SWB, EWB, FWB, PAAI	Motor symptoms in terms of physical activity,. Objective	Objective data from the Fitbit physical activity tracker.	Self-reported	No statistically significant difference found	No
Home setting.	Brief name- Telecoach Pilot study Why-To explore the uptake and implementation of two common methods of exercise	A1 Focused on physical activity specifically not PD in general , A2 Intervnetion focused , A3 No specfically mentioned A4 No, A5 exercise physiological parameters and measurements A6 Telecoach group only, A7 Yes described here under devices, A8 More	Adherence outcomes of study, Attendance (%) Total sessions, Time performing exercise, Time performing moderate exercise aerobic exercise	Determined by mapping qualitative findings to Bandura's Social cognitive theory	Qualitative findings suggested that high rates of adherence for TAE participants were largely influenced by increased self-efficacy, which was facilitated primarily by the assistance of the	Adherence outcomes of study, Attendance (%) Total sessions, Time performing exercise, Time performing moderate exercise aerobic exercise (min/week) Walking capacity outcomes by study group. 6 minute walk test.	No specifically, but looked at walking function and strength from physical activity	Physiological measurements from the various instrumentation used including wearable sensor.	Self-reported and objectively measured	In terms of the qualitative findings yes, with an explanation related to Bandura's social	Yes, exercise on the cycle was done in a recumbant position to reduce the risk of falls. Training was also provided.
Online- virtual	Brief name- Impact of Covid-19 on Community-based exercise classes for PwP. Why- To examine the	A1 N/A, A2 N/A, A3 N/A, A4 No, A5 Unclear for Virtual classes A6 Behavioural change through SEE, GLT-Q , A7 Requires the participant to be able to go online, A8 No, A9 No, A10 No, A11 potentnially , A12 Potentially , A13	Godin Leisure-Time Questionnaire, Self-efficacy for Exercise Scale, Schwab-England Activities of Daily Living Scale, Parkinson's Disease Questionnaire-8	Self-efficacy for Exercise Scale	Reduced face to face community-based exercise classes and the use of virtual class formats due to the Covid-19 Pandemic was associated with a reduction in Self-	Godin Leisure-Time Questionnaire, Schwab-England Activities of Daily Living Scale, Parkinson's Disease Questionnaire-8 (PDQ-8) (QoL)	Predominatly motor, Balance, Gait, Falling, Depression, FoG	No All participant reported	Self-reported/care partner reported, and instructor reported.	The restriction placed for Covid-19 reduced face to face community-based	No
Predominatly home but also agile	Brief name- Mobile health intervention Why- To evaluate the effects of a mobile health intervnetion for self-management on self-efficacy, motor	A1 Yes viewed holistically IMB model, A2 Yes message feature and extensive menu, A3 Part of exclusion/dropout criteria, however also has medicinal taking prompts, A4 No, A5 Yes, A6 Yes medicinal prompts, A7 Yes Smartwatches and Smartphones, A8 Yes via menu and reflective tracking, A9 limited description, A10 To	Self-efficacy, motor symptoms, Non-motor symptom, Self-management, Quality of Life	Self-efficacy for managing Chronic Disease 6-item Scale	The mobile health intervention for self-management was effective for self-efficacy and non-motor symptoms in PwP.	Motor symptoms, Non-motor symptom, Self-management, Quality of Life	Both motor and non-motor symptoms	In terms of engagement and use yes, as actions recorded	Self-reported	Yes	Not specifically mentioned

Implied home setting	Brief name- Engage-PD Why- Case report to describe a physical activity coaching programme.	A1 Yes, booklet and training, A2 Yes, as resources and via training, A3 Not directly , A4 Not direcrtly and physical activity focused, A5 Via physical activity devices A6 Yes in the form of	Construct- Acceptability- Measure Acceptibility & Fidelity- Perceive autonomy support healthcare, Climate	Norman self-efficacy scale	Does not explicitly state as this is an interim point case study, the full Engage-PD study by Shih do find this approach raised levels of	Construct- Acceptability- Measure Acceptibility & Fidelity- Perceive autonomy support healthcare, Climate Questionnaire (HCCQ), Rates of adherence and retention, Post intervention	Not directly symptom focused	Option of using different types of physical activity trackers and devices suggested and their use promoted.	Self-reported	Not stated, however Shih which is the full cohort study of Engage-PD notice a	Yes, including risk, benefit weighing
Home-based intervention	Brief name- PDSAFE Why- To reduce falls in PwP What- A multimodal physiotherapy intervnetion How- Home visits, supervised and unsupervised visits, DVD,s Video teleconferences	A1, A2, A3, A4, A5 A6, A7, A8, A9, A10, A11, A12, A13, A14	The primary outcome was risk of repeat of falling in the first 6 months after randomisation. Secondary outcomes were fractures and the rate of near falling; The MiniBesTest, The chair to stand test (CST) Geriatric Depression Scale	FES-I	Statistically significant change is Falls self-efficacy as a secondary outcome.	The primary outcome was risk of repeat of falling in the first 6 months after randomisation. Secondary outcomes were fractures and the rate of near falling; The MiniBesTest, The chair to stand test (CST) Geriatric Depression Scale (GDS) New Freezing of Gait Questionnaire (NFoG) The Parkinson's Disease Questionnaire. PDQ-39 (QoL)The Physical Activity	FoG, Balance, Gait, Depression, Walking, Falls	No All participant reported	Self-reported	Yes between moderate and severe group.	Yes, Adverse events and deaths reported
Home setting but agile	Brief name- Engage-PD Why- To determine the feasibility and preliminary efficacy of the Engage-PD intervention and to explore whether baseline	A1 Yes disease specific workbook, A2 Yes multimodally, A3 No , A4 Only in the course of usual care, A5 Speficially in terms of physical activity A6 Behavioural in terms of coaching to promote physical activity, A7 Unclear uses Zoom © but is this through the participants own device and WiFi, A8 Number of coaching sessions is	Feasibility- Recruitment, Retenion, Adverse Events, acceptibility, Participant perspectives via open ended questions. Intervention outcomes- Physical Activity via the	Exercise self-efficacy scores	Participants with lower baseline planned physical activity exoperienced greater improvements in planned physical activity, and those with lower exercise self-efficacy experienced greater improvements in Exercise self-efficacy	The Brunel Lifestyle Inventory (meassure of physical activity), The Exercise Self-efficacy Scale (ESE), Canadian Occupational Performance Measure (mCOPM) Particpant goals.	Not symptom focused by indirectly in terms of physical activity, Exercise Self-efficacy, Participant Goals (linked to behaviour) Participant	No All participant reported	Self-reported	Participants with lower baseline planned physical activity exoperienced greater improvements in planned physical activity, and	Yes No adverse events reported and evidence of safety monitoring

Intervention-home Ourcome-Laboratory setting	Brief name-Stepmania Why-To see if intervention improves balance gait and reduction in falls. What- A videogame (exergame) for use in the home, links to television Who-Physiotherapists How- Remote in the home. Where-Intervention in the home, outcome measures in the laboratory. When an how much- 15 minutes per session, 3 sessions per week over 12 weeks. Tailoring-Unclear,	A1 In the context of the intervention but more broadly, A2 Yes, A3 Potentially during training, A4 No, A5 Indirectly and only within the scope of the intervention A6 No, A7 Yes Videogame provided, A8 Not explictly stated, A9 Yes training with Physiotherapist , A10 Only in relation to the focus of the intervention, A11 Yes , A12 Yes in relation to secondary outcomes, A13 Not specifically , A14 In relation to movement and physical activity through stepping.	Primary outcomes-Stepping performance CSRT task Reaction time (ms) CSRT task Movement time (ms) CSRT task Response time (MS) Mobility FGA (0-30) Secondary outcomes- Power Average hip abductor peak power (w) Average hip abductor power at load (33N) (w) Mobility TUG, Tug avg, GAT accuracy (cm) GAT velocity (cm/s) Hand movement Hand reaction time (ms) Cognition- MOCA, TMT, FOG NFOGQ (0-28) Falls efficacy-FES-I (16-64)	Falls efficacy FES-I (Falls eficacy scale-International)	Difference between groups Week 12 minus Week Intervention minus Control 0 2.8 (-0.8 to 6.5) P=0.13	Primary outcomes-Stepping performance CSRT task Reaction time (ms) CSRT task Movement time (ms) CSRT task Response time (MS) Mobility FGA (0-30) Secondary outcomes- Power Average hip abductor peak power (w) Average hip abductor power at load (33N) (w) Mobility TUG, Tug avg, GAT accuracy (cm) GAT velocity (cm/s) Hand movement Hand reaction time (ms) Cognition- MOCA, TMT, FOG NFOGQ (0-28)	Stepping reaction time test, functional gait assessment, Physical and neuropsychological measures associated with falls, number of falls, mobility and balance	Hip abduction, hand movement, reaction and response time, TUG Test	Self-reported	Not in terms of self-efficacy	Yes including booklet for safe use.

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Title page

Digital Health Technologies and Self-Efficacy in Parkinson's: A Scoping Review

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Digital Health Technologies and Self-Efficacy in Parkinson's: A Scoping Review.

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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 1st 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 eligibly 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 33165 unique records following screening and independent review by two reviewers eleven 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.

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 replicatable and methodologically robust.
A diverse collection of bibliographic databases were utilised 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

INTRODUCTION

Background Parkinson's disease (PD) is a progressive neurodegenerative disorder with no known cure [1]. It causes both motor symptoms (MS) 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 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 determinant's 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 focussing 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 organize 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 forms the rationale for undertaking this scoping review. Placing this review into context a recent systematic review has focussed 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 focusses 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 medicator for self-management in PwP, and in doing so filling an important and potentially sizable 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 1st January 2008 to the 24th July 2024, while Google Scholar™ was principally used to search the grey literature shown in appendix i.

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 Ovid was felt more appropriate then 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 the 24th 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].

Table 1 Population Intervention Comparator Outcome Study design (PICOS) Framework [34].

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].

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 Supplement 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 and 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 to 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+ years old 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 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].

* 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].

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 ones 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. Firstly, 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 36887 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 33165 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 34 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 eleven records were included in the final review. Ten of these records were identified from bibliographic databases and one from other sources (citation checking) (shown in Table 2). The eleven records which were included in the final review and

are summarised in Table 2.The search process is presented in a PRISMA 2020 Flowchart 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] dataset available (shown in Supplement 2).

All eligible studies included both male and female participants [44-54]. Study designs included; randomised controlled trials (RCTs), feasibility, mixed methods pilot, cohort, and cross-sectional studies, and one case report. Sample sizes ranged from 5 and 474 participants. Included studies were geographically distributed widely, reflecting the ubiquity of PD and PD research (shown in Supplement 2).

Self-efficacy was a primary outcome in two studies 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], and 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 a access to a social media platform and online modules [48, 53].

Participant safety was a consideration in six of the eleven 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 eleven 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 used across the eleven 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 sub-study 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 based on the information-motivation-behaviour (IMB) skills model used; smartphones, mobile applications, smartwatches, smartphone-based short text messages and 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 RCT's [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 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 to 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]. Firstly, the self-efficacy measure used was the PAAI, and was the only study which used this self-efficacy measure [58]. Whilst 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. Whilst 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]. **Table 2 Summary of included studies**

Studies which showed a statistically significant improvement in the self-efficacy measure				
Authors year Title	Study design, measure	Sample size	Self-efficacy measure	Results as reported by the authors
Chivers Seymour, K., Pickering, R., Rochester, L. et al. (2019) Multicentre, randomised controlled trial of PDSAFE, a physiotherapist-delivered fall prevention programme for people with Parkinson's [50].	**Study design:** Randomised Controlled Trial.	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.
Lai, B., Bond, K., Kim, Y. et al. (2020) Exploring the uptake and implementation of tele-monitored home-exercise programmes in adults with Parkinson's disease: A mixed methods pilot study [51].	Mixed Methods Pilot.	n=20.	Qualitative thematic analysis.	Perceived increased exercise motivation, and self-efficacy in the intervention group identified using qualitative thematic analysis.
Park, Y., Kim, R.S., So, H. Y., et al. (2022) Effects of mobile phone intervention for self-management on self-efficacy, motor and non-motor symptoms, self-management, and quality of life in people with Parkinson's disease: Randomised controlled trial [54].	Randomised Controlled Trial	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 to the control group (t=2.33, p=0.025). Intervention Pre-Post score (t=2.85 p=0.011) Compared to the control Pre-post test score (t=0.26 p=0.796).
Quinn, L., Macpherson, C., Long, K. et al (2020) Promoting physical activity via telehealth in people with Parkinson disease: The path forward after the COVID-19 pandemic [46].	Case Report	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). Study design does not have a control or blinding.

Shih, S. H-J., Macpherson, C.E., King, M., et al. (2018) Physical activity coaching via telehealth for people with Parkinson disease: A cohort study [45].	A single cohort study with no control group or blinding of participants	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.
Studies which did not raise the level of self-efficacy to a statistically significant level				
Authors Year Title	Study design, and	Sample size	self-efficacy measure	Reports as reported by authors
Agley et al., 2024 Digital intervention promoting physical activity in people newly diagnosed with Parkinson's disease: Feasibility and acceptability of knowledge, exercise-self-efficacy, and participation (KEEP) Intervention [53].	An assessor blinded, randomised controlled feasibility study.	n=30	Self-efficacy for Exercise (SEE) [53, 57].	Intervention group **b**aseline 56 (49-68) post-intervention 40 (37.5-63.5) 6-months post follow- 65 (53.75-78.25). Control group baseline 64 (52.5-74) post-intervention 56 (51.5-69.5) 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.
Colón-Semenza et al., 2018 Peer coaching through mHealth targeting physical activity in people with Parkinson's disease: Feasibility study [47].	Feasibility study	n=10 (5 dyads)	Self-efficacy for walking-duration 10-item questionnaire (SEW_Dur) [66].	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.
Ginis P., Nieuwboer, A., Dorfman, M., et al (2016) Feasibility and effects of home-based smart-phone delivered automated feedback training for gait in people with Parkinson's. A pilot randomised controlled trial [52].	Pilot Randomised Controlled trial	n=40	Falls Self-efficacy Scale International (FES-I) [55]	Self-efficacy was measured using the FES-I measure [67]. Effects at 6 weeks (Time (p=0.91) X Group (p=0.84 equals p=0.89) and was not raised to a statistically significant level.
Manãgo M.M., Swink, L.A., Hager, E.R. (2021) The impact of COVID-19 pandemic on community-based exercise classes for people with Parkinson disease [44].	Cross-sectional Study	n=87	Self-efficacy for Exercise (SEE) [57].	Whilst 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
Song, J., Paul, S.S., Caetano, M.J.D., et al (2018) Home-based step training using videogame technology in people with Parkinson's a single-blinded randomised controlled study [49].	A Two-arm, Parallel, Single-blinded Randomised Controlled Trial	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.
Studies which lowered the levels of self-efficacy from baseline				
Authors Year Title	Study design, and	Sample size	Self-efficacy measure	
Hermanns, M., Haas, B.K., Lisk, J (2019) Engaging older adults with Parkinson's physical activity: A feasibility study [48]	Longitudinal Pre-test Post-test design	n=5	Physical Activity Assessment inventory (PAAI) [58].	Statistical analysis involved pre-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 nonsignificant changes ($p > .05$).

A fuller description of study interventions can be found in Supplement 3.

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. Eleven 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]. Whilst self-efficacy has been strongly associated as a mediator of self-management in areas which 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].

Whilst evidence standards for DHT exist, they have not been created to explicitly encompass self-efficacy which highlights the challenges researchers face when interpretating 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 underreporting of psychometric studies [71, 72].

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 focusses 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 sizable 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 [73]. 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 is value [74, 75].

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 [76-78], and also in the management of chronic obstructive pulmonary disease (COPD) and lung transplant recipients [79-81]. 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 focussed.

Three studies included acceptability and usability as a measured outcome [45-47]. two of these were feasibility studies [45, 47], and one was a case report based on an adapted form of the intervention used in the later feasibility in order to be Covid-19 compliant [46]. In terms of considering the pros and cons of these studies in terms of the intervention this appeared to be more context specific rather than participant specific focussing on the primary outcome. Disappointingly, across studies satisfaction was discussed subtly or in general terms but not in a specific way and was not directly measured as an outcome using a specific measure, which was unexpected given the types of studies included in this review and for which the authors cannot provide an explanation.

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 whilst seemingly neglecting NMS (shown in Table 2).

This review identified that a potential reason for gaps in the literature related to NMS related self-efficacy is that technology to remotely monitor these symptoms is still in its infancy [82]. This review has also identified that barriers to synthesis to better characterise gaps in the literature potentially stems from, firstly a lack of consensus on which self-efficacy measure to use, secondly, 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 [83].

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 [84-89]. An integrative review of behaviour change strategies that promote self-efficacy found that they are either; self-management programmes, telehealth, mobile applications and gaming and social media which is helpful to be aware of [89]. **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 was 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 [90].

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 review that have focused on self-management interventions to support PwP [11, 12, 91, 92]. Additionally, this review has identified substantial knowledge and evidence gaps in the literature which future research must address to strength the evidence on this topic which has previously been identified as weak [11, 74, 75].

Five interventions produced statistically significant improvements in self-efficacy compared to controls, two being RCT's, 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 postive behaviour changes which improve self-efficacy [45, 54, 93, 94]. These studies have not specifically focused on acceptance and satisfaction of the DHT, 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, 95]. 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 [96-98]. 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) [99].

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 [100].

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 omitted from the review but may have been eligible. Whilst 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 replicatable. 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 sizable 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.

ETHICS AND DISSEMINATION

As this is a piece of secondary research which has used retrospectively retrieved pre-exiting primary research studies which are published and in the public domain ethical approval was not required.

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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Contributors

AMH was involved in study design, development of scoping review search strategy, data collection, data analysis, data interpretation, production of figures and writing of the manuscript and contributed meaningfully to the drafting and editing. AMH has approved the final manuscript. VA was involved in title and abstract and full text screening and data extraction checking and has approved the final manuscript. CBC, VA, and EM were involved with revisions to manuscript, scrutiny of the data analysis, presentation of findings and their interpretation. CBC, VA, and EM have all approved the final manuscript. EM is the Guarantor.

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Competing interests VA sits on the Statistical Advisory Board of the BMJ Open. AMH, CBC and EM have no competing interests to declare.

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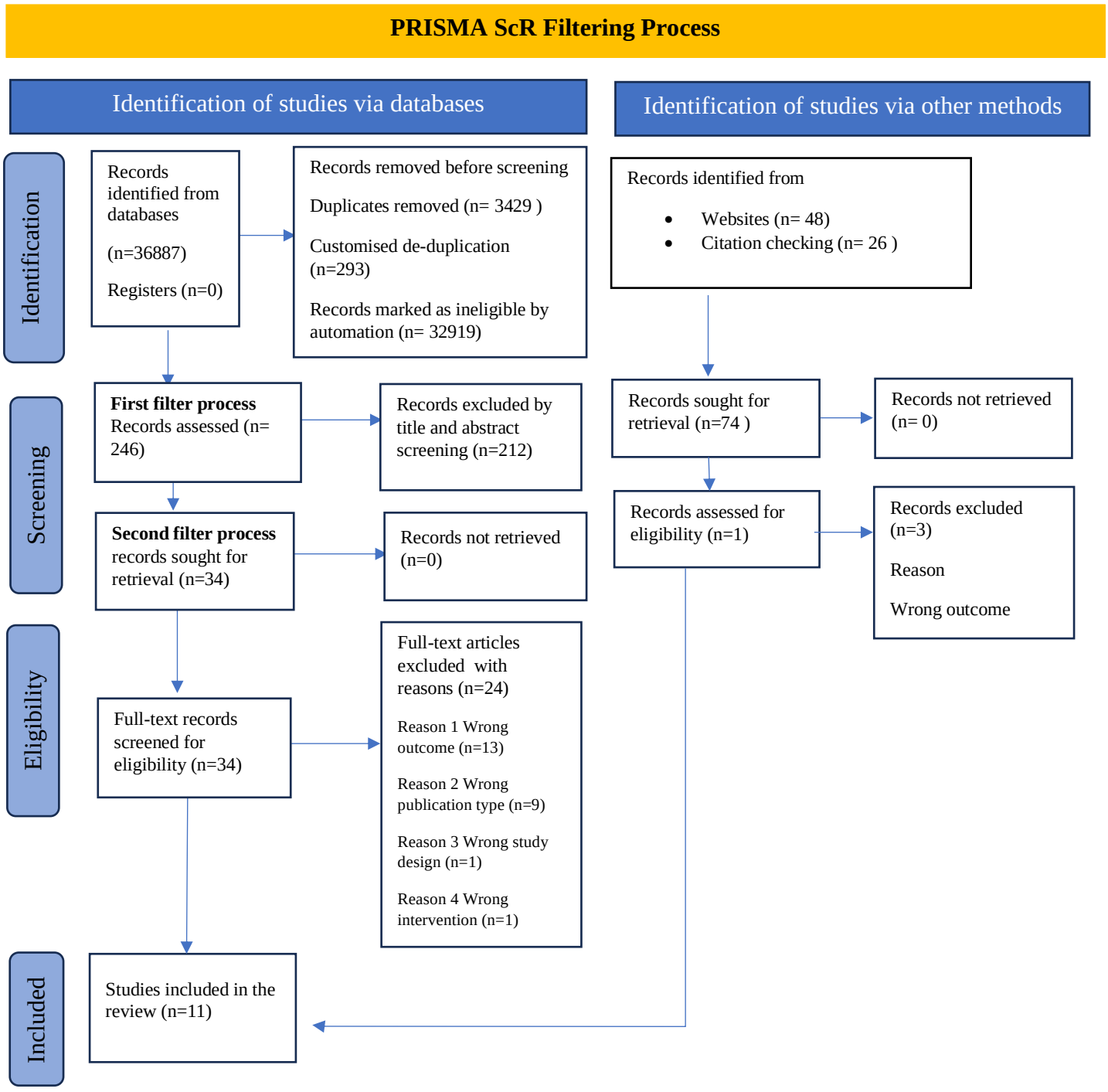
Figure 1 PRISMA ScR flowchart

Supplement 1 Combinations of search terms, Boolean operators, and databases.

Supplement 2 Full data extraction from all studies included in the review.

Supplement 3 Full descriptions of all included studies.



Database	Search terms to be used and Boolean operators	Number of records identified in the initial search
Medline (EBSCO host)	Parkinsonian disorders **AND** Tele* OR Telemedicine OR Telehealth OR Telemonitoring OR Telepractice OR Telenursing OR Telecare **AND** Self* OR Behavior change OR Behavior Modification[1]	**9, 875**
PsycINFO	((Parkin* AND PEER (yes)) OR ((Parkinson disease) AND PEER (yes) OR ((Parkinsons disease) AND PEER (yes)) OR ((Parkinson's disease) AND PEER (yes)) OR ((Movement disorders) AND PEER (yes)) OR ((alpha synuclein) AND PEER (yes)) **AND** Technology AND PEER ((yes) OR ((Health technology) AND PEER ((yes) OR (Tele*AND PEER ((yes) OR (Telehealth AND PEER (yes)) OR (Telemedicine AND PEER ((yes) OR (Telemetry AND PEER (yes)) OR Sensors AND PEER (yes)) OR Wearables AND PEER (yes)) OR ((Assistive technology) AND PEER (yes)) OR ((Home based care) AND PEER (Yes)) OR ((Home-based care) AND PEER (yes)) OR ((IoT AND PEER (yes)) OR ((Internet of things) AND PEER (yes)) OR ((Virtual consultations) AND PEER (yes)) OR ((Video Consultations) AND PEER (yes))) **AND** ((Behav* AND PEER (yes)) OR Behavior AND PEER (Yes)) OR Behaviour AND PEER (yes)) OR ((Behavior Change) AND PEER (yes)) OR ((Behavior modification) AND PEER (yes)) OR (Self* AND PEER (yes)) OR ((Self Concept) AND PEER (yes)) OR ((Self efficacy) AND PEER (yes)) OR (AND PEER (yes)) OR (Self-efficacy AND PEER (yes)) OR (Self-management AND PEER (yes)) OR Rehabilitation AND PEER (yes)) OR (Resilience AND PEER (yes)) AND (La.exact(ENG*) AND PEER (yes))	**1, 576**
CINAHL	MW (Parkinson's disease or Parkinson disease or pd or parkinsonism) **OR** SU Movement disorders **OR** MW Parkinsonian disorders **OR** TI Parkinson disease **AND** (telehealth or telemedicine or telemonitoring or telepractice or telecare) **OR** MW technology in healthcare **OR** MW digital technology **AND** TX (Self-efficacy or self efficacy or confidence or self esteem) **OR** TX self concept **OR** (self-management or self-care or self-regulation or self-monitoring) **OR** MW (Behavior change or Behavior modification)	**3, 891**

Web of Science	**((((((((((((((((((TI=(Parkinson disease)) OR TI=(Parkinson's disease)) OR TS=(Movement disorders)) OR ALL=(Parkin*)) AND ALL=(Tele*)) OR TS=(Digital health)) OR TS=(Mobile health)) OR TS=(eHealth)) OR TS=(Sensors)) OR TS=(Home based care)) OR TS=(Telemetry)) OR TI=(Virtual consultations)) AND TI=(self-efficacy)) OR TI=(self-efficacy)) OR TI=(self management)) OR TI=(self-management)) OR TS=(Patient activation level)) OR TS=(Behavior change)) OR TS=(Behaviour change)) OR TS=(Behaviour modification)) OR TS=(Behavior modification)**	**2,651**
Embase	#1 Parkinson disease/or Parkin/or Parkin*.mp. #2 Parkinson's disease.mp. or exp Parkinson disease/ #3 controlled study/exp Parkinson disease/ or exp levodopa/or Parkinson disease*.mp. #4 Movement disorders.mp. exp motor dysfunction/ #5 1 or 2 or 3 or 4 **AND** #6 telecommunication/or Tele*.mp. or telemedicine/ #7 telemedicine.mp. or telemedicine robot/ or telecommunication/or telemedicine/ or healthcare delivery /or patient/ #8 telehealth.mp.or telecommunication/ or telehealth/or health care/or telemedicine #9 telecare.mp. or exp telecare/ #10 exp medical informatics/ or digital health.mp. #11 eHealth.mp./exp telehealth/ #12 mHealth.mp.or mobile health application/ #13 6 or 7 or 8 or 9 or 10 or 11 or 12 **AND** #14 exp self care / or self medication/or exp self concept/exp self-testing/ or self evaluation/ exp self-monitoring/or General self-efficacy scale/ or exp self help/ or self*mp. or exp self report/ or self esteem/ or self-help device/ or Self-rating Depression Scale/ #15 self management.mp. or exp self care/ #16 self-efficacy.mp. or exp self concept #17 behavior*.mp. or exp behaviour modification/or exp care behavior #18 14 or 15 or 16 or 17 #19 5 **AND** 13 **AND** 18	**3, 136**
IEEE Xplore	("Mesh_Terms":Parkin*) OR ("All Metadata":Parkinson's disease) OR ("All Metadata":Neurodegenerative disorders) OR ("All Metadata":Idiopathic Parkinson's Disease) **AND** ("Mesh_Terms":Tele*) OR ("All Metadata":Digital Health) OR ("All Metadata":Mobile Health) **AND** ("Mesh_Terms":Self*) OR ("All Metadata":Self,	**3195**

	concept) OR ("All Metadata":self, rehabilitation) OR ("All Metadata": Self-management)	
Google Scholar™	Parkinsonian disorders Telemedicine Self-efficacy Self-management No Boolean operators used Filtered by date-2012-2022	**2210**

General information Author(s) title	Reject/not for data extraction and reason	Year of Publication	Country of study	Country of Publication	Initial sample size	Analysed sample size
Digital Intervention promoting physical activity in People newly diagnosed with Parkinson's Disease: Feasibility and Acceptability of the knowledge, Exercise-efficacy and Participation (KEEP) Intervention. **Agley, L., Hartley, P., Duffill, D., Iqbal, A., Mackett, A., Rennie, K.L., & Lafortune, L.**	Include?	2024	United Kingdom	England	n=30	n=29
Peer Coaching Through mHealth Targeting Physical Activity in People with Parkinson's disease: Feasibility Study. **Colón-Semenza, C., Latham, N. K., Quintiliani, L.M., Ellis, T. D.**	Include?	2018	United States of America	United States of America	n=10 PwP (5 Dyads)	n=10 PwP (5 Dyads)
Feasability and effects of home-based smartphone-delivered automated feedback training for gait in People with Parkinson's diseaase: A pilot study **Ginis, P.; Nieuwboer, A.; Dorfman, M.; Ferrari, A.; Gazit, E.; Canning, C. G.; Rocchi, L.; Chiari, L.; Hausdorff, J. M.; Mirelman, A.;**	Include?	2015	Belgium & Israel	Belgium	n=40 PwP Participants were included if they were able to walk for 10 minutes continuously; had a MoCA score higher than 24; were in a Hoehn and Yahr Stage II to III in the 'on' state and were stable on PD medication.	40 ITT
Engaging Older Adults With Parkinson's Disease in Physical Activity Using Technology: A Feasibility Study. **Hermanns, M.; Haas, B. K.; Lisk, J.**	Include?	2019	United States of America	United States of America	n=5 PwP	5 PwP
Exploring the uptake and implementation of tele-monitored home-exercise programmes in adults with Parkinson's disease: A mixed-methods pilot study **Lai, B.; Bond, K.; Kim, Y.; Barstow, B.; Jovanov, E.; Bickel, C. S.**	Include?	2020	United States of America	United States of America	n=20 PwP	n=20 PwP
The Impact of COVID-19 on Community-Based Exercise Classes for People With Parkinson Disease **Manago, M. M.; Swink, L. A.; Hager, E. R.; Gisbert, R.; Earhart, G. M.; Christiansen, C. L.; Schenkman, M.;**	Include?	2021	United States of America	United States of America	n=87 PwP and 43 Instructors	n=87 PwP and 43 Instructors

Effect of mobile health intervention for self-management on self-efficacy, motor and non-motor symptoms, self-management, and quality of life in people with Parkinson's disease: Randomized controlled trial **Park, Y.; Kim, S. R.; So, H. Y.; Jo, S.; Lee, S. H.; Hwang, Y. S.; Kim, M. S.; Chung, S. J.;**	Include?	2022	South Korea	South Korea	n=50	43 PwP
Promoting Physical Activity via Telehealth in People With Parkinson Disease: The Path Forward After the COVID-19 Pandemic? **Quinn, L.; Macpherson, C.; Long, K.; Shah, H**	Include?	2020	United States of America	United States of America	n=27	n=27
Multicentre, randomised controlled trial of PDSAFE, a physiotherapist-delivered fall prevention programme for people with Parkinson's **Seymour, Kim Chivers; Pickering, Ruth; Rochester, Lynn; Roberts, Helen C.; Ballinger, Claire; Hulbert, Sophia; Kunkel, Dorit; Marian, Ioana R.; Fitton, Carolyn; McIntosh, Emma; Goodwin, Victoria A.; Nieuwboer, Alice; Lamb, Sarah E.; Ashburn, Ann**	Include?	2019	England	England	n=474 (I) 6 Months n=176 (C) n= 196	n=372
Physical Activity Coaching via Telehealth for People With Parkinson Disease: A Cohort Study **Shih, Hai-Jung Steffi Macpherson, Chelsea E King, Miriam Delaney, Elizabeth Gu, Yu Long, Katrina Reid, Jennifer Fineman, Julie Yu, Geraldine Rieger, Jamie Satchidanand, Ashrita Shah, Hiral Alcalay, Roy N Quinn, Lori**	Include?	2022	United States of America	United States of America	n=62	Analysed for ESE n=52
Home-based step training using videogame technology in people with Parkinson's disease: a single-blinded randomised controlled trial **Song, J.; Paul, S. S.; Caetano, M. J. D.; Smith, S.; Dibble, L. E.; Love, R.; Schoene, D.; Menant, J. C.; Sherrington, C.; Lord, S. R.; Canning, C. G.; Allen, N. E.**	Include?	2018	Australia	Australia	60 Community dwelling people with Parkinson's	**Intervention group** n=3 withdrew from study. N= 6 discontinued intervention. **Control group** Loss to follow-up n=3 withdrew from study n= 1 partial follow-up due to ankle injury

Study design	Demographic data	Age Range	Ethnicity	PwP or CG (and relationship between the two)	H&Y score at time of recruitment or other measure of disease severity
An assessor blinded, randomised controlled feasibility study.	Age All (n=30) 67.3 (±10.8) Intervention (n=15) 70.27 (± 5.23) Control (n=15) 64.40 (±13.99) Male All (n=30) 23 (76.7%) Intervention (n=15) Control (n=15) 12 (80.0) White British All (n=30) Years in education All (n=30) 15.0 (±3.9) Intervention (n=15) 14.1 (±4) Control (n=15) 15.9 (±3.8) Married/partnership All (n=30) 25 (73.3%) Intervnetion (n-15) (100%) Intervnetion (n=15) 10 (60.0) Employed All (n=30) 10 (33.3%) Intervention (n=15) 5 (33.3%) Control (n=15) (33.3%) Retired All (n=15) 15 (50%) Intervention (n=15) 10 (66.7%) Control (n=15) 5 (4%) Unemployed All (n=30) 5 (16.7%) Intervnetion (n=15) 0 (0%) Control (n=15) 5 (33.3%) H & Y 1 All (n=30) 7 (23%) Intervention (n=15) 4 (26.6%) Control (n=15) 3 (20%) H & Y 2 All (n=30) 9 (30%) Intervention (n=15) 6 (40%) Control (n=15) 3 (20%) H & Y 3 All (n=30) 13 (43%) Intervention (n=15) 5 (33.3%) Control (n=15) 8 (53.3%) H & Y 4 (n=30) 1 (0.03%) Intervention (n=15) none Control (n=15) 1 (6.6%) On PD Medication All (n=30) 28/30 (93%) Intervention (n=15) 14/15 (93%) Control (n=15) 14/15 (93%) Number of comorbidities All (n=30) 1.0 (±1.1) Intervention (n=15) 1.3 (±1.4) Control (n=15) 0.7 (±0.7) Number of falls All (n=30) 0.7 (±1.6) Intervnetion (n=15) 0.5 (±0.6) Control (n=15) 0.9 (±2.10)	67.3 (±10.8)	Whitre British All (n=30)26 (86.7%) Intervention (n=15) 13 (86.7%) Control (n=15) 13 (86.7%)	PwP	H & Y 1 All (n=30) 7 (23%) Intervention (n=15) 4 (26.6%) Control (n=15) 3 (20%) H & Y 2 All (n=30) 9 (30%) Intervention (n=15) 6 (40%) Control (n=15) 3 (20%) H & Y 3 All (n=30) 13 (43%) Intervention (n=15) 5 (33.3%) Control (n=15) 8 (53.3%) H & Y 4 (n=30) 1 (0.03%) Intervention (n=15) none Control (n=15) 1 (6.6%
Feasibility study	Age in years (SD) 64.6 (4.04) Education in years (SD) 18.0 (0.89) Male, n (%) 3 (60) Race (white) 3 (60) Race (White, n (%) n=5 (100) Disease duration in years (SD) 5.2 (1.24) Hoehn and Yahr Stage, n (5) Stage 1 n=3 Stage 2 n=1 Stage 3 n=1	Age in years (SD) 64.6 (4.04)	Race (White, n (%) n=5 (100)	PwP only	Hoehn and Yahr Stage, n (5) Stage 1 n=3 Stage 2 n=1 Stage 3 n=1
Pilot study (Intervention and Control)	Not specifically described	Not specifically described	Not specifically described	PwP	II-III in ON state
Longitudinal pretest/posttest design	**Demographic variables Gender** Male 3 (60%) Female 2 (40%) **Race/ethnicity** Caucasian, non-hispanic 5 (100%) **Marital status** Married living with a significant other 4 (80%) Divorced 1 (20%) **Living conditions** Lives alone 1 (20%) Lives with spouse or significant other 4 (80%) **Level of Education** Some College 2 (40%) College graduate 3 (60%) **Physical activity level** Activity 4 (80%) Very Active 1 (20%)	Age (years) M/Mdn 73.00/72.00 SD (4.95) Range 69-81 yrs	100% (5) Caucasian/non-hispanic	PwP	Stage of Parkinson's disease M/Mdn 1.70/1.50 (SD) 0.57 Range 1.00-2.50
Mixed methods pilot study two interventions, telecoach assisted vs self-regulated home exercise.	**Age years** (I) n=10) 63.4+/-10.4(56-71) (c) n=10) 70.8 +/- 7.1 (66-76) **BMI (Kg/m2) (**I) 29.2 +/- 6.7 (24-34) (C) 27.2 +/- (22-32) **Sex** n Male/female (I) 7/3 (C) 7/3 Ethnicity n Non-hispanic White/Black (I) 9/1 (C) 10/0	Age years (I) n=10) 63.4+/-10.4(56-71) (c) n=10) 70.8 +/- 7.1 (66-76)	Ethnicity n Non-hispanic White/Black (I) 9/1 (C) 10/0	PwP	Hoehn and Yahr scores (I) 2.15+/- 0.47 (1.5-3) (c) 2.3 +/- 0.63 (1-3)
Crossectional study Custom-designed electronic surveys	**Participants** (n=87)- Age y Mean (SD) 70.2 (7.3) Sex % female (n) 51.7% (45) **Race %** Caucasian (n) 93% (81) **Ethnicity %** non-Hispanic (n) 92% (80) **Highest degree earned** High School diploma/assocaites 14.9% (13)Degree % (n) 39.1% (34) Master, doctoral, professional degree % (n) 40.2% Years since Diagnosis <1, % (n) 0% (0) 1-3% (n) 20.7% (18) 3-5% 21.8% (19) 5-10, % 29.9 (26) >10, % (n) 27.6 (24) Schwab-England mean (SD) 84.0 (15.7) PDQ-8 score, mean (SD) 21.0 (14.6) SEE score, mean (Sd) 55.0 (23.5) Falls per year None 44.8% (39) greater than or equal to 1 (55% (48) Instructors Descriptive Characteristics of the Instructor Group Characteristics n = 43 Age, y, mean (SD) 51.4 (12.1) Sex, % female (n) 86.0% (37) Race, % Caucasian (n) 93% (40) Ethnicity, % non-Hispanic (n) 91% (39) Years teaching class 10, % (n) 9.3% (4) Degree/training Athletic trainer, % (n) 51.2% (22) Physical therapist/occupational therapist or assistant, % (n) 32.6% (14) Other (aquatic, dance, medical exercise, Pilates, yoga), % (n) 13.9% (6) Parkinson disease-specific exercise training, % (n) 79.1% (34)	(n=87)- Age years Mean (SD) 70.2 (7.3) Sex % female (n) 51.7% (45)	Race % Caucasian (n) 93% (81) Ethnicity % non-Hispanic (n) 92% (80) H	PwP and Instructors	Not measured

Randomised, Controlled Trial	Demographic characteristics **Gender** Men (I) 5 (25.0) (C) 8 (34.8) **Age yrs (I)** 62.20 +/- 7.43 (c) 64.27 +/- 8.28 **Education level (I)** 5 (25.0) 2 (10.0) 9 (45.0) College or above 4 (20.0) (C) Elementary school 3 (13.00) 1 (4.4) 7 (30.4) 12 (52.2) 15 (65.2) **Marital status** Married (I) 13 (65.0) (c) 8 (34.8) Not married (I) 7 (35.0) (c) 3 (13.0) Family income (10,000 won/Month) (I) <100 8(40) 100-199 4 (20) 200-299 3 (15)equal to or greater than 300 5 (25.0)	(I) 62.2 +/- 7.43 (c) 64.27 +/- 8.28	Not found in the demographic data	PwP	**Modified H & Y stage On** (I) 3.0 (2.625-3.0) (C) 3.0 (2.5-3.0) **Modified H & Y Stage Off** (I)3.0 (3.0-3.875) (C) 3.0 (3.0-4.0)
Single cohort implementation study (Case description)	**Age** Mean (SD) age for the participants was 66.5 (8.6); **Ethnicity** 22 identifed as white, 1 Asian, 1 Hispanic, 1 Other 2 Declined **Education level** Incomplete data for 8 participants, 1 had some college education, 7 had advanced degrees. Baseline physical acivity and self-efficacy measures. Mean (SD) (range) Brunel score was 3.7 (1.0) (1.0-4.7) for planned and 2.4 (0.7) (1.3-3.3) for unplanned; Norman self-efficacy was 56.8 (178.0; range 19-84).	**Age** Mean (SD) age for the participants was 66.5 (8.6) (n=27);	**Ethnicity** 22 identifed as white, 1 Asian, 1 Hispanic, 1 Other 2 Declined	PwP and 12 PwP were accompanied by a caere partner.	Modified inclusion criteria from initially **H&Y score** I-II to H & Y score III
Multicentre, randomised controlled trial.	Baseline characteristics in the PDSAFE and control groups: figures are number (%) unless stated otherwise PDSAFE (n=238*) Control (n=236†) Gender Male Female 147 (62%) 91 (38%) 119 (50%) 117 (50%) Age (years) Mean (SD) Min to max 71 (7.7) 51 to 91 73 (7.7) 46 to 88 Disease duration (years) Mean (SD) Min to max 8 (6.6) 0 to 36 8 (5.8) 0 to 29 MMSE Mean (SD) Min to max 28 (1.7) 24 to 30 29 (1.6) 24 to 30 MoCA Mean (SD) Min to max ≤25 (cognitively impaired) 26 (2.9) 15 to 30 91 (38%) 26 (3.2) 9 to 30 93 (39%) Living status Lived alone With a spouse/partner With a friend/family 48 (20%) 174 (73%) 15 (6%) 59 (25%) 166 (70%) 10 (4%) Hoehn and Yahr stage 1 2 3 4 26 (11%) 78 (33%) 102 (43%) 32 (13%) 30 (13%) 56 (24%) 112 (48%) 38 (16%) UPDRS Mean (SD) Min to max TD phenotype PIGD phenotype Indeterminate phenotype 32 (15.2) 2 to 77 21 (9%) 194 (83%) 20 (8%) 33 (17.3) 4 to 92 19 (8%) 206 (88%) 10 (4%) Freezing of gait in the past month 152 (64%) 139 (59%) Number of falls in 12 months prior to screening Median (min to max) Mean (SD) Repeat falling in 12 months 3 (1 to 1460) 26 (132.7) 186 (78%) 3 (1 to 1095) 19 (105.4) 189 (80%) Rate of falls/person/3 months prior to randomisation Median (min to max) Mean (SD) 1.98 (0 to 319) 5.9 (22.8) 0.99 (0 to 73) 3.0 (7.3) Rate of near falls/person/3 months prior to randomisation Median (min to max) Mean (SD) 4.4 (0 to 440) 13.8 (35.8) 4.3 (0 to 601) 15.6 (51.4) Medications Levodopa Dopamine agonist Monoamine oxidase inhibitor COMT inhibitors Other PD medication 208 (88%) 108 (46%) 52 (22%) 59 (25%) 19 (8%) 216 (92%) 106 (45%) 46 (20%) 41 (17%) 23 (10%) GDS score at baseline >5 (suggestive of depression) ≥10 (indicative of depression) 147/235 (63%) 50/235 (21%) 164/236 (70%) 49/236 (21%) Coexisting conditions Orthopaedic Cardio/respiratory 109 (46%) 85 (36%) 129 (54%)	Age (years) Mean (SD) Min to max 71 (7.7) 51 to 91 73 (7.7) 46 to 88	Not recorded in baseline characteristics	PwP	Hoehn and Yahr stage 1 26 (11%) 78 (33%) 2 102 (43%) 32 (13%) 3 30 (13%) 56 (24%) 4 112 (48%) 38 (16%
Cohort study	**Demographic data** (n=62) (Mean and standard deviation) **Age** yrs 65.4 +/- 9.2 **Sex** Male 39 (62.9%) Female 23 (37.1%) **Weight,** Kg 73.6 +/- 14.2 **Height, cm** 172.0 +/- 8.9 **Race/ethnicity** White 53 (85.5%) Black/African American 3 (4.8%) Hispanic 1 (1.6%) Asian 0 (0%) Other 2 (3.2%) Declined 3 (4.8%) **Education** High school 2 (3.25%) College 25 (40.3%) Associates 2 (3.2%) Masters 15 (24.2%) Doctorate 5 (8.1%) Other advanced degree 7 (11.3%) Unknown 6 (9.7%) Missing 6 (9.7%) **H & Y** Stage I 16 (25.8%) Stage II 25 (40%) Stage III 21 (34%) **Time since diagnosis** Yrs 4.7 +/- 4.3 **MDS-UPDR**S 25.9 +/- 4.1 MoCA 23.4 +/-12.9	**Age yrs** 65.4 +/- 9.2	**Race/ethnicity** White 53 (85.5%) Black/African American 3 (4.8%) Hispanic 1 (1.6%) Asian 0 (0%) Other 2 (3.2%) Declined 3 (4.8%)	PwP	**H & Y** Stage I 16 (25.8%) Stage II 25 (40%) Stage III 21 (34%)
Two-arm parallel, single blinded randomised controlled trial.	**Mean (SD) or number for participants' characteristics at baseline. Groups Intervention (n=31) (I) Control (n=29) (C)** Age (I) 68 (7) (C) 65 (7) Gender (male) (I) 15 (48%) (C) 9 (31) Height (m) (I) 1.7 (0.1) (C) 1.7 (0.1) Weight (kg) (I) 76 (15) (C) 78 (18) Cognitive status (MMSE 0-30) (I) 28 (2) (C) 29 (1) Duration of disease (years) (I) 7 (4) (C) 9 (6) Disease severity "on" MDS-UDPRS part III (0-132) (I) 31 (11) (C) 33 (11) Fallen in past year (participants-yes) (I) 17 (55%) (C) 16 (55%) Freezing of gait (participants-yes) (I) 12 (39%)(C) 7 (24%) Daily levodopa equivilant dose (mg) (I) 668 (405) (C) 757 (498)	Intervention (n=31) 68 (7) Control (n=29%) 65 (7)	Not recorded demographic data table	PwP	Not measured instead MDS-UPDRS part III (0-132) (I) 31 (11) (C) 33(13)

Socio-economic status	Disease duration	Index of multiple deprevation	Level of digital litracy	Excluded populations	Intervention description	Intervention type	Type of device
Employment status and years in education recorded.	Not stated	Not stated	Health literacy mentioned	Those not diagosed with idiopathic Parkinson's, residing outside the Cambridgeshire area, not having a computer, tablet or telephone connected to the internet, having acute illness or a history of other neurological conditions or a clinical diagnosis of dementia. Those who recieved or participated in NHS or private PD-specific education with or without excercise classes in the last 12 months	Co-designed digital intervention promoting excercise and physical activity in people newly diagnosed with PD	Utilises an innovative blended learning format comprising of 6 onlines modules tailored to people who are newly diagnosed with PD	Online platform, accelorometer
Not stated	Disease duration in years (SD) 5.2 (1.24	Not stated.	Only states all participants were highly educated	Diagnosed with atypical Parkinsonism, More than two falls in the previous 2 months (due to safety reasons) a score of 3 or greater on the item number 3 of freezing of Gait questionnaire (often or always freezing when walking) Serious co-morbidities (including heart failure, diabetes mellitus or cancer that may interfere with the ability to participate in a walking programme.	A peer coach training programme and remote peer-monitopred walking programme using an mHealth App (FitBit Friends) and a FitBit Zip physical activity tracker.	Peer coaching using an mHealth App (FitBit Friends, FitBit Zip and trainined active trained peer mentors.	FitBit Zip and FitBit Friends App
Not specified	Not stated	Not stated	Not recorded		Two applications were used in the study 1) The audio-biofeedback (AFB-gait App) and the instrumented cueing for FOG-training (FOG-cue App) Feedback and cues were provided via earphones or the smart phones speaker. 30 mins per day, three days per week for 6 weeks	mHealth Apps around gait and balance	Smartphone- Galaxy S3-mini, Samsung South Korea
Not specified	Not stated	Not stated	Not recorded	Exclusion criteria included inability to perform large muscle physical movements and cognitive impairments that prohibited particpation in an online support group. Physician approval to undertake exercise required. Must be able to speak and read English, must have access to WiFi	Fitbits and Ipads and online resources included preloaded videos Exercise 3 times a week Online participant a minimum of three times per week. Trial period 12 weeks	Fitbit (activity tracker), Ipad, pre-loaded videos, access to an online support group.	Physical activity tracker and an electronic table to engage with an online support group
No included in demographic data except employment status Employed/unemployed (I) 3/8 (C) 2/8	Duration of disease (years) (I) 6.55+/- 4.52 (1-16) (C) 7.55 +/- 4.78 (0.8-15.5)	Not included	Not recorded	Exclusion criteria included (a) performing > 150 min/week moderate intensity exercise (B) no wireless internet access at home (c) any orthopaedic, vascular, or cardiac problems that limited participation in moderate excercise of the study protocol.	Telecoach-assisted exercise, with an exercise prescription. Includes telecoach supervision. Consists of three components; telecoach console Homestation and the the internet via a server as a conduit between the two.	Online supervised telecoaching via the internet, exercise equipment, instrumental recording of physical activity via a bloodtooth enabled tablet.	10.5 inch Android computer tablet with Bluetooth and wireless internet capability, mounted to an adjustable floor stand. Custom designed Android application. (user interface from both the participant and the telecoach view) which is installed on a tablet that allowed live streaming of audio, video and text messages between the participant and telecoach, and real-time screening of physiological parameters.The application enabled the ability to view and archive exercise dat from the computer tablet to a Web-based server and; a wearable physiologic monitor (Bioharness 3, Zephyr) and (Exerpeutic 900XL Recumbent Bike)
Highest degree earned High School diploma/assocaites 14.9% (13)Degree % (n) 39.1% (34) Master, doctoral, professional degree % (n) 40.2%	Years since Diagnosis <1, % (n) 0% (0) 1-3% (n) 20.7% (18) 3-5% 21.8% (19) 5-10, % 29.9 (26) >10, % (n) 27.6	Not measured	Not measured however, Barriers, facilitators, and needs in PD and instructor groups explored	Those unable to answer survey questions either with or without someone to support. Participants were also required to be able to provide written informed consent.	Transition of community-based exercise classes to virtual intervention for PwP during the Covid-19 pandemic.	Face to face vs virtual class formats of usual care.	Online survey Virtual class format not very clearly described.

Marital status Married (I) 13 (65.0) (c) 8 (34.8) Not married (I) 7 (35.0) (c) 3 (13.0) **Family income** (10,000 won/Month) (I) <100 8(40) 100-199 4 (20) 200-299 3 (15)equal to or greater than 300 5 (25.0)	Duration of PD years (I) 9.95 +/- 5.26 (c) 10.50 +/- 4.58	Not specfically IMD	No only educational level	Those with other serious diseaases that may affect QoL, Non-motor symptoms (such as depression and Pain) and self-management and those whose PD medication had been changed within the past month . In addition, participants who change parkinsonian medication due to worsening symptoms during the intervention period were considered drop outs for this study as such medications affect motor symptoms, non-motor symptoms and QoL	The mobile intervention in this study consisted of mobile applications, smartwatches, smartphone-based short text messages and information and telephone counselling for 16 weeks.	Mobile health Smartphone Smartwatch	Smartphone and Smartwatch
On in terms of general demographic data.	Not stated	No	No only level of education, however technology issues last more than 15 minutes were recorded.	PAR-Q as a screening tool and medical approval to participate.	Engage-PD is a Telecoaching intervention grounded in self-determination theory. Up to 4 coaching sessions all delivered via a telehealth platform . The intervention incorporated 1:1 coaching, Physical activity monitoring and use of a disease specific workbook to promote and support safe excercise uptake.	Single cohort implementation study	Mentions workbook on physical activity monitoring to support autonomy, which participants can do using wearable activity monitors, smartphones or exercise diaries.
Not recorded in baseline characteristics	Disease duration (years) Mean (SD) Min to max 8 (6.6) 0 to 36 8 (5.8)	Not stated	Not measured	People were eligible if they had a clinically confirmed diagnosis of PD in accordance with UK Brain Bank criteria were living in their own home; independently mobile with or without an aid; experienced one fall in the previous 12 months; score 24 or more on the MMSE had the cognitive ability to give informed consent; were able to understand and follow commands; and considered able to participate in an exercise and strategy programme.	PDSAFE comprised individually tailored, progressive home-based exercise and strategies to avoid falls. Home visits with trained PT's 12 supervised sessions 1-1.5 duration over 6 months This was tapered Unsupervised exercise for about 30 mins. Participants were given a folder with picture discriptions and descriptions of excercises a rating perceived exertion scale, an excercise log, and DVD's of both excercise demonstrations and personal videos taken by their physiotherapist of them doing the excercises. Monthly 'Master class' conferences' and regular clinical supervision sessions were implemented	Multimodal, Home-based, Physiotherapy, digital training videos, teleconferences	Audiovisual, digital images of excercises.
Education High school 2 (3.25%) College 25 (40.3%) Associates 2 (3.2%) Masters 15 (24.2%) Doctorate 5 (8.1%) Other advanced degree 7 (11.3%) Unknown 6 (9.7%) Missing 6 (9.7%)	**Time since diagnosis Yrs** 4.7 +/- 4	Not measured	Not measured	Participants were excluded if they had coexisting neurological or musculoskeletal conditions that would restrict exercise. They were also excluded had more than 150 minutes of moderate vigorous physical activity per week. No approved for exercise by a medical doctor or failed the Physical Activity Readiness Questionnaire (PAR-Q). .	The Engage-PD intervention consists of up to 5 personal coaching sessions delivered via telehealth over a 3-month period. Using Zoom © delivered by licenced Physical Therapists. Engage-PD is grounded in self-determination theory. Multimodal programmes of exercise including aerobic, strengthening, balance, and flexibility excercises.	Telehealth	Telehealth via Zoom©
Not recorded in demographic data table	Duration of disease (years) (I) 7 (4) (C) 9 (6)	Not recorded	Not recorded	Participants were excluded if they had substantial cognitive impairment (MMSE <24) or a medical condition which would preclude or interfere with physical assessment or stepping training.	Exergame 15 minutes three times a week for 12 weeks while on usual medicinal treatment. The exergame was a modified version of the open source Dance Dance Revolution "stepmania game"	Exergame	Videogame

Duration of intervention and type	Length of intervention	Level of interventions modification	Setting intervention took place	TIDieR items	PRISMS taxonomic domains* listed full at foot of column
Variable depending on capability	8 Weeks (with access to online resources for the intervention and control groups after completion of the trials for up to 1 year.	Authors state no modification was undetaken.	Cambridge University Hospital NHS Foundation Trust and Cambridgeshire and Peterborough NHS Foundation Trust.	TiDIER Items all described in great detail (beyond the limits of this data extraction sheet) . These items in relation to this study can be found in the papers Supplment 1 found at https://dx.doi.org/ 10.3233/JPD-240071	A1 In online modules A2 In online modules A3 Not described A4 Not specifically mentioned A5 Access to a specialist physiotherapist A6 Behavioural uses the COM-B model A7 Appears accelerometers were provided whilst participants required their own devices to access the internet. A9-12 Were framed around these to an extent but with an overriding theme of physical activity. A13 Yes in so far as the modules have been developed around the COM-B model A13-14 Described in general terms in the study discussion.
8 weeks Peer-coaching using mHealth to	8 Weeks	Some modification based on participants level of walking ability	In the home	**Brief name** No brief name provided intervnetion described a peer coaching through mHealth **Why** To conduct a feasibility study on an mHealth intervention to improve physcial activity on PwP who are sedentary **What** Peer coaching using FitBit Zip as a physical activity tracker, use of a moble App FitBit Friends and access to specialist physiotherapists who train the peer mentors who also offer support to mentees. **How** Training PwP who are active as mentors, mentees also had support from the FitBit Friends mobile App **When** over a 8 week period **When and How much** Mentee led goal setting from an ation plan 2-4 hour face to face sessions **Tailoring** **Modifications** Neither tailoring or medification of the intervention were described **Fidelity** As this was a feasibility study fidelity was not described.	A1 Yes through motivational interviewing including 2 4-hr face to face sessions in a neurorehabilitation setting with Mentors A2 Yes via support from the FitbBit Friends mobile App A3 Not specifically described A4 Implied only via safety AE reporting A5 Only through 7-day walking monitoring and disability measures A6 As this intervention utilises motivational interviewing support and adherence is behavioural in nature A7 FitBit Zips are provided however participants would require a smartphone to download and use the FitBit Friends App. A8-A9 Yes from face-to-face training and with PD specialists and via the FitBit Friends App. A10-12 in relationship to mentor training which provides rehearsal activities and self-management and psychological support via the dyad relationships A13 A-13-14 with the FitBit Friends App and via the relationship between mentor and their mentee as they share their personal experiences of living with PD.
CuPiD Smartphone App's and walk 3 times per week according to ACSM exercise guidelines.	6 weeks	Duration and frequency times specific, however some flexibility around timing and type of walking activity.	Home with researcher home visits.	**Brief name-** CuPiD **Why-** Study investigated the CuPiD-system's feasiility and effectiveness compared to conventional gait training **What-** Smartphone and two associated Apps **How-** Use of a SmartPhone through in-home training **Where-**In the home setting. **When an how much-** 30 mins oer day three time a week for six weeks, cost not recorded in the outcomes **Tailoring-** Unclear, but seems to be indivualised as training done in the individuals home **Modifications-** Not specifically mentioned **Fidelity-** No mentioned but was a small feasibility study.	A1 Not specifically, A2 Only in relation to gait and walking, A3 In part, A4 Yes, A5 Unclear A6 Yes Training , A7 Smartphone and Apps, A8 Unclear in terms of outside training visits, A9 Yes weekly training and instruction, A10 Only in terms of gait and walking, A11 Limited to intervention scope, A12 Not directly , A13 No specifically in the intervention . A14 Based on the intervention discription supports and encourages a healthy lifestyle through physical activity.
Activity 3 times per week and a minimum of three sessions per week online support for a duration of 12 weeks.	12 weeks	No specified, however, exercise is unsupervised	Home setting	**Brief name-** Physical activity using technology: A feasibility study **Why-** The purposes of the study were to (a) assess the feasibility of an intervention that requires wearing a feasibility tracker and (b) examine the effect of this intervention on self-efficacy for physical activity and QoL of older adults with PD **What-** Fitbit activity tracker, Ipad, online support **How-** Partial online delivery **Where-** Online, the home setting, agile **When an how much-** **Tailoring-** Not specified **Modifications-** Not specified **Fidelity-** Small feasibility study	A1 Some information but mainly about movement, A2 Signposting to online resources and support group, A3 not mentioned, A4 not mentioned, A5 Indirectly A6 yes, must demonstrate engagament, A7 yes fitbit, iPad and preloaded videos, A8 unclear, A9 very little detail, A10 not explictly stated, A11 To an extent, A12 Yes in relation to self-efficacy and physical activity , A13 not stated though community involvment in recruitment, A14 Indirectly as promotes monitors, measure and support physical activity
Exercise prescription included eight weeks of exercise (three times per week:24 total sessions) with a goal of 165 min/week of combined aerobic and strength excercises. Participants were instructed to perform moderate aerobic exercise within 40-60% of their heart rate reserve , using the telehealth system and a stationary recumbent cycle (Exerpeutic 900XL Recumbent Bike) For strength excercises, participants used adjustable ankle weights (1-5lb) to perform 2-3 sets of 30-30 repetitions.	Eight weeks	Intervention description appears to suggest standardised rather than tailored intervention	Home setting.	**Brief name-** Telecoach Pilot study **Why-**To explore the uptake and implementation of two common methods of exercise training **What-** Supervised and self-reguiated home excercise **How-** exercise equipment, physiological measurements via sensors, internet resources and coaching. **Where-** Home setting **When an how much-** 165min/week over eight weeks (3 tmes per week, 24 sessions in total) **Tailoring** Not mentioned in intervention description **Modifications-** Not mentioned in intervention description **Fidelity-** No examined, but was a pilot study	A1 Focused on physical activity specifically not PD in general , A2 Intervnetion focused , A3 No spsecfically mentioned A4 No, A5 exercise physiological parameters and measurements A6 Telecoach group only, A7 Yes described here under devices, A8 More so for the TAE group, A9 Training was provided , A10 more around excercise, A11 Only indirectly, and more so in the SRE group A12 Not direcly A13 In the form of the telecoach support A14 Aims to improve physical activity through technology and excercise equipment use.
Survey closed February 2021	Single data capture point for both groups	N/A but the usual care face to face community-based care to virtual classes required significant levels of modification.	Online- virtual	**Brief name-** Impact of Covid-19 on Community-based exercise classes for PwP. **Why-** To examine the impact of Covid-19 restrictions on specific outcomes **What-** Physical activity, Exercise self-efficacy Activities of daily living and QoL **How-** Electronic database surveys **Where-** Online **When an how much-** An open survey format **Tailoring** None to the research method but yes to virtual class format **Modifications- None to the research method but yes to virtual class format** **Fidelity-** N/A	A1 N/A, A2 N/A, A3 N/A, A4 No, A5 Unclear for Virtual classes A6 Behavioural change through SEE, GLT-Q , A7 Requires the participant to be able to go online, A8 No, A9 No, A10 No, A11 potentnially , A12 Potentially , A13 Contact with healthcare professionals during Covid-19 restrictions, A14 Looks to continue community-based excercise classes for PwP during Covid-19 restrictions.

Complex 30 minute schedules based around activities and time of the day and diary prompts.	16 weeks	The design and data collection points seem very specific	Predominatly home but also agile	**Brief name-** Mobile health intervention **Why-** To evaluate the effects of a mobile health intervnetion for self-management on self-efficacy, motor symptoms and non-motor symptom, self-management and quality of life in PwP **What-** To evaluate a mobile health intervention and Smartphone and Smartwatch. **How-** Conducting an RCT **Where-** Home/agile **When an how much-** A series of multiple prompts through out the day **Tailoring** Potentially, **Modifications- No Fidelity-** Not mentioned	A1 Yes viewed holistically IMB model, A2 Yes message feature and extensive menu, A3 Part of exclusion/dropout criteria, however also has medicinal taking prompts, A4 No, A5 Yes, A6 Yes medicinal prompts, A7 Yes Smartwatches and Smartphones, A8 Yes via menu and reflective tracking, A9 limited description, A10 To an extent, A11 Yes, A12 Yes, A13 Yes, A14 Yes, especially around physical activity
Up to 4 telehealth coaching sessions over three months	3 months	Intervention was modified, however this was not unlimited.	Implied home setting	**Brief name-** Engage-PD **Why-** Case report to describe a physical activity coaching programme. **What-** **Telehealth coaching via Zoom© How-** Virtual delivery, training, disease management reasons. **Where-** Up to 4 sessions with a specially trained PT virtually tele-coached via Zoom (c) Home setting. **When an how much-** Up to 4 coaching sessions over 3 months. **Tailoring** Yes but with limits **Modifications-** Yes around functional ability **Fidelity-** Yes	A1 Yes, booklet and training, A2 Yes, as resources and via training, A3 Not directly , A4 Not direcrtly and physical activity focused, A5 Via physical activity devices A6 Yes in the form of telecoaching , A7 Unclear, but potentially yes , A8 Limited to up to 4 telecoaching sessions over 3 months, A9 Training is given , A10 Mainly in relation to promotion of physical and self-efficacy, A11 Mainly in relation to physical activity, A12 Yes in terms of behaviour change via motivational interviewing, A13 Not directly specified, A14 Yes, in relation to physical activity sustained through raised self-efficacy
	6 Months	Intervention is modified or tailored but there are limits and fidelity checks.	Home-based intervention	**Brief name-** PDSAFE **Why-** To reduce falls in PwP **What-** A multimodal physiotherapy intervnetion **How- Home visits,** supervised and unsupervised visits, DVD,s Video teleconferences 'Master classes'. **Where-** Home-based care. **When an how much-** 30 mins per day for 6 months **Tailoring** Yes **Modifications-** Yes **Fidelity-** Yes	A1, A2, A3, A4, A5 A6, A7, A8, A9, A10, A11, A12, A13, A14
5 sessions over Three-months via Zoom ©	Three months	Some level of modification, described as advice on modified extensions based on functional ability	Home setting but agile	**Brief name-** Engage-PD **Why-** To determine the feasibility and preliminary efficacy of the Engage-PD intervention and to explore whether baseline characteristics are associated with outcomes **What-**Physical activity coaching via telehealth **How-** Delivering the intervention via five coaching sessions using Zoom (c) **Where-** Participants homes **When an how much-** Five sessions delivered by licenced PT's over Three months **Tailoring** Yes specifically stated **Modifications-** Yes specifically mentioned **Fidelity-** No, but was a feasibility study	A1 Yes disease specific workbook, A2 Yes multimodally, A3 No , A4 Only in the course of usual care, A5 Spefically in terms of physical activity A6 Behavioural in terms of coaching to promote physical activity, A7 Unclear uses Zoom © but is this through the participants own device and WiFi, A8 Number of coaching sessions is specifically 5 over 3 months, A9 Therapists are trained to train in things like motivational interviewing , A10 Only in relation to physical activity, A11 Specifically in relation to physical activity, A12 Coaching promotes ESE and by extension psychological activities, A13 Yes via terehealth coaching , A14 Yes via coaching and promotion of physical activity
Stepping excersie 15 minutes three times a week for 12 weeks.	15 minutes per session	No specified, however, exercise is unsupervised	Intervention-home Ourcome-Laboratory setting	**Brief name-** Stepmania **Why-** To see if intervention improves balance gait and reduction in falls. **What-** A videogame (exergame) for use in the home, links to television **Who- Physiotherapists How-** Remote in the home. **Where-** Intervention in the home, outcome measures in the laboratory. **When an how much-** 15 minutes per session, 3 sessions per week over 12 weeks. **Tailoring-** Unclear, **Modifications-** not mentioned **Fidelity-** Unclear but suggests standardised.	A1 In the context of the intervention but more broadly, A2 Yes, A3 Potentially during training, A4 No, A5 Indirectly and only within the scope of the intervention A6 No, A7 Yes Videogame provided, A8 Not explictly stated, A9 Yes training with Physiotherapist , A10 Only in relation to the focus of the intervention, A11 Yes , A12 Yes in relation to secondary outcomes, A13 Not specifically , A14 In relation to movement and physical activity through stepping.

Key A1 Infiormation about condition and/or its management **A2** Information about available resources **A3** Provison of/agreement on special clinical actionplans and/or rescue medication **A4** Regular clinical review **A5** Monitoring of condition and feedback **A6** Practical support and adherence (Medicinal or behavioural **A7** Provision of equipment **A8** Provisionof easy access to advice or support when needed **A9** Training/reheersal to communicate with healthcare professionals **A10** Training rehersal of everyday activities **A11** Training rehersal for practical self-management activities **A12** Training/rehersal for psychological activities **A13** Social support **A14** Lifestyle advice and support

Outcome/Outcome measures	Scale used to measure self-efficacy	Magnitude of change in level of self-efficacy
Performance-based outcome measures included: 1) the Unified Parkinson's Disease Rating Scale (UPDRS) motor examination part 3; 2) the Mini-BESTest; 3) the Five Time Sit To Stand (5TSTS) These outcomes were measured by a PD specialist physiotherapist at baseline and 6 months post intervention. Patient reported outcome measures (PROMS) included ; the Geriatric Depression Scale (GDS); the Apathy Evaluation Scale (AES) , the Oxford Participation and Activities Questionnaire (Ox-PAQ); the Self-Efficacy for exercise scale (SEE) ; the Multidimensional Outcomes Expectations for Exercise Scale49 (MOEES); & the Gait-Specific Attentional Profile scale (GSAP).	Self-efficacy for Exercise Scale (SEE)	Intervention group baseline 56 (49-68) post-intervention 40 (37.5-63.5) 6-months post follow- 65 (53.75-78.25). Control group baseline 64 (52.5-74) post-intervention 56 (51.5-69.5) 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
Feasibility measured be examining recruitment and retention, Safety was measured through reporting AE's, Acceptability questionnaire, Walking Activity measured objectively over 7 days , Self-efficacy measured using the self-efficacy for Exercise measure & Disability was measured using the Late Life Function and Disability Instrument (LLFDI)	Self-efficacy was measured using the Self-efficacy for walking duration 10-item Questionnaire (SEW_Dur)	The mean self-efficacy for peer mentees increased from 66.8 (SD 25.7) points at baseline to 70 (SD 25.9) points post intervention. Clinically important differences were not established.
Primary: Gait speed under dual conditions HR-QOL- 2 Minute walk test. MiniBESTTest, Four square step test (FSST) Falls Efficacy Scale International (FES-I)	FES-I	No statistically significant changes noted
Self-efficacy via PAAI, The funcational Assessment of Cancer Therapy-General (FACT-G) -QoL-PWB-7-Item, Social and Family Wellbeing SWB 7-item Emotional wellbeing EWB- 6-item, Functional wellbeing FWB 7-item, Objective data from fitbit physical activity tracker.	Physical Activity Assessment Inventory (PAAI)	No statistically significant changes noted but authors mention small sample size (n=5)
Adherence outcomes of study, Attendance (%) Total sessions, Time performing exercise, Time performing moderate exercise aeorobic exercise (min/week) Walking capacity outcomes by study group. 6 minute walk test. Qualitative themes- 1) Telecoach-assisted excercise positive programme experiences, Suggestions for improving technology, Self-regulated group- Challenges that affected excercise adherence. Potential benefits of telehealth.	Determined by mapping qualitative findings to Bandura's Social cognitive theory	Qualitative findings suggested that high rates of adherence for TAE participants were largely influenced by increased self-efficacy, which was facilitated primarily by the assistance of the telecoach.
Godin Leisure-Time Questionnaire, Self-efficacy for Exercise Scale, Schwab-England Activities of Daily Living Scale, Parkinson's Disease Questionnaire-8 (PDQ-8) (QoL)	Self-efficacy for Exercise Scale	Reduced face to face community-based exercise classes and the use of virtual class formats due to the Covid-19 Pandemic was associated with a reduction in Self-efficacy for Exercise levels.

Self-efficacy, motor symptoms, Non-motor symptom, Self-management, Quality of Life	Self-efficacy for managing Chronic Disease 6-item Scale	The mobile health intervention for self management is effective for self-efficacy and non-motor symptoms in PwP.
Construct- *Acceptability*- Measure Acceptibility & Fidelity- Perceive autonomy support healthcare, Climate Questionnaire (HCCQ), Rates of adherence and retention, Post intervention Questionnaire, **Physical Activity** *Planned and unplanned activity*- Brunel Inventory Scale. **Disease specific impairments** *Balance* TUG, 30CST *Gait speed* - 10WT. **Motivation and Self efficacy** *Self-efficacy* Norman Self-efficacy scale *Satisfaction/performance with exercise* Modified Canadian Occupational Performance measure.	Norman self-efficacy scale	Does not explicitly state as this is an interim point case study, the full Engage-PD study by Shih did find this approach raised levels of Exercise Self-efficacy.
The primary outcome was risk of repeat of falling in the first 6 months after randomisation. Secondary outcomes were fractures and the rate of near falling; The MiniBesTest, The chair to stand test (CST) Geriatric Depression Scale (GDS) The International Version of Falls Efficacy Scale (FES-I) New Freezing of Gait Questionnaire (NFoG) The Parkinson's Disease Questionnaire. PDQ-39 (QoL)The Physical Activity Scale for the elderly (PASE) EuroQol (ED-5D-3L)	FES-I	Statistically significant change is Falls self-efficacy as a secondary outcome.
Feasibility- Recruitment, Retenion, Adverse Events, acceptibility, Participant perspectives via open ended questions. **Intervention outcomes**- Physical Activity via the Brunel Inventory Scale, Execercise-Self-Efficacy via the Exercise Self-efficacy Scale, Participant Goals	Exercise self-efficacy scores	Participants with lower baseline planned physical activity exoperienced greater improvements in planned physical activity, and those with lower exercise self-efficacy experienced greater improvements in Exercise self-efficacy.
Primary outcomes-Stepping performance CSRT task Reaction time (ms) CSRT task Movement time (ms) CSRT task Response time (MS) Mobility FGA (0-30) **Secondary outcomes**- Power Average hip abductor peak power (w) Average hip abductor power at load (33N) (w) Mobility TUG, Tug avg, GAT accuracy (cm) GAT velocity (cm/s) Hand movement Hand reaction time (ms) Cognition- MOCA, TMT, FOG NFOGQ (0-28) Falls efficacy- FES-I (16-64)	Falls efficacy FES-I (Falls eficacy scale-International)	Week 0- (I) 25.3 (6.4) (c) 26.0 (10.2) Week 12 (I) 27.0 (7.9) (C) 25.3 (10.1)

Outcomes measured in addition to self-efficacy	PD symptoms measured	Objective measurement Y/N	Self-reporterd or CG reported outcomes	Effective Y/N/ Not measured	Safety assessed
The Unified Parkinson's Disease Rating Scale (UPDRS) motor examination part 3; the Mini-BESTest; the Five Time Sit To Stand (5TSTS)	The Unified Parkinson's Disease Rating Scale (UPDRS) motor examination part 3	Subjective and objective from the accelerometer	Self-reported	N/A feasibility study	Yes (as a theme)
Feasibility was determined by examining recruitment, participation, and retention. Safety, satisfation and acceptability were measured, along with individual-level changes in physical activity were examined releative to clinically important differences.	Walking measurement, risk of falling, Indirect measures, study retention	Yes	Self-reported	No as this was a feasibility study	Yes
Single and dual task gait speed, MiniBESTest, Quality of Life (SF-36 physical health) Balance, Endurance, Disease severity, FOG, Cognition	Comfortable gait, Dual task gait, Balance, Endurance and Physical Activity	Comfortable gait, Dual task gait, Balance, Endurance and Physical Activity, MiniBESTest	Self-reported	Not in terms of self-efficacy	Not specifically mentioned
QoL, Wellbeing, PWB, SWB, EWB, FWB, PAAI	Motor symptoms in terms of physical activity,. Objective measure and qualititive thematic analysis, Quantative measures of physical activity, mutliple wellbing and QOL domains.	Objective data from the Fitbit physical activity tracker.	Self-reported	No statistically significant difference found	No
Adherence outcomes of study, Attendance (%) Total sessions, Time performing exercise, Time performing moderate exercise aeorobic exercise (min/week) Walking capacity outcomes by study group. 6 minute walk test.	No specifically, but looked at walking function and strength from physical activity	Physiological measurements from the various instrumentation used including wearable sensor.	Self-reported and objectively measured	In terms of the qualitative findings yes, with an explanation related to Bandura's social cognitive theory and a proposed mechanism proposed.	Yes, exercise on the cycle was done in a recumbant position to reduce the risk of falls. Training was also provided.
Godin Leisure-Time Questionnaire, Schwab-England Activities of Daily Living Scale, Parkinson's Disease Questionnaire-8 (PDQ-8) (QoL)	Predominatly motor, Balance, Gait, Falling, Depression, FoG	No All participant reported	Self-reported/care partner reported, and instructor reported.	The restriction placed for Covid-19 reduced face to face community-based exercise classes to some virtual classes. The effect of these changes resulted in a reduction in the level of SEE-Self-efficacy for exercise and physical activity in general.	No

Motor symptoms, Non-motor symptom, Self-management, Quality of Life	Both motor and non-motor symptoms	In terms of engagement and use yes, as actions recorded	Self-reported	Yes	Not specifically mentioned
Construct- Acceptability- Measure Acceptibility & Fidelity- Perceive autonomy support healthcare, Climate Questionnaire (HCCQ), Rates of adherence and retention, Post intervention Questionnaire, Physical Activity Planned and unplanned activity- Brunel Inventory Scale. Disease specific impairments Balance TUG, 30CST Gait speed - 10WT. Motivation and Self efficacy Satisfaction/performance with exercise Modified Canadian Occupational Performance measure.	Not directly symptom focused	Option of using different types of physical activity trackers and devices suggested and their use promoted.	Self-reported	Not stated, however Shih which is the full cohort study of Engage-PD notice a positive change in self-efficacy	Yes, including risk, benefit weighing
The primary outcome was risk of repeat of falling in the first 6 months after randomisation. Secondary outcomes were fractures and the rate of near falling; The MiniBesTest, The chair to stand test (CST) Geriatric Depression Scale (GDS) New Freezing of Gait Questionnaire (NFoG) The Parkinson's Disease Questionnaire. PDQ-39 (QoL)The Physical Activity Scale for the elderly (PASE) EuroQol (ED-5D-3L)	FoG, Balance, Gait, Depression, Walking, Falls	No All participant reported	Self-reported	Yes between moderate and severe group.	Yes, Adverse events and deaths reported
The Brunel Lifestyle Inventory (meassure of physical activity), The Exercise Self-efficacy Scale (ESE), Canadian Occupational Performance Measure (mCOPM) Particpant goals.	Not symptom focused by indirectly in terms of physical activity, Exercise Self-efficacy, Participant Goals (linked to behaviour) Participant perspectives via open-ended questions.	No All participant reported	Self-reported	Participants with lower baseline planned physical activity exoperienced greater improvements in planned physical activity, and those with lower exercise self-efficacy experienced greater improvements in Exercise self-efficacy.	Yes No adverse events reported and evidence of safety monitoring
Primary outcomes-Stepping performance CSRT task Reaction time (ms) CSRT task Movement time (ms) CSRT task Response time (MS) Mobility FGA (0-30) **Secondary outcomes**- Power Average hip abductor peak power (w) Average hip abductor power at load (33N) (w) Mobility TUG, Tug avg, GAT accuracy (cm) GAT velocity (cm/s) Hand movement Hand reaction time (ms) Cognition- MOCA, TMT, FOG NFOGQ (0-28)	Stepping reaction time test, functional gait assessment, Physical and neuropsychological measures associated with falls, number of falls, mobility and balance	Hip abduction, hand movement, reaction and response time, TUG Test	Self-reported	Not in terms of self-efficacy	Yes including booklet for safe use.

Studies which showed a statistically significant improvement in the self-efficacy measure		
Authors year Title	Study design, sample size and self-efficacy measure	Intervention description and key findings
Chivers Seymour, K., Pickering, R., Rochester, L. et al. (2019) Multicentre, randomised controlled trial of PDSAFE, a physiotherapist-delivered fall prevention programme for people with Parkinson's [80].	**Study design:** Randomised Controlled Trial. **Sample size:** n=474 **Self-efficacy measure:** Falls Self-efficacy Scale International (FES-I) [67].	**Intervention:**. Tailored video vignettes of strategies were given to participants on a DVD to remind/reinforce between face-to-face sessions, using images of them performing the activities using a Tablet. Control used a standard instructional DVD only [80]. **Primary outcome:** No reduction in falls **Secondary outcome:** Self-efficacy measured using the FES-I showed a statistically significant improvement compared to control at 6-months. Between-group difference 1.60 points, 95% CI 3.00 to 0.19, p=0.026 for the intervention at 6-months.
Lai, B., Bond, K., Kim, Y. et al. (2020) Exploring the uptake and implementation of tele-monitored home-exercise programmes in adults with Parkinson's disease: A mixed methods pilot study [77].	**Study design:** Mixed Methods Pilot. **Sample size:** n=20. **Self-efficacy measure:** Qualitative thematic analysis.	**Intervention:** Eight-week telecoach-assisted programme comprised of a strength and aerobic exercise, vital signs and exercise measurements, and supervised exercise via videoconferencing. Control group performed self-regulated exercise only. **Outcomes:** Perceived increased exercise motivation, and self-efficacy in the intervention group identified using qualitative thematic analysis.
Park, Y., Kim, R.S., So, H. Y., et al. (2022) Effects of mobile phone intervention for self-management on self-efficacy, motor and non-motor symptoms, self-management, and quality of life in people with Parkinson's disease: Randomised controlled trial [76].	**Study design:** Randomised Controlled Trial **Sample size:** n=20 **Self-efficacy measure:** Self Efficacy for managing Chronic Disease 6-Item (SEMCD-6-item) [73].	**Intervention:** Mobile health intervention using Smartphone and smartwatch devices, telehealth communication and tele-counselling over a 16-week period, based on the Information-motivation-behaviour (IMB) skills model. The control group was similar to the intervention but did not include the use of smartphones and smart watches [86, 87] **Outcome:** The intervention group improved self-efficacy to a statistically significant level when compared to the control group (t=2.33, p=0.025). Intervention Pre-Post score (t=2.85 p=0.011) Compared to the control Pre-post test score (t=0.26 p=0.796).
Quinn, L., Macpherson, C., Long, K. et al (2020) Promoting physical activity via telehealth in people with Parkinson disease: The path forward after the COVID-19 pandemic [79].	**Study design:** Case Report **Sample Size:** n=27 **Self-efficacy measure:** Norman Self-efficacy Scale for Exercise [72].	**Intervention**: Tele-coaching intervention comprising of; 4 tele-coaching sessions, that incorporate 1:1 coaching, goal-setting, physical activity monitoring, and a disease-specific workbook resources aimed at promoting physical activity. **Outcome:** Pre/post scores showed a statistically significant increase in self-efficacy (d=0.95 p<0.001). Study design does not have a control or blinding.
Shih, S. H-J., Macpherson, C.E., King, M., et al. (2018) Physical activity coaching via telehealth for people with Parkinson disease: A cohort study [83].	**Study design:** A single cohort study with no control group or blinding of participants **Sample Size:** n=62 **Self-efficacy measure:** Exercise Self-efficacy Scale (ESE) [68].	**Intervention:** Up to 5 personal telecoaching sessions over a 3-month period. The intervention seeks to promote self-initiated physical activity, competence, relatedness to improve physical activity and uptake of exercise. Use of a multimodal approach involving 150mins of exercise per week. Number and frequency of coaching sessions was based on the individuals' needs and progress. Time periods between sessions are tapered. The telecoaching intervention was led by licensed physical therapists using Zoom™ video communication **Outcome:**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.
Studies which did not raise self-efficacy to a statistically significant level in the measure used		

Authors Year Title	Study design, sample size and self-efficacy measure	Intervention description and key findings
Agley et al., 2024 Digital intervention promoting physical activity in people newly diagnosed with Parkinson's disease: Feasibility and acceptability of knowledge, exercise-self-efficacy, and participation (KEEP) Intervention [70].	**Study design:** An assessor blinded, randomised controlled feasibility study. **Sample size:** n=30 **Self-efficacy measure:** Self-efficacy for Exercise (SEE) [69, 70].	**Intervention:** The KEEP intervention used a blended learning format comprising of 6 online modules focusing on acceptance of knowledge, exercise self-efficacy and participation, using COM-B behaviour change model [89]. The intervention also used four online discussion groups facilitated by a specialist physiotherapist. **Outcome:** Intervention group **b**aseline 56 (49-68) post-intervention 40 (37.5-63.5) 6-months post follow- 65 (53.75-78.25). Control group baseline 64 (52.5-74) post-intervention 56 (51.5-69.5) 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.
Colón-Semenza et al., 2018 Peer coaching through mHealth targeting physical activity in people with Parkinson's disease: Feasibility study [74].	**Study design:** Feasibility study **Sample size:** n=10 (5 dyads) **Self-efficacy measure:** Self-efficacy for walking-duration 10-item questionnaire (SEW_Dur) [90].	**Intervention:** A peer-mentored walking programme involving motivational interviewing, mHealth technology, a FitbBit Zip activity tracker and FitBit *friends* mobile App and action planning over an 8-week period. **Outcome:** 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.
Ginis P., Nieuwboer, A., Dorfman, M., et al (2016) Feasibility and effects of home-based smart-phone delivered automated feedback training for gait in people with Parkinson's. A pilot randomised controlled trial [75].	**Study design:** Pilot Randomised Controlled trial **Sample size:** n=40 **Self-efficacy measure:** Falls Self-efficacy Scale International (FES-I) [67].	**Intervention**: Two smartphone applications that offered positive and corrective feedback on gait were used in this study. One app used the audio biofeedback ABF-gait app the second employing an instrumented cueing for Freezing of gait (FOG) training (FOG-cue app). Feedback and cues were provided via earphones or the smartphone's speaker. In terms and frequency gait training was undertaken 30 minutes 3 times a week for a 6-week period. **Outcome**: Self-efficacy was measured using the FES-I measure [91]. Effects at 6 weeks (Time (p=0.91) X Group (p=0.84 equals p=0.89) and was not raised to a statistically significant level.
Manãgo M.M., Swink, L.A., Hager, E.R. (2021) The impact of COVID-19 pandemic on community-based exercise classes for people with Parkinson disease [66].	**Study design:** Cross-sectional Study **Sample Size:** n=87 **Self-efficacy measure:** Self-efficacy for Exercise (SEE) [69].	**Intervention:** Data were collected via custom-designed electronic surveys for people with PD and physical therapy class instructors who reported attending or teaching PD-specific exercise class ≥1 time/week for ≥3 months prior to pandemic restrictions. Self-efficacy was measured using the Self-efficacy for exercise scale (SEE). **Outcome:** Whilst 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
Song, J., Paul, S.S., Caetano, M.J.D., et al (2018) Home-based step training using videogame technology in people with Parkinson's a single-blinded randomised controlled study [82].	**Study design** A Two-arm, Parallel, Single-blinded Randomised Controlled Trial **Sample size**: n=60 **Self-efficacy scale:** Falls Efficacy Scale-International (FES-I) [67].	**Intervention:** Step pad training, taught by experienced physiotherapists in order that the participants can perform exergaming in their home. Participants were encouraged to perform the exergame for a minimum of 15 minutes, three times a week for 12 weeks. The exergame was an adapted version of dance mania Stepmania™ game [92]. **Outcomes**: 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.
Studies which statistically lowered self-efficacy in the measure.		
Authors Year Title	Study design, sample size and self-efficacy measure	Intervention description and key findings

Hermanns, M., Haas, B.K., Lisk, J (2019) Engaging older adults with Parkinson's physical activity: A feasibility study [81]	**Study design:** Longitudinal Pre-test Post-test design **Sample size:** n=5 **Self-efficacy measure**: Physical Activity Assessment inventory (PAAI) [71].	**Intervention**: Devices used were Fitbits™ and iPads given to participants. Additionally, participants had access to a private social media support group. via an electronic tablet, exercise compliance was measured using the Fitbit™ device, along with instructional videos. The frequency and duration of the intervention was 3 times a week for 12 weeks**.** This study did not have a control group. **Outcome:** Statistical analysis involved pre-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 nonsignificant changes ($p > .05$). A full breakdown of PAAI is shown in appendix iii.

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Digital Health Technologies and Self-Efficacy in Parkinson's: A Scoping Review

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Title page

Digital Health Technologies and Self-Efficacy in Parkinson's: A Scoping Review

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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 1st 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 eligibly 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 33165 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.

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 replicatable and methodologically robust.
A diverse collection of bibliographic databases were utilised 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

INTRODUCTION

Background Parkinson's disease (PD) is a progressive neurodegenerative disorder with no known cure [1]. It causes both motor symptoms (MS) 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 determinant's 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 focussing 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 organize 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 forms the rationale for undertaking this scoping review. Placing this review into context a recent systematic review has focussed 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 focusses 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 medicator for self-management in PwP, and in doing so filling an important and potentially sizable 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 1st January 2008 to the 24th July 2024, while Google Scholar™ was principally used to search the grey literature shown in Supplement 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 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 the 24th 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].

Table 1 Population Intervention Comparator Outcome Study design (PICOS) Framework [34].

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].

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] Supplement 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 to 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+ years old 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 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].

* 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].

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 ones 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. Firstly, 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 36887 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 33165 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. Ten 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] Supplement 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] Supplement 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 a access to a social media platform and online modules [48, 53].

Participant safety was a consideration in six of the eleven 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 eleven 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 used across the eleven 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 sub-study 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 based on the information-motivation-behaviour (IMB) skills model used; smartphones, mobile applications, smartwatches, smartphone-based short text messages and 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 RCT's [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 to 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]. Firstly, the self-efficacy measure used was the PAAI, and was the only study which

used this self-efficacy measure [58]. Whilst 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. Whilst 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]

Table 2 Summary of included studies

Interventions which raised self-efficacy to a statistically significant level for the given measure			
Authors Year	Study design and sample size	Self-efficacy measure	Results as reported by the authors
Chivers Seymour, K.et al. 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 focussed 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**.** et al. 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. et al**.** 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 to the control group (t=2.33, p=0.025). Intervention Pre-Post score (t=2.85 p=0.011) Compared to 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 was considered.
Quinn, L.et al 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 focussed on MS, including measuring self-efficacy using the Norman self-efficacy scale for exercise. NMS where not explicitly mentioned.
Shih, S. et al. 2018 [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 focussed on MS, including measuring self-efficacy using the exercise self-efficacy scale for exercise. NMS where not explicitly mentioned.
Interventions which did not raised self-efficacy to a statistically significant level for the given measure			
Authors Year	Study design, and sample size	Self-efficacy measure	Results as reported by authors
Agley et al., 2024 [53].	An assessor blinded, randomised controlled feasibility study. Sample size n=30	Self-efficacy for Exercise (SEE) [53, 57].	Intervention group **b**aseline 56 (49-68) post-intervention 40 (37.5-63.5) 6-months post follow- 65 (53.75-78.25). Control group baseline 64 (52.5-74) post-intervention 56 (51.5-69.5) 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 focussed on physical activity with self-efficacy measured using the self-efficacy for exercise measure.
Colón-Semenza et al. 2018 [47].	Feasibility study Sample size n=10 (5 dyads)	Self-efficacy for walking-duration 10-item questionnaire (SEW_Dur) [66].	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 focussed on MS.
Ginis, P., et al. 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 [67]. Effects at 6 weeks (Time (p=0.91) X 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 wellbeing looking at the impact of disability, cognition, and other symptoms. QoL was measured separately using the SF-36 physical and mental health scales.
Manãgo M.M., Swink, L.A., Hager, E.R. 2021[44].	Cross-sectional Study Sample size n=87	Self-efficacy for Exercise (SEE) [57].	Whilst 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 pandemic)

Song, J.et al. 2018 .	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			
Authors Year	Study design, and sample size	Self-efficacy measure	Results as reported by authors
Hermanns, M., Haas, B.K., Lisk, J 2019 [48]	Longitudinal Pre-test Post-test design Sample size n=5	Physical Activity Assessment inventory (PAAI) [58].	Statistical analysis involved pre-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 nonsignificant changes ($p > .05$) 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, Wellbeing and QoL was measured using a number of different scales cited in the paper, The PAAI has 13 items which measures confidence and was used as the self-efficacy scale.

A fuller description of study interventions can be found in [dataset] Supplement 3.

Unlike systematic reviews which appraise study quality, for scoping reviews this is optional and in this review this has not undertaken [32, 68]. 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 [69], 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 and used to measure/determine; acceptability using satisfaction surveys, and online surveys [53 47], custom designed electronic and paper questionnaires to examine preference [44, 46], 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, 70]. All 11 eligible studies primarily focussed 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 focussed 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]. Whilst self-efficacy has been strongly associated as a mediator of self-management in areas which 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, 71]. 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 [72].

Whilst evidence standards for DHT exist, they have not been created to explicitly encompass self-efficacy which highlights the challenges researchers face when interpretating 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 underreporting of psychometric studies [73, 74].

To date DHT have provided good support of MS for PwP used in conjunction with pharmacological management [75]. 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 [75]. 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) [75, 76]. NMS digital-solutions differ from MS digital solutions in that the former is proactive and the latter reactive [75]. 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 [77]. This new model of care will be predictive and personalised, enabling care which reduces CP burden through preventative and participatory strategies [77]. 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 focusses 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 sizable 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 [78]. 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 [79, 80]

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 [81-83], and also in the management of chronic obstructive pulmonary disease (COPD) and lung transplant recipients [84-86]. 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 focussed.

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

Pleasingly, acceptability and satisfaction was determined a number of ways including, direct measurement of satisfaction/acceptability [45, 47, 53] barriers opportunities to use [44, 46, 51], being user-friendly [52], participant likes and dislikes [48] 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 pros and cons to using surveys, case studies, and direct objective measurements. The use of this methods are 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 dimmish their merit. Meanwhile direct objective measure are more precise but do 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 whilst 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 [75]. This review has also identified that barriers to synthesis to better characterise gaps in the literature potentially stem from, firstly a lack of consensus on which self-efficacy measure to

use, secondly 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 [87].

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 [88-93]. 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 [93].

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 was 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 [94].

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, 95, 96]. Additionally, this review has identified substantial knowledge and evidence gaps in the literature which future research must address to strength the evidence on this topic which has previously been identified as weak [11, 79, 80].

Five interventions produced statistically significant improvements in self-efficacy compared to controls, two being RCT's, 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 postive behaviour changes which improve self-efficacy [45, 54, 97, 98]. 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 [72].

Some researchers have considered the implementation of telemedicine interventions to support self-management in PwP as not '*the 'panacea for all'* [17, 99]. 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 [100-102]. 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) [103].

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 [104].

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. Whilst 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 replicatable. 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 sizable 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.

ETHICS AND DISSEMINATION

As this is a piece of secondary research which has used retrospectively retrieved pre-exiting primary research studies which are published and in the public domain ethical approval was not required.

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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Contributors

AMH was involved in study design, development of scoping review search strategy, data collection, data analysis, data interpretation, production of figures and writing of the manuscript and contributed meaningfully to the drafting and editing. AMH has approved the final manuscript. VA was involved in title and abstract and full text screening and data extraction checking and has approved the final manuscript. CBC, VA, and EM were involved with revisions to manuscript, scrutiny of the data analysis, presentation of findings and their interpretation. CBC, VA, and EM have all approved the final manuscript. EM is the Guarantor.

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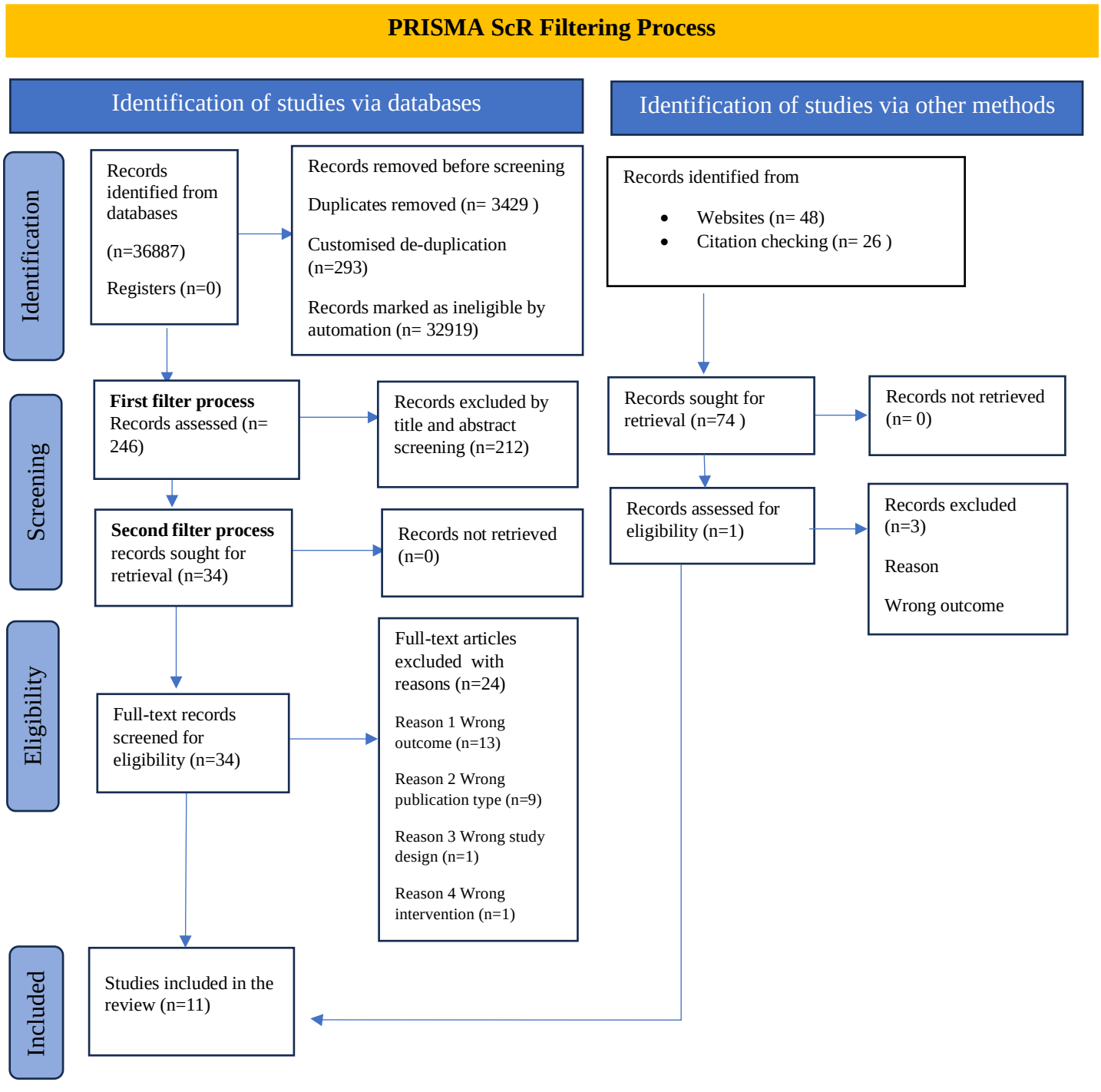
Figure 1 PRISMA ScR flowchart

PRISMA ScR Checklist

Supplement 1 Combinations of search terms, Boolean operators, and databases.

Supplement 2 Full data extraction from all studies included in the review.

Supplement 3 Full descriptions of all included studies.



Database	Search terms to be used and Boolean operators	Number of records identified in the initial search
Medline (EBSCO host)	Parkinsonian disorders **AND** Tele* OR Telemedicine OR Telehealth OR Telemonitoring OR Telepractice OR Telenursing OR Telecare **AND** Self* OR Behavior change OR Behavior Modification[1]	**9, 875**
PsycINFO	((Parkin* AND PEER (yes)) OR ((Parkinson disease) AND PEER (yes) OR ((Parkinsons disease) AND PEER (yes)) OR ((Parkinson's disease) AND PEER (yes)) OR ((Movement disorders) AND PEER (yes)) OR ((alpha synuclein) AND PEER (yes)) **AND** Technology AND PEER ((yes) OR ((Health technology) AND PEER ((yes) OR (Tele*AND PEER ((yes) OR (Telehealth AND PEER (yes)) OR (Telemedicine AND PEER ((yes) OR (Telemetry AND PEER (yes)) OR Sensors AND PEER (yes)) OR Wearables AND PEER (yes)) OR ((Assistive technology) AND PEER (yes)) OR ((Home based care) AND PEER (Yes)) OR ((Home-based care) AND PEER (yes)) OR ((IoT AND PEER (yes)) OR ((Internet of things) AND PEER (yes)) OR ((Virtual consultations) AND PEER (yes)) OR ((Video Consultations) AND PEER (yes))) **AND** ((Behav* AND PEER (yes)) OR Behavior AND PEER (Yes)) OR Behaviour AND PEER (yes)) OR ((Behavior Change) AND PEER (yes)) OR ((Behavior modification) AND PEER (yes)) OR (Self* AND PEER (yes)) OR ((Self Concept) AND PEER (yes)) OR ((Self efficacy) AND PEER (yes)) OR (AND PEER (yes)) OR (Self-efficacy AND PEER (yes)) OR (Self-management AND PEER (yes)) OR Rehabilitation AND PEER (yes)) OR (Resilience AND PEER (yes)) AND (La.exact(ENG*) AND PEER (yes))	**1, 576**
CINAHL	MW (Parkinson's disease or Parkinson disease or pd or parkinsonism) **OR** SU Movement disorders **OR** MW Parkinsonian disorders **OR** TI Parkinson disease **AND** (telehealth or telemedicine or telemonitoring or telepractice or telecare) **OR** MW technology in healthcare **OR** MW digital technology **AND** TX (Self-efficacy or self efficacy or confidence or self esteem) **OR** TX self concept **OR** (self-management or self-care or self-regulation or self-monitoring) **OR** MW (Behavior change or Behavior modification)	**3, 891**

Web of Science	**((((((((((((((((((TI=(Parkinson disease)) OR TI=(Parkinson's disease)) OR TS=(Movement disorders)) OR ALL=(Parkin*)) AND ALL=(Tele*)) OR TS=(Digital health)) OR TS=(Mobile health)) OR TS=(eHealth)) OR TS=(Sensors)) OR TS=(Home based care)) OR TS=(Telemetry)) OR TI=(Virtual consultations)) AND TI=(self-efficacy)) OR TI=(self-efficacy)) OR TI=(self management)) OR TI=(self-management)) OR TS=(Patient activation level)) OR TS=(Behavior change)) OR TS=(Behaviour change)) OR TS=(Behaviour modification)) OR TS=(Behavior modification)**	**2,651**
Embase	#1 Parkinson disease/or Parkin/or Parkin*.mp. #2 Parkinson's disease.mp. or exp Parkinson disease/ #3 controlled study/exp Parkinson disease/ or exp levodopa/or Parkinson disease*.mp. #4 Movement disorders.mp. exp motor dysfunction/ #5 1 or 2 or 3 or 4 **AND** #6 telecommunication/or Tele*.mp. or telemedicine/ #7 telemedicine.mp. or telemedicine robot/ or telecommunication/or telemedicine/ or healthcare delivery /or patient/ #8 telehealth.mp.or telecommunication/ or telehealth/or health care/or telemedicine #9 telecare.mp. or exp telecare/ #10 exp medical informatics/ or digital health.mp. #11 eHealth.mp./exp telehealth/ #12 mHealth.mp.or mobile health application/ #13 6 or 7 or 8 or 9 or 10 or 11 or 12 **AND** #14 exp self care / or self medication/or exp self concept/exp self-testing/ or self evaluation/ exp self-monitoring/or General self-efficacy scale/ or exp self help/ or self*mp. or exp self report/ or self esteem/ or self-help device/ or Self-rating Depression Scale/ #15 self management.mp. or exp self care/ #16 self-efficacy.mp. or exp self concept #17 behavior*.mp. or exp behaviour modification/or exp care behavior #18 14 or 15 or 16 or 17 #19 5 **AND** 13 **AND** 18	**3, 136**
IEEE Xplore	("Mesh_Terms":Parkin*) OR ("All Metadata":Parkinson's disease) OR ("All Metadata":Neurodegenerative disorders) OR ("All Metadata":Idiopathic Parkinson's Disease) **AND** ("Mesh_Terms":Tele*) OR ("All Metadata":Digital Health) OR ("All Metadata":Mobile Health) **AND** ("Mesh_Terms":Self*) OR ("All Metadata":Self,	**3195**

	concept) OR ("All Metadata":self, rehabilitation) OR ("All Metadata": Self-management)	
Google Scholar™	Parkinsonian disorders Telemedicine Self-efficacy Self-management No Boolean operators used Filtered by date-2012-2022	**2210**

General information Author(s) title	Reject/not for data extraction and reason	Year of Publication	Country of study	Country of Publication	Initial sample size	Analysed sample size
Digital Intervention promoting physical activity in People newly diagnosed with Parkinson's Disease: Feasibility and Acceptability of the knowledge, Exercise-efficacy and Participation (KEEP) Intervention. **Agley, L., Hartley, P., Duffill, D., Iqbal, A., Mackett, A., Rennie, K.L., & Lafortune, L.**	Include?	2024	United Kingdom	England	n=30	n=29
Peer Coaching Through mHealth Targeting Physical Activity in People with Parkinson's disease: Feasibility Study. **Colón-Semenza, C., Latham, N. K., Quintiliani, L.M., Ellis, T. D.**	Include?	2018	United States of America	United States of America	n=10 PwP (5 Dyads)	n=10 PwP (5 Dyads)
Feasability and effects of home-based smartphone-delivered automated feedback training for gait in People with Parkinson's diseaase: A pilot study **Ginis, P.; Nieuwboer, A.; Dorfman, M.; Ferrari, A.; Gazit, E.; Canning, C. G.; Rocchi, L.; Chiari, L.; Hausdorff, J. M.; Mirelman, A.;**	Include?	2015	Belgium & Israel	Belgium	n=40 PwP Participants were included if they were able to walk for 10 minutes continuously; had a MoCA score higher than 24; were in a Hoehn and Yahr Stage II to III in the 'on' state and were stable on PD medication.	40 ITT
Engaging Older Adults With Parkinson's Disease in Physical Activity Using Technology: A Feasibility Study. **Hermanns, M.; Haas, B. K.; Lisk, J.**	Include?	2019	United States of America	United States of America	n=5 PwP	5 PwP
Exploring the uptake and implementation of tele-monitored home-exercise programmes in adults with Parkinson's disease: A mixed-methods pilot study **Lai, B.; Bond, K.; Kim, Y.; Barstow, B.; Jovanov, E.; Bickel, C. S.**	Include?	2020	United States of America	United States of America	n=20 PwP	n=20 PwP
The Impact of COVID-19 on Community-Based Exercise Classes for People With Parkinson Disease **Manago, M. M.; Swink, L. A.; Hager, E. R.; Gisbert, R.; Earhart, G. M.; Christiansen, C. L.; Schenkman, M.;**	Include?	2021	United States of America	United States of America	n=87 PwP and 43 Instructors	n=87 PwP and 43 Instructors

Effect of mobile health intervention for self-management on self-efficacy, motor and non-motor symptoms, self-management, and quality of life in people with Parkinson's disease: Randomized controlled trial **Park, Y.; Kim, S. R.; So, H. Y.; Jo, S.; Lee, S. H.; Hwang, Y. S.; Kim, M. S.; Chung, S. J.;**	Include?	2022	South Korea	South Korea	n=50	43 PwP
Promoting Physical Activity via Telehealth in People With Parkinson Disease: The Path Forward After the COVID-19 Pandemic? **Quinn, L.; Macpherson, C.; Long, K.; Shah, H**	Include?	2020	United States of America	United States of America	n=27	n=27
Multicentre, randomised controlled trial of PDSAFE, a physiotherapist-delivered fall prevention programme for people with Parkinson's **Seymour, Kim Chivers; Pickering, Ruth; Rochester, Lynn; Roberts, Helen C.; Ballinger, Claire; Hulbert, Sophia; Kunkel, Dorit; Marian, Ioana R.; Fitton, Carolyn; McIntosh, Emma; Goodwin, Victoria A.; Nieuwboer, Alice; Lamb, Sarah E.; Ashburn, Ann**	Include?	2019	England	England	n=474 (I) 6 Months n=176 (C) n= 196	n=372
Physical Activity Coaching via Telehealth for People With Parkinson Disease: A Cohort Study **Shih, Hai-Jung Steffi Macpherson, Chelsea E King, Miriam Delaney, Elizabeth Gu, Yu Long, Katrina Reid, Jennifer Fineman, Julie Yu, Geraldine Rieger, Jamie Satchidanand, Ashrita Shah, Hiral Alcalay, Roy N Quinn, Lori**	Include?	2022	United States of America	United States of America	n=62	Analysed for ESE n=52
Home-based step training using videogame technology in people with Parkinson's disease: a single-blinded randomised controlled trial **Song, J.; Paul, S. S.; Caetano, M. J. D.; Smith, S.; Dibble, L. E.; Love, R.; Schoene, D.; Menant, J. C.; Sherrington, C.; Lord, S. R.; Canning, C. G.; Allen, N. E.**	Include?	2018	Australia	Australia	60 Community dwelling people with Parkinson's	**Intervention group** n=3 withdrew from study. N= 6 discontinued intervention. **Control group** Loss to follow-up n=3 withdrew from study n= 1 partial follow-up due to ankle injury

Study design	Demographic data	Age Range	Ethnicity	PwP or CG (and relationship between the two)	H&Y score at time of recruitment or other measure of disease severity
An assessor blinded, randomised controlled feasibility study.	Age All (n=30) 67.3 (±10.8) Intervention (n=15) 70.27 (± 5.23) Control (n=15) 64.40 (±13.99) Male All (n=30) 23 (76.7%) Intervention (n=15) Control (n=15) 12 (80.0) White British All (n=30) Years in education All (n=30) 15.0 (±3.9) Intervention (n=15) 14.1 (±4) Control (n=15) 15.9 (±3.8) Married/partnership All (n=30) 25 (73.3%) Intervnetion (n-15) (100%) Intervnetion (n=15) 10 (60.0) Employed All (n=30) 10 (33.3%) Intervention (n=15) 5 (33.3%) Control (n=15) (33.3%) Retired All (n=15) 15 (50%) Intervention (n=15) 10 (66.7%) Control (n=15) 5 (4%) Unemployed All (n=30) 5 (16.7%) Intervnetion (n=15) 0 (0%) Control (n=15) 5 (33.3%) H & Y 1 All (n=30) 7 (23%) Intervention (n=15) 4 (26.6%) Control (n=15) 3 (20%) H & Y 2 All (n=30) 9 (30%) Intervention (n=15) 6 (40%) Control (n=15) 3 (20%) H & Y 3 All (n=30) 13 (43%) Intervention (n=15) 5 (33.3%) Control (n=15) 8 (53.3%) H & Y 4 (n=30) 1 (0.03%) Intervention (n=15) none Control (n=15) 1 (6.6%) On PD Medication All (n=30) 28/30 (93%) Intervention (n=15) 14/15 (93%) Control (n=15) 14/15 (93%) Number of comorbidities All (n=30) 1.0 (±1.1) Intervention (n=15) 1.3 (±1.4) Control (n=15) 0.7 (±0.7) Number of falls All (n=30) 0.7 (±1.6) Intervnetion (n=15) 0.5 (±0.6) Control (n=15) 0.9 (±2.10)	67.3 (±10.8)	Whitre British All (n=30)26 (86.7%) Intervention (n=15) 13 (86.7%) Control (n=15) 13 (86.7%)	PwP	H & Y 1 All (n=30) 7 (23%) Intervention (n=15) 4 (26.6%) Control (n=15) 3 (20%) H & Y 2 All (n=30) 9 (30%) Intervention (n=15) 6 (40%) Control (n=15) 3 (20%) H & Y 3 All (n=30) 13 (43%) Intervention (n=15) 5 (33.3%) Control (n=15) 8 (53.3%) H & Y 4 (n=30) 1 (0.03%) Intervention (n=15) none Control (n=15) 1 (6.6%
Feasibility study	Age in years (SD) 64.6 (4.04) Education in years (SD) 18.0 (0.89) Male, n (%) 3 (60) Race (white) 3 (60) Race (White, n (%) n=5 (100) Disease duration in years (SD) 5.2 (1.24) Hoehn and Yahr Stage, n (5) Stage 1 n=3 Stage 2 n=1 Stage 3 n=1	Age in years (SD) 64.6 (4.04)	Race (White, n (%) n=5 (100)	PwP only	Hoehn and Yahr Stage, n (5) Stage 1 n=3 Stage 2 n=1 Stage 3 n=1
Pilot study (Intervention and Control)	Not specifically described	Not specifically described	Not specifically described	PwP	II-III in ON state
Longitudinal pretest/posttest design	**Demographic variables Gender** Male 3 (60%) Female 2 (40%) **Race/ethnicity** Caucasian, non-hispanic 5 (100%) **Marital status** Married living with a significant other 4 (80%) Divorced 1 (20%) **Living conditions** Lives alone 1 (20%) Lives with spouse or significant other 4 (80%) **Level of Education** Some College 2 (40%) College graduate 3 (60%) **Physical activity level** Activity 4 (80%) Very Active 1 (20%)	Age (years) M/Mdn 73.00/72.00 SD (4.95) Range 69-81 yrs	100% (5) Caucasian/non-hispanic	PwP	Stage of Parkinson's disease M/Mdn 1.70/1.50 (SD) 0.57 Range 1.00-2.50
Mixed methods pilot study two interventions, telecoach assisted vs self-regulated home exercise.	**Age years** (I) n=10) 63.4+/-10.4(56-71) (c) n=10) 70.8 +/- 7.1 (66-76) **BMI (Kg/m2) (**I) 29.2 +/- 6.7 (24-34) (C) 27.2 +/- (22-32) **Sex** n Male/female (I) 7/3 (C) 7/3 Ethnicity n Non-hispanic White/Black (I) 9/1 (C) 10/0	Age years (I) n=10) 63.4+/-10.4(56-71) (c) n=10) 70.8 +/- 7.1 (66-76)	Ethnicity n Non-hispanic White/Black (I) 9/1 (C) 10/0	PwP	Hoehn and Yahr scores (I) 2.15+/- 0.47 (1.5-3) (c) 2.3 +/- 0.63 (1-3)
Crossectional study Custom-designed electronic surveys	**Participants** (n=87)- Age y Mean (SD) 70.2 (7.3) Sex % female (n) 51.7% (45) **Race %** Caucasian (n) 93% (81) **Ethnicity %** non-Hispanic (n) 92% (80) **Highest degree earned** High School diploma/assocaites 14.9% (13)Degree % (n) 39.1% (34) Master, doctoral, professional degree % (n) 40.2% Years since Diagnosis <1, % (n) 0% (0) 1-3% (n) 20.7% (18) 3-5% 21.8% (19) 5-10, % 29.9 (26) >10, % (n) 27.6 (24) Schwab-England mean (SD) 84.0 (15.7) PDQ-8 score, mean (SD) 21.0 (14.6) SEE score, mean (Sd) 55.0 (23.5) Falls per year None 44.8% (39) greater than or equal to 1 (55% (48) Instructors Descriptive Characteristics of the Instructor Group Characteristics n = 43 Age, y, mean (SD) 51.4 (12.1) Sex, % female (n) 86.0% (37) Race, % Caucasian (n) 93% (40) Ethnicity, % non-Hispanic (n) 91% (39) Years teaching class 10, % (n) 9.3% (4) Degree/training Athletic trainer, % (n) 51.2% (22) Physical therapist/occupational therapist or assistant, % (n) 32.6% (14) Other (aquatic, dance, medical exercise, Pilates, yoga), % (n) 13.9% (6) Parkinson disease-specific exercise training, % (n) 79.1% (34)	(n=87)- Age years Mean (SD) 70.2 (7.3) Sex % female (n) 51.7% (45)	Race % Caucasian (n) 93% (81) Ethnicity % non-Hispanic (n) 92% (80) H	PwP and Instructors	Not measured

Randomised, Controlled Trial	Demographic characteristics **Gender** Men (I) 5 (25.0) (C) 8 (34.8) **Age yrs (I)** 62.20 +/- 7.43 (c) 64.27 +/- 8.28 **Education level (I)** 5 (25.0) 2 (10.0) 9 (45.0) College or above 4 (20.0) (C) Elementary school 3 (13.00) 1 (4.4) 7 (30.4) 12 (52.2) 15 (65.2) **Marital status** Married (I) 13 (65.0) (c) 8 (34.8) Not married (I) 7 (35.0) (c) 3 (13.0) Family income (10,000 won/Month) (I) <100 8(40) 100-199 4 (20) 200-299 3 (15)equal to or greater than 300 5 (25.0)	(I) 62.2 +/- 7.43 (c) 64.27 +/- 8.28	Not found in the demographic data	PwP	**Modified H & Y stage On** (I) 3.0 (2.625-3.0) (C) 3.0 (2.5-3.0) **Modified H & Y Stage Off** (I)3.0 (3.0-3.875) (C) 3.0 (3.0-4.0)
Single cohort implementation study (Case description)	**Age** Mean (SD) age for the participants was 66.5 (8.6); **Ethnicity** 22 identifed as white, 1 Asian, 1 Hispanic, 1 Other 2 Declined **Education level** Incomplete data for 8 participants, 1 had some college education, 7 had advanced degrees. Baseline physical acivity and self-efficacy measures. Mean (SD) (range) Brunel score was 3.7 (1.0) (1.0-4.7) for planned and 2.4 (0.7) (1.3-3.3) for unplanned; Norman self-efficacy was 56.8 (178.0; range 19-84).	**Age** Mean (SD) age for the participants was 66.5 (8.6) (n=27);	**Ethnicity** 22 identifed as white, 1 Asian, 1 Hispanic, 1 Other 2 Declined	PwP and 12 PwP were accompanied by a caere partner.	Modified inclusion criteria from initially **H&Y score** I-II to H & Y score III
Multicentre, randomised controlled trial.	Baseline characteristics in the PDSAFE and control groups: figures are number (%) unless stated otherwise PDSAFE (n=238*) Control (n=236†) Gender Male Female 147 (62%) 91 (38%) 119 (50%) 117 (50%) Age (years) Mean (SD) Min to max 71 (7.7) 51 to 91 73 (7.7) 46 to 88 Disease duration (years) Mean (SD) Min to max 8 (6.6) 0 to 36 8 (5.8) 0 to 29 MMSE Mean (SD) Min to max 28 (1.7) 24 to 30 29 (1.6) 24 to 30 MoCA Mean (SD) Min to max ≤25 (cognitively impaired) 26 (2.9) 15 to 30 91 (38%) 26 (3.2) 9 to 30 93 (39%) Living status Lived alone With a spouse/partner With a friend/family 48 (20%) 174 (73%) 15 (6%) 59 (25%) 166 (70%) 10 (4%) Hoehn and Yahr stage 1 2 3 4 26 (11%) 78 (33%) 102 (43%) 32 (13%) 30 (13%) 56 (24%) 112 (48%) 38 (16%) UPDRS Mean (SD) Min to max TD phenotype PIGD phenotype Indeterminate phenotype 32 (15.2) 2 to 77 21 (9%) 194 (83%) 20 (8%) 33 (17.3) 4 to 92 19 (8%) 206 (88%) 10 (4%) Freezing of gait in the past month 152 (64%) 139 (59%) Number of falls in 12 months prior to screening Median (min to max) Mean (SD) Repeat falling in 12 months 3 (1 to 1460) 26 (132.7) 186 (78%) 3 (1 to 1095) 19 (105.4) 189 (80%) Rate of falls/person/3 months prior to randomisation Median (min to max) Mean (SD) 1.98 (0 to 319) 5.9 (22.8) 0.99 (0 to 73) 3.0 (7.3) Rate of near falls/person/3 months prior to randomisation Median (min to max) Mean (SD) 4.4 (0 to 440) 13.8 (35.8) 4.3 (0 to 601) 15.6 (51.4) Medications Levodopa Dopamine agonist Monoamine oxidase inhibitor COMT inhibitors Other PD medication 208 (88%) 108 (46%) 52 (22%) 59 (25%) 19 (8%) 216 (92%) 106 (45%) 46 (20%) 41 (17%) 23 (10%) GDS score at baseline >5 (suggestive of depression) ≥10 (indicative of depression) 147/235 (63%) 50/235 (21%) 164/236 (70%) 49/236 (21%) Coexisting conditions Orthopaedic Cardio/respiratory 109 (46%) 85 (36%) 129 (54%)	Age (years) Mean (SD) Min to max 71 (7.7) 51 to 91 73 (7.7) 46 to 88	Not recorded in baseline characteristics	PwP	Hoehn and Yahr stage 1 26 (11%) 78 (33%) 2 102 (43%) 32 (13%) 3 30 (13%) 56 (24%) 4 112 (48%) 38 (16%
Cohort study	**Demographic data** (n=62) (Mean and standard deviation) **Age** yrs 65.4 +/- 9.2 **Sex** Male 39 (62.9%) Female 23 (37.1%) **Weight,** Kg 73.6 +/- 14.2 **Height, cm** 172.0 +/- 8.9 **Race/ethnicity** White 53 (85.5%) Black/African American 3 (4.8%) Hispanic 1 (1.6%) Asian 0 (0%) Other 2 (3.2%) Declined 3 (4.8%) **Education** High school 2 (3.25%) College 25 (40.3%) Associates 2 (3.2%) Masters 15 (24.2%) Doctorate 5 (8.1%) Other advanced degree 7 (11.3%) Unknown 6 (9.7%) Missing 6 (9.7%) **H & Y** Stage I 16 (25.8%) Stage II 25 (40%) Stage III 21 (34%) **Time since diagnosis** Yrs 4.7 +/- 4.3 **MDS-UPDR**S 25.9 +/- 4.1 MoCA 23.4 +/-12.9	**Age yrs** 65.4 +/- 9.2	**Race/ethnicity** White 53 (85.5%) Black/African American 3 (4.8%) Hispanic 1 (1.6%) Asian 0 (0%) Other 2 (3.2%) Declined 3 (4.8%)	PwP	**H & Y** Stage I 16 (25.8%) Stage II 25 (40%) Stage III 21 (34%)
Two-arm parallel, single blinded randomised controlled trial.	**Mean (SD) or number for participants' characteristics at baseline. Groups Intervention (n=31) (I) Control (n=29) (C)** Age (I) 68 (7) (C) 65 (7) Gender (male) (I) 15 (48%) (C) 9 (31) Height (m) (I) 1.7 (0.1) (C) 1.7 (0.1) Weight (kg) (I) 76 (15) (C) 78 (18) Cognitive status (MMSE 0-30) (I) 28 (2) (C) 29 (1) Duration of disease (years) (I) 7 (4) (C) 9 (6) Disease severity "on" MDS-UDPRS part III (0-132) (I) 31 (11) (C) 33 (11) Fallen in past year (participants-yes) (I) 17 (55%) (C) 16 (55%) Freezing of gait (participants-yes) (I) 12 (39%)(C) 7 (24%) Daily levodopa equivilant dose (mg) (I) 668 (405) (C) 757 (498)	Intervention (n=31) 68 (7) Control (n=29%) 65 (7)	Not recorded demographic data table	PwP	Not measured instead MDS-UPDRS part III (0-132) (I) 31 (11) (C) 33(13)

Socio-economic status	Disease duration	Index of multiple deprevation	Level of digital litracy	Excluded populations	Intervention description	Intervention type	Type of device
Employment status and years in education recorded.	Not stated	Not stated	Health literacy mentioned	Those not diagosed with idiopathic Parkinson's, residing outside the Cambridgeshire area, not having a computer, tablet or telephone connected to the internet, having acute illness or a history of other neurological conditions or a clinical diagnosis of dementia. Those who recieved or participated in NHS or private PD-specific education with or without excercise classes in the last 12 months	Co-designed digital intervention promoting excercise and physical activity in people newly diagnosed with PD	Utilises an innovative blended learning format comprising of 6 onlines modules tailored to people who are newly diagnosed with PD	Online platform, accelorometer
Not stated	Disease duration in years (SD) 5.2 (1.24	Not stated.	Only states all participants were highly educated	Diagnosed with atypical Parkinsonism, More than two falls in the previous 2 months (due to safety reasons) a score of 3 or greater on the item number 3 of freezing of Gait questionnaire (often or always freezing when walking) Serious co-morbidities (including heart failure, diabetes mellitus or cancer that may interfere with the ability to participate in a walking programme.	A peer coach training programme and remote peer-monitopred walking programme using an mHealth App (FitBit Friends) and a FitBit Zip physical activity tracker.	Peer coaching using an mHealth App (FitBit Friends, FitBit Zip and trainined active trained peer mentors.	FitBit Zip and FitBit Friends App
Not specified	Not stated	Not stated	Not recorded		Two applications were used in the study 1) The audio-biofeedback (AFB-gait App) and the instrumented cueing for FOG-training (FOG-cue App) Feedback and cues were provided via earphones or the smart phones speaker. 30 mins per day, three days per week for 6 weeks	mHealth Apps around gait and balance	Smartphone- Galaxy S3-mini, Samsung South Korea
Not specified	Not stated	Not stated	Not recorded	Exclusion criteria included inability to perform large muscle physical movements and cognitive impairments that prohibited particpation in an online support group. Physician approval to undertake exercise required. Must be able to speak and read English, must have access to WiFi	Fitbits and Ipads and online resources included preloaded videos Exercise 3 times a week Online participant a minimum of three times per week. Trial period 12 weeks	Fitbit (activity tracker), Ipad, pre-loaded videos, access to an online support group.	Physical activity tracker and an electronic table to engage with an online support group
No included in demographic data except employment status Employed/unemployed (I) 3/8 (C) 2/8	Duration of disease (years) (I) 6.55+/- 4.52 (1-16) (C) 7.55 +/- 4.78 (0.8-15.5)	Not included	Not recorded	Exclusion criteria included (a) performing > 150 min/week moderate intensity exercise (B) no wireless internet access at home (c) any orthopaedic, vascular, or cardiac problems that limited participation in moderate excercise of the study protocol.	Telecoach-assisted exercise, with an exercise prescription. Includes telecoach supervision. Consists of three components; telecoach console Homestation and the the internet via a server as a conduit between the two.	Online supervised telecoaching via the internet, exercise equipment, instrumental recording of physical activity via a bloodtooth enabled tablet.	10.5 inch Android computer tablet with Bluetooth and wireless internet capability, mounted to an adjustable floor stand. Custom designed Android application. (user interface from both the participant and the telecoach view) which is installed on a tablet that allowed live streaming of audio, video and text messages between the participant and telecoach, and real-time screening of physiological parameters.The application enabled the ability to view and archive exercise dat from the computer tablet to a Web-based server and; a wearable physiologic monitor (Bioharness 3, Zephyr) and (Exerpeutic 900XL Recumbent Bike)
Highest degree earned High School diploma/assocaites 14.9% (13)Degree % (n) 39.1% (34) Master, doctoral, professional degree % (n) 40.2%	Years since Diagnosis <1, % (n) 0% (0) 1-3% (n) 20.7% (18) 3-5% 21.8% (19) 5-10, % 29.9 (26) >10, % (n) 27.6	Not measured	Not measured however, Barriers, facilitators, and needs in PD and instructor groups explored	Those unable to answer survey questions either with or without someone to support. Participants were also required to be able to provide written informed consent.	Transition of community-based exercise classes to virtual intervention for PwP during the Covid-19 pandemic.	Face to face vs virtual class formats of usual care.	Online survey Virtual class format not very clearly described.

Marital status Married (I) 13 (65.0) (c) 8 (34.8) Not married (I) 7 (35.0) (c) 3 (13.0) **Family income** (10,000 won/Month) (I) <100 8(40) 100-199 4 (20) 200-299 3 (15)equal to or greater than 300 5 (25.0)	Duration of PD years (I) 9.95 +/- 5.26 (c) 10.50 +/- 4.58	Not specfically IMD	No only educational level	Those with other serious diseaases that may affect QoL, Non-motor symptoms (such as depression and Pain) and self-management and those whose PD medication had been changed within the past month . In addition, participants who change parkinsonian medication due to worsening symptoms during the intervention period were considered drop outs for this study as such medications affect motor symptoms, non-motor symptoms and QoL	The mobile intervention in this study consisted of mobile applications, smartwatches, smartphone-based short text messages and information and telephone counselling for 16 weeks.	Mobile health Smartphone Smartwatch	Smartphone and Smartwatch
On in terms of general demographic data.	Not stated	No	No only level of education, however technology issues last more than 15 minutes were recorded.	PAR-Q as a screening tool and medical approval to participate.	Engage-PD is a Telecoaching intervention grounded in self-determination theory. Up to 4 coaching sessions all delivered via a telehealth platform . The intervention incorporated 1:1 coaching, Physical activity monitoring and use of a disease specific workbook to promote and support safe excercise uptake.	Single cohort implementation study	Mentions workbook on physical activity monitoring to support autonomy, which participants can do using wearable activity monitors, smartphones or exercise diaries.
Not recorded in baseline characteristics	Disease duration (years) Mean (SD) Min to max 8 (6.6) 0 to 36 8 (5.8)	Not stated	Not measured	People were eligible if they had a clinically confirmed diagnosis of PD in accordance with UK Brain Bank criteria were living in their own home; independently mobile with or without an aid; experienced one fall in the previous 12 months; score 24 or more on the MMSE had the cognitive ability to give informed consent; were able to understand and follow commands; and considered able to participate in an exercise and strategy programme.	PDSAFE comprised individually tailored, progressive home-based exercise and strategies to avoid falls. Home visits with trained PT's 12 supervised sessions 1-1.5 duration over 6 months This was tapered Unsupervised exercise for about 30 mins. Participants were given a folder with picture discriptions and descriptions of excercises a rating perceived exertion scale, an excercise log, and DVD's of both excercise demonstrations and personal videos taken by their physiotherapist of them doing the excercises. Monthly 'Master class' conferences' and regular clinical supervision sessions were implemented	Multimodal, Home-based, Physiotherapy, digital training videos, teleconferences	Audiovisual, digital images of excercises.
Education High school 2 (3.25%) College 25 (40.3%) Associates 2 (3.2%) Masters 15 (24.2%) Doctorate 5 (8.1%) Other advanced degree 7 (11.3%) Unknown 6 (9.7%) Missing 6 (9.7%)	**Time since diagnosis Yrs** 4.7 +/- 4	Not measured	Not measured	Participants were excluded if they had coexisting neurological or musculoskeletal conditions that would restrict exercise. They were also excluded had more than 150 minutes of moderate vigorous physical activity per week. No approved for exercise by a medical doctor or failed the Physical Activity Readiness Questionnaire (PAR-Q). .	The Engage-PD intervention consists of up to 5 personal coaching sessions delivered via telehealth over a 3-month period. Using Zoom © delivered by licenced Physical Therapists. Engage-PD is grounded in self-determination theory. Multimodal programmes of exercise including aerobic, strengthening, balance, and flexibility excercises.	Telehealth	Telehealth via Zoom©
Not recorded in demographic data table	Duration of disease (years) (I) 7 (4) (C) 9 (6)	Not recorded	Not recorded	Participants were excluded if they had substantial cognitive impairment (MMSE <24) or a medical condition which would preclude or interfere with physical assessment or stepping training.	Exergame 15 minutes three times a week for 12 weeks while on usual medicinal treatment. The exergame was a modified version of the open source Dance Dance Revolution "stepmania game"	Exergame	Videogame

Duration of intervention and type	Length of intervention	Level of interventions modification	Setting intervention took place	TIDieR items	PRISMS taxonomic domains* listed full at foot of column
Variable depending on capability	8 Weeks (with access to online resources for the intervention and control groups after completion of the trials for up to 1 year.	Authors state no modification was undetaken.	Cambridge University Hospital NHS Foundation Trust and Cambridgeshire and Peterborough NHS Foundation Trust.	TiDIER Items all described in great detail (beyond the limits of this data extraction sheet) . These items in relation to this study can be found in the papers Supplment 1 found at https://dx.doi.org/ 10.3233/JPD-240071	A1 In online modules A2 In online modules A3 Not described A4 Not specifically mentioned A5 Access to a specialist physiotherapist A6 Behavioural uses the COM-B model A7 Appears accelerometers were provided whilst participants required their own devices to access the internet. A9-12 Were framed around these to an extent but with an overriding theme of physical activity. A13 Yes in so far as the modules have been developed around the COM-B model A13-14 Described in general terms in the study discussion.
8 weeks Peer-coaching using mHealth to	8 Weeks	Some modification based on participants level of walking ability	In the home	**Brief name** No brief name provided intervnetion described a peer coaching through mHealth **Why** To conduct a feasibility study on an mHealth intervention to improve physcial activity on PwP who are sedentary **What** Peer coaching using FitBit Zip as a physical activity tracker, use of a moble App FitBit Friends and access to specialist physiotherapists who train the peer mentors who also offer support to mentees. **How** Training PwP who are active as mentors, mentees also had support from the FitBit Friends mobile App **When** over a 8 week period **When and How much** Mentee led goal setting from an ation plan 2-4 hour face to face sessions **Tailoring Modifications** Neither tailoring or medification of the intervention were described **Fidelity** As this was a feasibility study fidelity was not described.	A1 Yes through motivational interviewing including 2 4-hr face to face sessions in a neurorehabilitation setting with Mentors A2 Yes via support from the FitbBit Friends mobile App A3 Not specifically described A4 Implied only via safety AE reporting A5 Only through 7-day walking monitoring and disability measures A6 As this intervention utilises motivational interviewing support and adherence is behavioural in nature A7 FitBit Zips are provided however participants would require a smartphone to download and use the FitBit Friends App. A8-A9 Yes from face-to-face training and with PD specialists and via the FitBit Friends App. A10-12 in relationship to mentor training which provides rehearsal activities and self-management and psychological support via the dyad relationships A13 A-13-14 with the FitBit Friends App and via the relationship between mentor and their mentee as they share their personal experiences of living with PD.
CuPiD Smartphone App's and walk 3 times per week according to ACSM exercise guidelines.	6 weeks	Duration and frequency times specific, however some flexibility around timing and type of walking activity.	Home with researcher home visits.	**Brief name-** CuPiD **Why-** Study investigated the CuPiD-system's feasiility and effectiveness compared to conventional gait training **What-** Smartphone and two associated Apps **How-** Use of a SmartPhone through in-home training **Where-**In the home setting. **When an how much-** 30 mins oer day three time a week for six weeks, cost not recorded in the outcomes **Tailoring-** Unclear, but seems to be indivualised as training done in the individuals home **Modifications-** Not specifically mentioned **Fidelity-** No mentioned but was a small feasibility study.	A1 Not specifically, A2 Only in relation to gait and walking, A3 In part, A4 Yes, A5 Unclear A6 Yes Training , A7 Smartphone and Apps, A8 Unclear in terms of outside training visits, A9 Yes weekly training and instruction, A10 Only in terms of gait and walking, A11 Limited to intervention scope, A12 Not directly , A13 No specifically in the intervention . A14 Based on the intervention discription supports and encourages a healthy lifestyle through physical activity.
Activity 3 times per week and a minimum of three sessions per week online support for a duration of 12 weeks.	12 weeks	No specified, however, exercise is unsupervised	Home setting	**Brief name-** Physical activity using technology: A feasibility study **Why-** The purposes of the study were to (a) assess the feasibility of an intervention that requires wearing a feasibility tracker and (b) examine the effect of this intervention on self-efficacy for physical activity and QoL of older adults with PD **What-** Fitbit activity tracker, Ipad, online support **How-** Partial online delivery **Where-** Online, the home setting, agile **When an how much-** **Tailoring-** Not specified **Modifications-** Not specified **Fidelity-** Small feasibility study	A1 Some information but mainly about movement, A2 Signposting to online resources and support group, A3 not mentioned, A4 not mentioned, A5 Indirectly A6 yes, must demonstrate engagament, A7 yes fitbit, iPad and preloaded videos, A8 unclear, A9 very little detail, A10 not explictly stated, A11 To an extent, A12 Yes in relation to self-efficacy and physical activity , A13 not stated though community involvment in recruitment, A14 Indirectly as promotes monitors, measure and support physical activity
Exercise prescription included eight weeks of exercise (three times per week:24 total sessions) with a goal of 165 min/week of combined aerobic and strength excercises. Participants were instructed to perform moderate aerobic exercise within 40-60% of their heart rate reserve , using the telehealth system and a stationary recumbent cycle (Exerpeutic 900XL Recumbent Bike) For strength excercises, participants used adjustable ankle weights (1-5lb) to perform 2-3 sets of 30-30 repetitions.	Eight weeks	Intervention description appears to suggest standardised rather than tailored intervention	Home setting.	**Brief name-** Telecoach Pilot study **Why-**To explore the uptake and implementation of two common methods of exercise training **What-** Supervised and self-reguiated home excercise **How-** exercise equipment, physiological measurements via sensors, internet resources and coaching. **Where-** Home setting **When an how much-** 165min/week over eight weeks (3 tmes per week, 24 sessions in total) **Tailoring** Not mentioned in intervention description **Modifications-** Not mentioned in intervention description **Fidelity-** No examined, but was a pilot study	A1 Focused on physical activity specifically not PD in general , A2 Intervnetion focused , A3 No spsecfically mentioned A4 No, A5 exercise physiological parameters and measurements A6 Telecoach group only, A7 Yes described here under devices, A8 More so for the TAE group, A9 Training was provided , A10 more around excercise, A11 Only indirectly, and more so in the SRE group A12 Not direcly A13 In the form of the telecoach support A14 Aims to improve physical activity through technology and excercise equipment use.
Survey closed February 2021	Single data capture point for both groups	N/A but the usual care face to face community-based care to virtual classes required significant levels of modification.	Online- virtual	**Brief name-** Impact of Covid-19 on Community-based exercise classes for PwP. **Why-** To examine the impact of Covid-19 restrictions on specific outcomes **What-** Physical activity, Exercise self-efficacy Activities of daily living and QoL **How-** Electronic database surveys **Where-** Online **When an how much-** An open survey format **Tailoring** None to the research method but yes to virtual class format **Modifications- None to the research method but yes to virtual class format** **Fidelity-** N/A	A1 N/A, A2 N/A, A3 N/A, A4 No, A5 Unclear for Virtual classes A6 Behavioural change through SEE, GLT-Q , A7 Requires the participant to be able to go online, A8 No, A9 No, A10 No, A11 potentnially , A12 Potentially , A13 Contact with healthcare professionals during Covid-19 restrictions, A14 Looks to continue community-based excercise classes for PwP during Covid-19 restrictions.

Complex 30 minute schedules based around activities and time of the day and diary prompts.	16 weeks	The design and data collection points seem very specific	Predominatly home but also agile	**Brief name-** Mobile health intervention **Why-** To evaluate the effects of a mobile health intervnetion for self-management on self-efficacy, motor symptoms and non-motor symptom, self-management and quality of life in PwP **What-** To evaluate a mobile health intervention and Smartphone and Smartwatch. **How-** Conducting an RCT **Where-** Home/agile **When an how much-** A series of multiple prompts through out the day **Tailoring** Potentially, **Modifications- No Fidelity-** Not mentioned	A1 Yes viewed holistically IMB model, A2 Yes message feature and extensive menu, A3 Part of exclusion/dropout criteria, however also has medicinal taking prompts, A4 No, A5 Yes, A6 Yes medicinal prompts, A7 Yes Smartwatches and Smartphones, A8 Yes via menu and reflective tracking, A9 limited description, A10 To an extent, A11 Yes, A12 Yes, A13 Yes, A14 Yes, especially around physical activity
Up to 4 telehealth coaching sessions over three months	3 months	Intervention was modified, however this was not unlimited.	Implied home setting	**Brief name-** Engage-PD **Why-** Case report to describe a physical activity coaching programme. **What-** **Telehealth coaching via Zoom© How-** Virtual delivery, training, disease management reasons. **Where-** Up to 4 sessions with a specially trained PT virtually tele-coached via Zoom (c) Home setting. **When an how much-** Up to 4 coaching sessions over 3 months. **Tailoring** Yes but with limits **Modifications-** Yes around functional ability **Fidelity-** Yes	A1 Yes, booklet and training, A2 Yes, as resources and via training, A3 Not directly , A4 Not direcrtly and physical activity focused, A5 Via physical activity devices A6 Yes in the form of telecoaching , A7 Unclear, but potentially yes , A8 Limited to up to 4 telecoaching sessions over 3 months, A9 Training is given , A10 Mainly in relation to promotion of physical and self-efficacy, A11 Mainly in relation to physical activity, A12 Yes in terms of behaviour change via motivational interviewing, A13 Not directly specified, A14 Yes, in relation to physical activity sustained through raised self-efficacy
	6 Months	Intervention is modified or tailored but there are limits and fidelity checks.	Home-based intervention	**Brief name-** PDSAFE **Why-** To reduce falls in PwP **What-** A multimodal physiotherapy intervnetion **How- Home visits,** supervised and unsupervised visits, DVD,s Video teleconferences 'Master classes'. **Where-** Home-based care. **When an how much-** 30 mins per day for 6 months **Tailoring** Yes **Modifications-** Yes **Fidelity-** Yes	A1, A2, A3, A4, A5 A6, A7, A8, A9, A10, A11, A12, A13, A14
5 sessions over Three-months via Zoom ©	Three months	Some level of modification, described as advice on modified extensions based on functional ability	Home setting but agile	**Brief name-** Engage-PD **Why-** To determine the feasibility and preliminary efficacy of the Engage-PD intervention and to explore whether baseline characteristics are associated with outcomes **What-**Physical activity coaching via telehealth **How-** Delivering the intervention via five coaching sessions using Zoom (c) **Where-** Participants homes **When an how much-** Five sessions delivered by licenced PT's over Three months **Tailoring** Yes specifically stated **Modifications-** Yes specifically mentioned **Fidelity-** No, but was a feasibility study	A1 Yes disease specific workbook, A2 Yes multimodally, A3 No , A4 Only in the course of usual care, A5 Spefically in terms of physical activity A6 Behavioural in terms of coaching to promote physical activity, A7 Unclear uses Zoom © but is this through the participants own device and WiFi, A8 Number of coaching sessions is specifically 5 over 3 months, A9 Therapists are trained to train in things like motivational interviewing , A10 Only in relation to physical activity, A11 Specifically in relation to physical activity, A12 Coaching promotes ESE and by extension psychological activities, A13 Yes via terehealth coaching , A14 Yes via coaching and promotion of physical activity
Stepping excersie 15 minutes three times a week for 12 weeks.	15 minutes per session	No specified, however, exercise is unsupervised	Intervention-home Ourcome-Laboratory setting	**Brief name-** Stepmania **Why-** To see if intervention improves balance gait and reduction in falls. **What-** A videogame (exergame) for use in the home, links to television **Who- Physiotherapists How-** Remote in the home. **Where-** Intervention in the home, outcome measures in the laboratory. **When an how much-** 15 minutes per session, 3 sessions per week over 12 weeks. **Tailoring-** Unclear, **Modifications-** not mentioned **Fidelity-** Unclear but suggests standardised.	A1 In the context of the intervention but more broadly, A2 Yes, A3 Potentially during training, A4 No, A5 Indirectly and only within the scope of the intervention A6 No, A7 Yes Videogame provided, A8 Not explictly stated, A9 Yes training with Physiotherapist , A10 Only in relation to the focus of the intervention, A11 Yes , A12 Yes in relation to secondary outcomes, A13 Not specifically , A14 In relation to movement and physical activity through stepping.

Key A1 Infiormation about condition and/or its management **A2** Information about available resources **A3** Provison of/agreement on special clinical actionplans and/or rescue medication **A4** Regular clinical review **A5** Monitoring of condition and feedback **A6** Practical support and adherence (Medicinal or behavioural **A7** Provision of equipment **A8** Provisionof easy access to advice or support when needed **A9** Training/reheersal to communicate with healthcare professionals **A10** Training rehersal of everyday activities **A11** Training rehersal for practical self-management activities **A12** Training/rehersal for psychological activities **A13** Social support **A14** Lifestyle advice and support

Outcome/Outcome measures	Scale used to measure self-efficacy	Magnitude of change in level of self-efficacy
Performance-based outcome measures included: 1) the Unified Parkinson's Disease Rating Scale (UPDRS) motor examination part 3; 2) the Mini-BESTest; 3) the Five Time Sit To Stand (5TSTS) These outcomes were measured by a PD specialist physiotherapist at baseline and 6 months post intervention. Patient reported outcome measures (PROMS) included ; the Geriatric Depression Scale (GDS); the Apathy Evaluation Scale (AES) , the Oxford Participation and Activities Questionnaire (Ox-PAQ); the Self-Efficacy for exercise scale (SEE) ; the Multidimensional Outcomes Expectations for Exercise Scale49 (MOEES); & the Gait-Specific Attentional Profile scale (GSAP).	Self-efficacy for Exercise Scale (SEE)	Intervention group baseline 56 (49-68) post-intervention 40 (37.5-63.5) 6-months post follow- 65 (53.75-78.25). Control group baseline 64 (52.5-74) post-intervention 56 (51.5-69.5) 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
Feasibility measured be examining recruitment and retention, Safety was measured through reporting AE's, Acceptability questionnaire, Walking Activity measured objectively over 7 days , Self-efficacy measured using the self-efficacy for Exercise measure & Disability was measured using the Late Life Function and Disability Instrument (LLFDI)	Self-efficacy was measured using the Self-efficacy for walking duration 10-item Questionnaire (SEW_Dur)	The mean self-efficacy for peer mentees increased from 66.8 (SD 25.7) points at baseline to 70 (SD 25.9) points post intervention. Clinically important differences were not established.
Primary: Gait speed under dual conditions HR-QOL- 2 Minute walk test. MiniBESTTest, Four square step test (FSST) Falls Efficacy Scale International (FES-I)	FES-I	No statistically significant changes noted
Self-efficacy via PAAI, The funcational Assessment of Cancer Therapy-General (FACT-G) -QoL-PWB-7-Item, Social and Family Wellbeing SWB 7-item Emotional wellbeing EWB- 6-item, Functional wellbeing FWB 7-item, Objective data from fitbit physical activity tracker.	Physical Activity Assessment Inventory (PAAI)	No statistically significant changes noted but authors mention small sample size (n=5)
Adherence outcomes of study, Attendance (%) Total sessions, Time performing exercise, Time performing moderate exercise aeorobic exercise (min/week) Walking capacity outcomes by study group. 6 minute walk test. Qualitative themes- 1) Telecoach-assisted excercise positive programme experiences, Suggestions for improving technology, Self-regulated group- Challenges that affected excercise adherence. Potential benefits of telehealth.	Determined by mapping qualitative findings to Bandura's Social cognitive theory	Qualitative findings suggested that high rates of adherence for TAE participants were largely influenced by increased self-efficacy, which was facilitated primarily by the assistance of the telecoach.
Godin Leisure-Time Questionnaire, Self-efficacy for Exercise Scale, Schwab-England Activities of Daily Living Scale, Parkinson's Disease Questionnaire-8 (PDQ-8) (QoL)	Self-efficacy for Exercise Scale	Reduced face to face community-based exercise classes and the use of virtual class formats due to the Covid-19 Pandemic was associated with a reduction in Self-efficacy for Exercise levels.

Self-efficacy, motor symptoms, Non-motor symptom, Self-management, Quality of Life	Self-efficacy for managing Chronic Disease 6-item Scale	The mobile health intervention for self management is effective for self-efficacy and non-motor symptoms in PwP.
Construct- *Acceptability*- Measure Acceptibility & Fidelity- Perceive autonomy support healthcare, Climate Questionnaire (HCCQ), Rates of adherence and retention, Post intervention Questionnaire, **Physical Activity** *Planned and unplanned activity*- Brunel Inventory Scale. **Disease specific impairments** *Balance* TUG, 30CST *Gait speed* - 10WT. **Motivation and Self efficacy** *Self-efficacy* Norman Self-efficacy scale *Satisfaction/performance with exercise* Modified Canadian Occupational Performance measure.	Norman self-efficacy scale	Does not explicitly state as this is an interim point case study, the full Engage-PD study by Shih did find this approach raised levels of Exercise Self-efficacy.
The primary outcome was risk of repeat of falling in the first 6 months after randomisation. Secondary outcomes were fractures and the rate of near falling; The MiniBesTest, The chair to stand test (CST) Geriatric Depression Scale (GDS) The International Version of Falls Efficacy Scale (FES-I) New Freezing of Gait Questionnaire (NFoG) The Parkinson's Disease Questionnaire. PDQ-39 (QoL)The Physical Activity Scale for the elderly (PASE) EuroQol (ED-5D-3L)	FES-I	Statistically significant change is Falls self-efficacy as a secondary outcome.
Feasibility- Recruitment, Retenion, Adverse Events, acceptibility, Participant perspectives via open ended questions. **Intervention outcomes**- Physical Activity via the Brunel Inventory Scale, Execercise-Self-Efficacy via the Exercise Self-efficacy Scale, Participant Goals	Exercise self-efficacy scores	Participants with lower baseline planned physical activity exoperienced greater improvements in planned physical activity, and those with lower exercise self-efficacy experienced greater improvements in Exercise self-efficacy.
Primary outcomes-Stepping performance CSRT task Reaction time (ms) CSRT task Movement time (ms) CSRT task Response time (MS) Mobility FGA (0-30) **Secondary outcomes**- Power Average hip abductor peak power (w) Average hip abductor power at load (33N) (w) Mobility TUG, Tug avg, GAT accuracy (cm) GAT velocity (cm/s) Hand movement Hand reaction time (ms) Cognition- MOCA, TMT, FOG NFOGQ (0-28) Falls efficacy- FES-I (16-64)	Falls efficacy FES-I (Falls eficacy scale-International)	Week 0- (I) 25.3 (6.4) (c) 26.0 (10.2) Week 12 (I) 27.0 (7.9) (C) 25.3 (10.1)

Outcomes measured in addition to self-efficacy	PD symptoms measured	Objective measurement Y/N	Self-reporterd or CG reported outcomes	Effective Y/N/ Not measured	Safety assessed
The Unified Parkinson's Disease Rating Scale (UPDRS) motor examination part 3; the Mini-BESTest; the Five Time Sit To Stand (5TSTS)	The Unified Parkinson's Disease Rating Scale (UPDRS) motor examination part 3	Subjective and objective from the accelerometer	Self-reported	N/A feasibility study	Yes (as a theme)
Feasibility was determined by examining recruitment, participation, and retention. Safety, satisfation and acceptability were measured, along with individual-level changes in physical activity were examined releative to clinically important differences.	Walking measurement, risk of falling, Indirect measures, study retention	Yes	Self-reported	No as this was a feasibility study	Yes
Single and dual task gait speed, MiniBESTest, Quality of Life (SF-36 physical health) Balance, Endurance, Disease severity, FOG, Cognition	Comfortable gait, Dual task gait, Balance, Endurance and Physical Activity	Comfortable gait, Dual task gait, Balance, Endurance and Physical Activity, MiniBESTest	Self-reported	Not in terms of self-efficacy	Not specifically mentioned
QoL, Wellbeing, PWB, SWB, EWB, FWB, PAAI	Motor symptoms in terms of physical activity,. Objective measure and qualititive thematic analysis, Quantative measures of physical activity, mutliple wellbing and QOL domains.	Objective data from the Fitbit physical activity tracker.	Self-reported	No statistically significant difference found	No
Adherence outcomes of study, Attendance (%) Total sessions, Time performing exercise, Time performing moderate exercise aeorobic exercise (min/week) Walking capacity outcomes by study group. 6 minute walk test.	No specifically, but looked at walking function and strength from physical activity	Physiological measurements from the various instrumentation used including wearable sensor.	Self-reported and objectively measured	In terms of the qualitative findings yes, with an explanation related to Bandura's social cognitive theory and a proposed mechanism proposed.	Yes, exercise on the cycle was done in a recumbant position to reduce the risk of falls. Training was also provided.
Godin Leisure-Time Questionnaire, Schwab-England Activities of Daily Living Scale, Parkinson's Disease Questionnaire-8 (PDQ-8) (QoL)	Predominatly motor, Balance, Gait, Falling, Depression, FoG	No All participant reported	Self-reported/care partner reported, and instructor reported.	The restriction placed for Covid-19 reduced face to face community-based exercise classes to some virtual classes. The effect of these changes resulted in a reduction in the level of SEE-Self-efficacy for exercise and physical activity in general.	No

Motor symptoms, Non-motor symptom, Self-management, Quality of Life	Both motor and non-motor symptoms	In terms of engagement and use yes, as actions recorded	Self-reported	Yes	Not specifically mentioned
Construct- Acceptability- Measure Acceptibility & Fidelity- Perceive autonomy support healthcare, Climate Questionnaire (HCCQ), Rates of adherence and retention, Post intervention Questionnaire, Physical Activity Planned and unplanned activity- Brunel Inventory Scale. Disease specific impairments Balance TUG, 30CST Gait speed - 10WT. Motivation and Self efficacy Satisfaction/performance with exercise Modified Canadian Occupational Performance measure.	Not directly symptom focused	Option of using different types of physical activity trackers and devices suggested and their use promoted.	Self-reported	Not stated, however Shih which is the full cohort study of Engage-PD notice a positive change in self-efficacy	Yes, including risk, benefit weighing
The primary outcome was risk of repeat of falling in the first 6 months after randomisation. Secondary outcomes were fractures and the rate of near falling; The MiniBesTest, The chair to stand test (CST) Geriatric Depression Scale (GDS) New Freezing of Gait Questionnaire (NFoG) The Parkinson's Disease Questionnaire. PDQ-39 (QoL)The Physical Activity Scale for the elderly (PASE) EuroQol (ED-5D-3L)	FoG, Balance, Gait, Depression, Walking, Falls	No All participant reported	Self-reported	Yes between moderate and severe group.	Yes, Adverse events and deaths reported
The Brunel Lifestyle Inventory (meassure of physical activity), The Exercise Self-efficacy Scale (ESE), Canadian Occupational Performance Measure (mCOPM) Particpant goals.	Not symptom focused by indirectly in terms of physical activity, Exercise Self-efficacy, Participant Goals (linked to behaviour) Participant perspectives via open-ended questions.	No All participant reported	Self-reported	Participants with lower baseline planned physical activity exoperienced greater improvements in planned physical activity, and those with lower exercise self-efficacy experienced greater improvements in Exercise self-efficacy.	Yes No adverse events reported and evidence of safety monitoring
Primary outcomes-Stepping performance CSRT task Reaction time (ms) CSRT task Movement time (ms) CSRT task Response time (MS) Mobility FGA (0-30) **Secondary outcomes**- Power Average hip abductor peak power (w) Average hip abductor power at load (33N) (w) Mobility TUG, Tug avg, GAT accuracy (cm) GAT velocity (cm/s) Hand movement Hand reaction time (ms) Cognition- MOCA, TMT, FOG NFOGQ (0-28)	Stepping reaction time test, functional gait assessment, Physical and neuropsychological measures associated with falls, number of falls, mobility and balance	Hip abduction, hand movement, reaction and response time, TUG Test	Self-reported	Not in terms of self-efficacy	Yes including booklet for safe use.

Studies which showed a statistically significant improvement in the self-efficacy measure		
Authors year Title	Study design, sample size and self-efficacy measure	Intervention description and key findings
Chivers Seymour, K., Pickering, R., Rochester, L. et al. (2019) Multicentre, randomised controlled trial of PDSAFE, a physiotherapist-delivered fall prevention programme for people with Parkinson's [80].	**Study design:** Randomised Controlled Trial. **Sample size:** n=474 **Self-efficacy measure:** Falls Self-efficacy Scale International (FES-I) [67].	**Intervention:**. Tailored video vignettes of strategies were given to participants on a DVD to remind/reinforce between face-to-face sessions, using images of them performing the activities using a Tablet. Control used a standard instructional DVD only [80]. **Primary outcome:** No reduction in falls **Secondary outcome:** Self-efficacy measured using the FES-I showed a statistically significant improvement compared to control at 6-months. Between-group difference 1.60 points, 95% CI 3.00 to 0.19, p=0.026 for the intervention at 6-months.
Lai, B., Bond, K., Kim, Y. et al. (2020) Exploring the uptake and implementation of tele-monitored home-exercise programmes in adults with Parkinson's disease: A mixed methods pilot study [77].	**Study design:** Mixed Methods Pilot. **Sample size:** n=20. **Self-efficacy measure:** Qualitative thematic analysis.	**Intervention:** Eight-week telecoach-assisted programme comprised of a strength and aerobic exercise, vital signs and exercise measurements, and supervised exercise via videoconferencing. Control group performed self-regulated exercise only. **Outcomes:** Perceived increased exercise motivation, and self-efficacy in the intervention group identified using qualitative thematic analysis.
Park, Y., Kim, R.S., So, H. Y., et al. (2022) Effects of mobile phone intervention for self-management on self-efficacy, motor and non-motor symptoms, self-management, and quality of life in people with Parkinson's disease: Randomised controlled trial [76].	**Study design:** Randomised Controlled Trial **Sample size:** n=20 **Self-efficacy measure:** Self Efficacy for managing Chronic Disease 6-Item (SEMCD-6-item) [73].	**Intervention:** Mobile health intervention using Smartphone and smartwatch devices, telehealth communication and tele-counselling over a 16-week period, based on the Information-motivation-behaviour (IMB) skills model. The control group was similar to the intervention but did not include the use of smartphones and smart watches [86, 87] **Outcome:** The intervention group improved self-efficacy to a statistically significant level when compared to the control group (t=2.33, p=0.025). Intervention Pre-Post score (t=2.85 p=0.011) Compared to the control Pre-post test score (t=0.26 p=0.796).
Quinn, L., Macpherson, C., Long, K. et al (2020) Promoting physical activity via telehealth in people with Parkinson disease: The path forward after the COVID-19 pandemic [79].	**Study design:** Case Report **Sample Size:** n=27 **Self-efficacy measure:** Norman Self-efficacy Scale for Exercise [72].	**Intervention**: Tele-coaching intervention comprising of; 4 tele-coaching sessions, that incorporate 1:1 coaching, goal-setting, physical activity monitoring, and a disease-specific workbook resources aimed at promoting physical activity. **Outcome:** Pre/post scores showed a statistically significant increase in self-efficacy (d=0.95 p<0.001). Study design does not have a control or blinding.
Shih, S. H-J., Macpherson, C.E., King, M., et al. (2018) Physical activity coaching via telehealth for people with Parkinson disease: A cohort study [83].	**Study design:** A single cohort study with no control group or blinding of participants **Sample Size:** n=62 **Self-efficacy measure:** Exercise Self-efficacy Scale (ESE) [68].	**Intervention:** Up to 5 personal telecoaching sessions over a 3-month period. The intervention seeks to promote self-initiated physical activity, competence, relatedness to improve physical activity and uptake of exercise. Use of a multimodal approach involving 150mins of exercise per week. Number and frequency of coaching sessions was based on the individuals' needs and progress. Time periods between sessions are tapered. The telecoaching intervention was led by licensed physical therapists using Zoom™ video communication **Outcome:**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.
Studies which did not raise self-efficacy to a statistically significant level in the measure used		

Authors Year Title	Study design, sample size and self-efficacy measure	Intervention description and key findings
Agley et al., 2024 Digital intervention promoting physical activity in people newly diagnosed with Parkinson's disease: Feasibility and acceptability of knowledge, exercise-self-efficacy, and participation (KEEP) Intervention [70].	**Study design:** An assessor blinded, randomised controlled feasibility study. **Sample size:** n=30 **Self-efficacy measure:** Self-efficacy for Exercise (SEE) [69, 70].	**Intervention:** The KEEP intervention used a blended learning format comprising of 6 online modules focusing on acceptance of knowledge, exercise self-efficacy and participation, using COM-B behaviour change model [89]. The intervention also used four online discussion groups facilitated by a specialist physiotherapist. **Outcome:** Intervention group **b**aseline 56 (49-68) post-intervention 40 (37.5-63.5) 6-months post follow- 65 (53.75-78.25). Control group baseline 64 (52.5-74) post-intervention 56 (51.5-69.5) 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.
Colón-Semenza et al., 2018 Peer coaching through mHealth targeting physical activity in people with Parkinson's disease: Feasibility study [74].	**Study design:** Feasibility study **Sample size:** n=10 (5 dyads) **Self-efficacy measure:** Self-efficacy for walking-duration 10-item questionnaire (SEW_Dur) [90].	**Intervention:** A peer-mentored walking programme involving motivational interviewing, mHealth technology, a FitbBit Zip activity tracker and FitBit *friends* mobile App and action planning over an 8-week period. **Outcome:** 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.
Ginis P., Nieuwboer, A., Dorfman, M., et al (2016) Feasibility and effects of home-based smart-phone delivered automated feedback training for gait in people with Parkinson's. A pilot randomised controlled trial [75].	**Study design:** Pilot Randomised Controlled trial **Sample size:** n=40 **Self-efficacy measure:** Falls Self-efficacy Scale International (FES-I) [67].	**Intervention**: Two smartphone applications that offered positive and corrective feedback on gait were used in this study. One app used the audio biofeedback ABF-gait app the second employing an instrumented cueing for Freezing of gait (FOG) training (FOG-cue app). Feedback and cues were provided via earphones or the smartphone's speaker. In terms and frequency gait training was undertaken 30 minutes 3 times a week for a 6-week period. **Outcome**: Self-efficacy was measured using the FES-I measure [91]. Effects at 6 weeks (Time (p=0.91) X Group (p=0.84 equals p=0.89) and was not raised to a statistically significant level.
Manãgo M.M., Swink, L.A., Hager, E.R. (2021) The impact of COVID-19 pandemic on community-based exercise classes for people with Parkinson disease [66].	**Study design:** Cross-sectional Study **Sample Size:** n=87 **Self-efficacy measure:** Self-efficacy for Exercise (SEE) [69].	**Intervention:** Data were collected via custom-designed electronic surveys for people with PD and physical therapy class instructors who reported attending or teaching PD-specific exercise class ≥1 time/week for ≥3 months prior to pandemic restrictions. Self-efficacy was measured using the Self-efficacy for exercise scale (SEE). **Outcome:** Whilst 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
Song, J., Paul, S.S., Caetano, M.J.D., et al (2018) Home-based step training using videogame technology in people with Parkinson's a single-blinded randomised controlled study [82].	**Study design** A Two-arm, Parallel, Single-blinded Randomised Controlled Trial **Sample size**: n=60 **Self-efficacy scale:** Falls Efficacy Scale-International (FES-I) [67].	**Intervention:** Step pad training, taught by experienced physiotherapists in order that the participants can perform exergaming in their home. Participants were encouraged to perform the exergame for a minimum of 15 minutes, three times a week for 12 weeks. The exergame was an adapted version of dance mania Stepmania™ game [92]. **Outcomes**: 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.
Studies which statistically lowered self-efficacy in the measure.		
Authors Year Title	Study design, sample size and self-efficacy measure	Intervention description and key findings

Hermanns, M., Haas, B.K., Lisk, J (2019) Engaging older adults with Parkinson's physical activity: A feasibility study [81]	**Study design:** Longitudinal Pre-test Post-test design **Sample size:** n=5 **Self-efficacy measure**: Physical Activity Assessment inventory (PAAI) [71].	**Intervention**: Devices used were Fitbits™ and iPads given to participants. Additionally, participants had access to a private social media support group. via an electronic tablet, exercise compliance was measured using the Fitbit™ device, along with instructional videos. The frequency and duration of the intervention was 3 times a week for 12 weeks**.** This study did not have a control group. **Outcome:** Statistical analysis involved pre-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 nonsignificant changes ($p > .05$). A full breakdown of PAAI is shown in appendix iii.