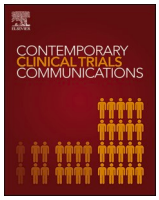
Contemporary Clinical Trials Communications 36 (2023) 101222

Contents lists available at ScienceDirect

Contemporary Clinical Trials Communications

journal homepage: www.elsevier.com/locate/conctc



Physical Activity Together for Multiple Sclerosis (PAT-MS): A randomized controlled feasibility trial of a dyadic behaviour change intervention

Afolasade Fakolade [a,*], Zain Awadia [b], Katherine Cardwell [c], Odessa McKenna [d], Myriam Venasse [c], Taylor Hume [c], Julia Ludgate [c], Mark S. Freedman [e], Marcia Finlayson [a], Amy E. Latimer-Cheung [f], Lara A. Pilutti [c,g]

[a] School of Rehabilitation Therapy, Queen's University, Kingston, Canada
[b] Faculty of Health Sciences, McMaster University, Hamilton, Canada
[c] Interdisciplinary School of Health Sciences, University of Ottawa, Ottawa, Canada
[d] Department of Medicine, University of Ottawa, Ottawa, Canada
[e] University of Ottawa, Department of Medicine and the Ottawa Hospital Research Institute, Ottawa, Canada
[f] School of Kinesiology and Health Studies, Queen's University, Kingston, Canada
[g] Brain and Mind Research Institute, University of Ottawa, Ottawa, Canada

ARTICLE INFO

Keywords:
Multiple sclerosis
Dyads
Randomized controlled trial
Physical activity

ABSTRACT

Background: Many people with advanced multiple sclerosis (MS) and their care-partners do not engage in sufficient physical activity (PA) for health benefits. We developed "Physical Activity Together for MS (PAT-MS)", a 12-week dyadic behavioural intervention, to promote PA among these dyads. Herein, we evaluated the feasibility of PAT-MS before a definitive trial.

Methods: A randomized controlled feasibility trial, with 1:1 allocation into the intervention or wait-list control condition. Predefined progression criteria included rates of *recruitment*, *retention*, *safety*, *participant satisfaction* and *adherence*. Changes in self-reported and accelerometer-measured PA were assessed at baseline and post-intervention using mixed-factor ANOVAs. Effects sizes were calculated as Cohen's *d*.

Results: The *recruitment* rate (i.e., 20 participants in 10 months) was not acceptable. However, *retention* (80%) was acceptable. No *serious adverse* events were reported. There were high levels of *participant satisfaction* with the intervention (content (median = 6 out of 7), facilitator (median = 7 out of 7), and delivery (median = 5 out of 7)) and a*dherence* (92% of the group sessions, 83% of the individual support calls, and 80% of the practice activities were completed). There were statistically significant time-by-condition interactions on self-reported PA, steps/day, and %wear time and minutes in sedentary behaviour, and moderate-to-vigorous PA from baseline to post-intervention in people with MS and their family care-partners.

Conclusion: PAT-MS appears feasible, safe, and efficacious for PA promotion in MS dyads. We established effect size estimates to power a future definitive trial and identified necessary methodological changes to increase the efficiency of study procedures and improve the quality of the intervention.

Trial registration: ClinicalTrials.gov NCT04267185; Registered February 12, 2020, https://clinicaltrials.gov/ct2/show/NCT04267185.

1. Introduction

Multiple sclerosis (MS) remains one of the leading causes of non-traumatic neurological disability among adults in North America [1]. In Canada alone, current estimates suggest that more than 90,000 individuals live with MS [2]. By 2031, the number of Canadians living with MS is projected to be 133,635, and their total healthcare costs will reach $2 B annually [3]. Individuals with MS have to manage a complex, incurable, neurodegenerative disease with a variable course and largely unpredictable exacerbations that often result in progressive disability [4]. Approximately 93% of people with MS report gait impairment (i.e., moderate disability) within 10 years of disease onset. Further, an estimated 50% are unable to walk unaided (i.e., severe disability) within 15 years of diagnosis [5–7].

* Corresponding author. School of Rehabilitation Therapy, Louise D. Acton Building, 31 George Street, Queen's University, Kingston, K7L 3N6, Canada.
E-mail address: a.fakolade@queensu.ca (A. Fakolade).

https://doi.org/10.1016/j.conctc.2023.101222
Received 12 May 2023; Received in revised form 8 September 2023; Accepted 15 October 2023
Available online 16 October 2023

As disability accumulates, most people with MS rely on family members or close friends (i.e., care-partners) for assistance and support [8]. Although there are positive aspects of MS caregiving [9,10], many care-partners report detrimental impacts on quality of life (QoL), well-being, and resilience [10–12]. Together, this evidence suggests that MS has life-altering consequences for people with the disease and their care-partners, highlighting an opportunity to develop strategies to improve the health of *both* partners to benefit each individual and the dyad (i.e., partnership).

Within the general dyadic health literature, emerging cross-sectional and prospective evidence indicates that people with or at risk of chronic diseases and their care-partners have a "reciprocal influence" on each other that affects health behaviours (e.g., physical activity (PA)) and outcomes [13–19]. In literature specific to dyads with advanced MS, low PA levels have also been reported [20]. These findings further highlight the importance of acknowledging the unique inter-relatedness of health behaviours and outcomes among dyads affected by chronic diseases, such as MS.

Dyadic behavioural PA interventions (i.e., targeting behaviour change relative to PA determinants such as goal setting among care-recipients and their care-partners together, as active participants) can improve the health and well-being of dyads affected by chronic diseases [21]. For instance, one randomized controlled trial of a dyadic PA intervention for people with chronic osteoarthritis and their care-partners reported that dyadic participants were more likely to have improved coping, self-efficacy, pain control, and physical fitness than individuals participating without their partners [22]. Similar improvements in physical and psychological health outcomes were reported by people with dementia and their care-partners participating in dyadic PA interventions [23–26]. However, despite the promise of such interventions, no studies have capitalized on the potential benefits of including people with advanced MS and their care-partners as *active participants* in a dyadic behavioural PA intervention [27].

In response, we systematically applied a staged research approach [20,28], incorporating guidance from the Medical Research Council (MRC) framework [29], and elements from Bleijenberg et al. [30] and O'Cathain et al. [31] to develop Physical Activity Together for MS (PAT-MS) – the first dyadic behavioural PA intervention for care-recipient-care-partner dyads affected by moderate-to-severe MS disability. We defined moderate-to-severe disability as experiencing significant walking limitations that require support for gait—Patient Determined Disease Step (PDDS) score between 3 and 6 [32]. In the present study, our objective was to test the feasibility of PAT-MS versus a wait-list control condition. Specifically, we explored primary feasibility indicators [33,34] recommended for PA studies in MS [35], and assessed the signals of improvement (baseline to post-test) in PA levels. Secondary outcomes related to dyadic adjustment, caregiving tasks, care-partner quality of life, coping, and MS impact, as well as qualitative feedback from participants, will be reported elsewhere.

2. Methods

The published protocol provides full details of the study design and methods [36], and as such, these are only briefly described below. Supplementary Table 1 summarizes key protocol modifications to ensure the trial's safety and continuity due to the COVID-19 pandemic [37]. Reporting of this trial is in line with CONSORT guidelines for pilot and feasibility studies [38].

2.1. Study design

This study was a single-site, parallel-group, randomized controlled feasibility trial using a 1:1 allocation into the intervention or a wait-list control condition. Ethics approval was granted by The Ottawa Hospital Research Ethics Board (20190329-01H) and the University of Ottawa Research Ethics Board (H-09-19-4886). The trial was conducted in compliance with the Declaration of Helsinki. Informed written consent was obtained from all participants.

2.2. Participants

2.2.1. Sample size

As a feasibility trial, a formal calculation was not appropriate [39,40]. In keeping with recommendations for feasibility trials [39,40] and similar trials for people with MS [41], our goal was to recruit and randomize 20 MS dyads with moderate-to-severe disability per condition within a 6-month recruitment window.

2.2.2. Recruitment and enrollment

Our original recruitment plan was to provide potential participants with a study information sheet at our local MS Clinic, and obtain their consent to be contacted by the research team to discuss the study and screen for eligibility [36]. Recruitment efforts began in February 2020 but had to be discontinued in March 2020, due to the COVID-19 pandemic and restrictions to in-person clinic visits. With no known end to the pandemic at the time, we modified our procedures to enable study progression via a remote protocol. We restarted recruitment in April 2021, following ethical approval of our revised protocol. Our revised recruitment strategies included online outlets via relevant community-based support organizations across Canada (e.g., Carers Canada, MS Canada Research Portal, etc.). Social media websites (e.g., Facebook) were also used as platforms to disseminate information about the study. Further, recruitment emails were sent to individuals who had participated in previous studies conducted by members of our research team and consented to be contacted for additional research projects. The original and modified eligibility criteria for people with MS and their care-partners are presented in Supplementary Table 1.

2.3. Study procedures

In our published protocol [36], we had planned for eligible participants to be scheduled for a baseline assessment (T1) for the provision of informed consent and collection of baseline data by blinded assessors at a university research laboratory. However, our research laboratory was required to halt any in-person contact with research participants in March 2020. As with other clinical trials, we were unable to enroll new participants through in-person assessments until further notice. Therefore, we transitioned to a remote assessment process – See Supplementary Table 1. Participants received a link to an online survey via a university-licensed SurveyMonkey account (SurveyMonkey Inc., San Mateo, CA, USA) to confirm eligibility and for baseline assessment. When participants activated the online survey link, they were prompted to provide informed consent before completing the baseline assessment. Participants were sent an accelerometer, via postal services. Each participant was instructed to wear their accelerometer in the 7 days after completing the baseline survey. Participants were instructed to wear the accelerometer in a pouch on an elastic belt around their waist with the device placed at the non-dominant hip during all waking hours. Pre-stamped, pre-addressed envelopes were provided for the return of each accelerometer.

Randomization occurred after the collection of baseline data. Participants were randomized using a randomization sequence generated by a biostatistician independent of the research team, using 1:1 allocation into the intervention or a wait-list condition (i.e., maintenance of usual activities for 12-weeks). Participants in the wait-list condition received the intervention after the post-intervention assessment (T2). We followed the same intervention delivery procedures for the wait-list condition as for the intervention condition. Members of the research team monitoring and entering participant data were unaware of group allocation.

2.4. PAT-MS intervention

The full details of the PAT-MS intervention content, including theoretical frameworks, are reported in the published protocol [36]. We had planned to deliver the intervention via teleconference. However, an e-Delphi consensus process to further refine study procedures, completed during the COVID-19 pandemic in October 2020 [42], indicated a preference for videoconference delivery. Hence, participants received six group videoconference sessions delivered via Zoom (Zoom Video Communications Inc., San Jose, CA, USA) every other week for a period of 12 weeks. The group sessions were interspersed with one-on-one support calls in the weeks that the group sessions did not occur. Each group session was facilitated by a trained facilitator using a structured intervention manual. Participants also received a PDF or hard copy of the intervention manual, depending on preference. The manual had six sections corresponding to each bi-weekly group session. Each section included a review of the material from the previous week, new teaching content (e.g., information about shared disease appraisal, benefits of shared participation in PA as a dyadic coping strategy etc.), group discussion questions, and an explanation of practice activities to be completed before the next session. We also included a section for participants to take notes and document areas to discuss with the facilitator during the one-on-one support calls. PAT-MS was delivered to the intervention and wait-list control conditions in two concurrent waves of 5 dyads per wave.

2.5. Feasibility outcomes

We assessed outcomes related to: 1) *recruitment* (i.e., percentage of participants recruited within the recruitment window); 2) *retention* (i.e., percentage of randomized participants who completed the post-intervention assessment at T2); 3) *cost of intervention* (i.e., cost of intervention materials and delivery); 4) *staff time* (i.e., time for the group sessions, individual support calls, and staff preparation and de-briefing); 5) *technical requirements* (i.e., number of technical issues reported by participants and/or staff during intervention delivery and data collection); and 6) *safety* (i.e., overall rate, severity and characteristics of adverse events (AEs)). We defined AEs as any unfavourable change in health experienced by a participant during the trial period [43]. Participants recorded any unfavourable change in their health in their PAT-MS intervention manual. During the one-on-one support calls, the facilitator asked for, recorded, and rated any AE reported by each participant. AEs were then discussed with the intervention team. Each AE was rated using the National Institutes of Health terminology and classification scheme [43]); 7) *participant satisfaction* with intervention components (i.e., content, facilitator, and delivery), assessed using a questionnaire adapted from Wong et al., [44]. Items were scored using a 7-point scale with higher scores reflecting greater satisfaction; 8) *participant adherence* (i.e., number of group sessions, one-on-one support calls, and practice activities completed); and 9) *facilitator compliance with the protocol*, assessed using a checklist and weekly review meetings with the first (AF) and/or last (LP) authors [45].

We assessed treatment effect (i.e., change in self-reported and accelerometer-measured PA at baseline and post-intervention (12 weeks) between intervention and control conditions). See Supplementary Table 2. Self-reported PA was assessed using the Godin Leisure-Time Exercise Questionnaire (GLTEQ) [46]. Accelerometer-measured PA (i.e., steps/day, and %wear time and minutes in sedentary behaviour, light and moderate-to-vigorous PA) was assessed using an ActiGraph model GT3X-BT (ActiGraph LLC, Pensacola, FL, USA).

The following criteria were used to define acceptable feasibility and progression to a definitive trial [47]: 1) a minimum of 50% of the intended 20 dyads, recruited within a 6-month recruitment window; 2) $\geq$80% retention; 3) <10% of participants report a serious AE; 4) a minimum of 70% participant adherence; and 5) $\geq$4 out of 7 on a satisfaction survey.

2.6. Data analyses

Data analyses were conducted using SPSS Statistics, Version 28 (IBM Corporation, Armonk, NY). Given the sample size and phase of study development, people with MS and their care-partners were considered together in these analyses. Descriptive summaries (means, SD, frequencies, and proportions, as appropriate) were reported for baseline characteristics and feasibility outcomes. We conducted a per-protocol analysis of changes in PA levels using mixed-factor ANOVAs. Condition (Intervention and Control) was the between-subjects factor and time (Baseline and 12-weeks) was within-subjects factor. Effects sizes associated with *F*-statistics were expressed as partial eta^2 (η_p^2). Effect sizes representing the difference between conditions over time were also expressed as Cohen's *d* [48].

3. Results

3.1. Participant characteristics

Baseline participant characteristics for the overall sample and by conditions (i.e., intervention and wait-list control) are presented in Table 1. Ten eligible people with MS and their 10 respective care-partners completed baseline assessment, and were randomized to the intervention or wait-list condition. People with MS were mostly women

Table 1
Characteristics of participants who completed baseline assessments and were randomized into the intervention and control conditions.

Variable	Total sample	Intervention condition	Control condition
Persons with MS	n = 10	n = 5	n = 5
Median (Range) Age, y	51.5 (33–67)	50.0 (38–54)	57.0 (33–67)
Sex (n, %)			
Male	3 (30.0)	1 (20.0)	2 (40.0)
Female	7 (70.0)	4 (80.0)	3 (60.0)
Education (n, %)			
Technical or trade school	–	–	–
College	6 (60.0)	3 (60.0)	3 (60.0)
Bachelor's degree	2 (20.0)	1 (20.0)	1 (20.0)
Master's degree	2 (20.0)	1 (20.0)	1 (20.0)
I'd rather not say	–	–	–
Employment (n, %)			
Full-time ($\geq$40 h/week)	3 (30.0)	1 (20.0)	2 (40.0)
Unemployed	5 (50.0)	4 (80.0)	1 (20.0)
Retired	2 (20.0)	–	2 (40.0)
Type of MS (n, %)			
Relapsing-remitting MS	7 (70.0)	3 (60.0)	4 (80.0)
Primary progressive MS	3 (30.0)	2 (40.0)	1 (20.0)
Median (Range) Disease diagnosis, y	7.5 (2–16)	6 (6–9)	9.0 (2–16)
Median (Range) PDDS	4.0 (3–6)	4.0 (4–5)	4.0 (3–6)
Care-partners	*n=10*	*n=5*	*n=5*
Median (Range) Age, y	51.0 (32–67)	48.0 (35–56)	54.0 (32–67)
Sex (n, %)			
Male	3 (30.0)	2 (40.0)	1 (20.0)
Female	7 (70.0)	3 (60.0)	4 (80.0)
Education (n, %)			
Technical or trade school	1 (10.0)	1 (20.0)	–
College	4 (40.0)	3 (60.0)	1 (20.0)
Bachelor's degree	2 (20.0)	–	2 (40.0)
Master's degree	1 (10.0)	1 (20.0)	–
I'd rather not say	2 (20.0)	–	2 (40.0)
Employment (n, %)			
Full-time ($\geq$40 h/week)	7 (70.0)	4 (80.0)	3 (60.0)
Unemployed (unable to find work)	–	–	–
Retired	3 (30.0)	1 (20.0)	2 (40.0)
Median (Range) min/day of caregiving	75.0 (30–1440)	40.0 (30–1440)	90.0 (45–720)

MS: Multiple Sclerosis, PDDS: Patient Determined Disease Steps.

(70%), with a median age of 51.5 (range = 33–67) years, and with relapsing-remitting MS (70%). Their median PDDS score was 4.0 (range = 3–6). Care-partners were about the same age as their care-recipients, (median = 51.0, range = 3–6) years, and predominantly women (70%) who reported caregiving for a median of 75.0 (range = 30–1440) min/day.

3.2. Feasibility outcomes

Fig. 1 details participant flow through the trial (i.e., recruitment and retention rates). Table 2 provides details on feasibility outcomes, including staff time, participant adherence, and facilitator compliance with the protocol.

Recruitment: Between April 2021 and February 2022, 80 potential participants were screened prior to eligibility assessment, and 22 were

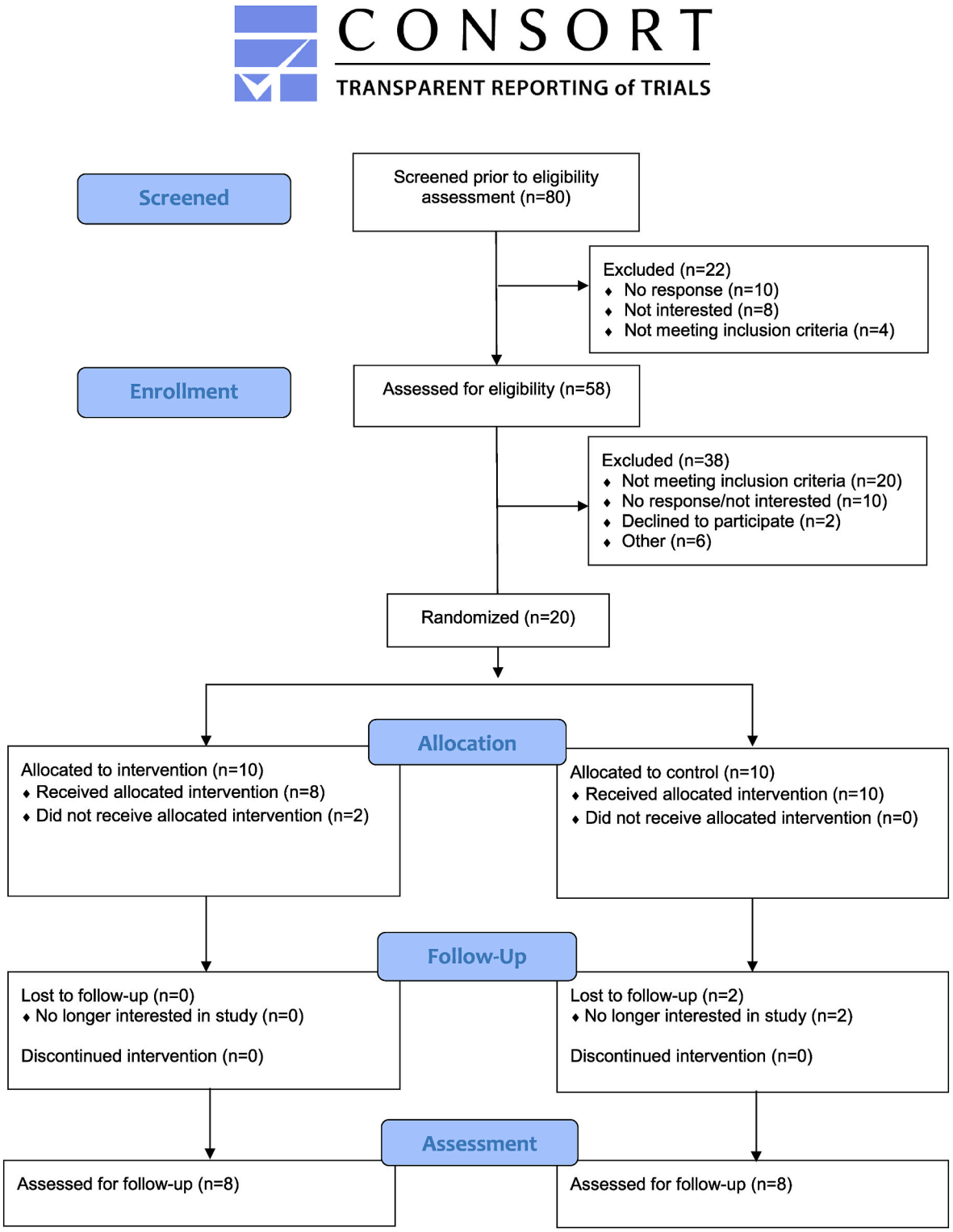


Fig. 1. CONSORT flow diagram.

Table 2
Description of staff time, participant adherence, and facilitator compliance in the intervention and control conditions for the participants who completed the 12-week program.

	Total sample (n = 16)	Intervention condition (n = 8)	Control condition (n = 8)
Staff time			
Mean (SD) per wave, hours	20.7 (4.0)	23.0 (4.2)	18.4 (1.7)
Mean (SD) preparation time per wave, hours	4.9 (0.8)	5.5 (0.0)	4.3 (0.8)
Mean (SD) debrief time per wave, hours	6.3 (1.5)	7.0(1.8)	5.7 (0.3)
Group Sessions			
Attendance, %	93.8	91.7	95.6
Perfect Attendance, %	62.5	50.0	75
Activity Completion, %	88.8	80.0	97.5
Mean (SD) Duration, min	36.8 (12.8)	40.2 (13.6)	33.4 (11.6)
Individual Calls			
Attendance, %	82.9	82.5	83.3
Perfect Attendance, %	43.8	62.5	25.0
Completion as Dyad, %	57.5	55.0	66.7
Mean (SD) Duration, min	13.0 (5.1)	13.7 (6.2)	12.3 (3.3)
Facilitator Compliance			
High (>75%), %	97.1	96.1	98.0
Medium (50–75%), %	2.9	3.9	2.0

excluded. Of the 58 potential participants assessed for eligibility, 20 participants (10 dyads) met the eligibility criteria, completed the baseline assessment, and were randomized into the intervention or wait-list control condition. Taking the recruitment period as 10 months, a mean of one dyad (i.e., two participants) per month were recruited and randomized into the study conditions.

Retention: Of the 20 randomized participants, 16 completed the study and returned post-intervention assessment materials (retention rate 80%). In wave 1, two participants (one person with MS and their respective care-partner) in the intervention condition dropped out of the study after randomization and did not receive the allocated intervention. In wave 2, two participants (one person with MS and their respective care-partner) in the control condition did not complete the post-intervention assessment at T2. Reasons for drop-out are presented in Fig. 1. The data from these four individuals are not considered in the analysis of treatment effects.

Time, costs, and technical requirements: In both waves, a main facilitator and an assistant (for support e.g., monitoring the chat) delivered the group sessions and debriefed afterwards. The same facilitator was involved in the individual support calls. The intervention delivery time was distributed across the group sessions (mean duration = 36.8 ± 12.5 min), individual support calls (mean duration = 12 ± 5.1 min), facilitator preparation time (mean = 32.3 ± 15.2 min) and de-briefing time (mean = 31.7 ± 9.9 min).

The Zoom subscription cost for the group sessions and individual support calls across both waves was $90.40 ($22.60/mo x 4 mo). In addition, the cost of reproducing the facilitator manual was $13.10 (131 pages x $0.05 x 2 copies (for the facilitator and assistant)). The cost of reproducing and mailing the participant manual to four participants (two dyads) who requested a hard copy was $66.93. These costs were related to photocopying (183 pages/manual x $0.05/page x 4 manuals), purchasing envelopes ($0.09 x 4 envelopes) and courier charges for mailing ($29.97). All costs are in Canadian Dollars.

Two technical issues occurred during intervention delivery. The first issue, in wave 1, was related to a participant experiencing audio issues during the first videoconference and subsequent individual support call. The participant was able to use the phone call-in option in both instances. The second issue, in wave 2, was related to a participant experiencing problems with renaming themselves (for confidentiality) during the first videoconference session. The facilitator was able to resolve this issue by manually renaming the participant.

Safety, satisfaction, adherence, and facilitator compliance: There were no serious AEs reported over the 12-week intervention period. Two participants (one person with MS and an unrelated care-partner) in the intervention condition reported mild AEs - One injured back (grade 1, unexpected, unrelated), and one rolled ankle (grade 1, unexpected, unrelated). In both cases, participants were able to continue the program sessions with modifications to chosen activities. Participant satisfaction was high with the intervention content (median = 6, IQR = 1), facilitator (median = 7, IQR = 0), and delivery method (median = 5, IQR = 0). Participant adherence with the intervention was high (92% of the group sessions (median = 6, IQR = 1); 83% of the individual support calls (median = 4, IQR = 2); and 80% of the practice activities (median = 5, IQR = 1) were completed). Compliance of the facilitator with the protocol was high (96%) across all 6 group sessions.

Treatment effect: The effect sizes (η_p^2) associated with the time-by-condition interaction for PA for both people with MS and their care-partners are presented in Table 3. We found statistically significant time-by-condition interactions on self-reported PA ($F = 6.093$, $p = 0.027$, $\eta_p^2 = 0.303$), minutes of sedentary behaviour ($F = 10.468$, $p = 0.006$, $n_p^2 = 0.428$) and moderate-to-vigorous PA ($F = 7.905$, $p = 0.014$, $n_p^2 = 0.361$), and steps/day ($F = 6.657$, $p = 0.022$, $n_p^2 = 0.322$), with the intervention condition reporting less sedentary behaviour and more moderate-to-vigorous PA over time. Although there was no statistically significant time-by-condition interaction on minutes of light PA ($F = 1.428$, $p = 0.252$, $\eta_p^2 = 0.093$), a moderate effect size ($d = 0.47$) was reported for this outcome. There were also significant time-by-condition interactions on %wear time in sedentary behaviour ($F = 8.139$, $p = 0.013$, $n_p^2 = 0.368$), light ($F = 5.345$, $p = 0.037$, $n_p^2 = 0.276$), and moderate-to-vigorous PA ($F = 7.742$, $p = 0.015$, $n_p^2 = 0.356$), with the intervention condition reporting less %wear time in sedentary behaviour and more %wear time in light and moderate-to-vigorous PA over time. The effect sizes expressed as Cohen's d demonstrate a medium-to-large improvement for these outcomes, with the largest effect size for % wear time in moderate-to-vigorous PA ($d = 1.83$).

4. Discussion

This study aimed to establish the feasibility of a definitive trial to evaluate PAT-MS among persons with moderate-to-severe MS and their care-partners. Progression criteria based on published recommendations [47] were pre-set for *recruitment*, *participant adherence*, *retention*, and *safety*. Throughout the COVID-19 pandemic, we implemented crucial processes to ensure research integrity, progression, and participant and staff safety. Our pilot findings suggest PAT-MS is feasible, safe, and efficacious for PA promotion in MS dyads. Below, we discuss specific results related to our progression criteria and the efficacy of PAT-MS.

Recruitment: We recruited and randomized 50% of the intended 20 dyads within 10 months, which does not fulfil the recruitment criteria for progression. Given that recruitment was paused for 13 months during the COVID-19 lockdown, recruitment rates may likely have been higher if this disruption did not occur. Nevertheless, we must acknowledge the inherent difficulties in recruiting dyads into this study. We had seven people with MS who were interested and qualified, but not enrolled because they had no care-partner (n = 1), their care-partner was unavailable/unwilling to participate in the study (n = 1), or their care-partner already participated in regular PA (n = 5). These difficulties were not surprising, as various researchers have reported similar issues during recruitment for dyadic studies [49–52]. Indeed, we had incorporated several evidence-based strategies [50,51,53] (e.g., avoiding the use of the term "caregiver" when talking with potential participants, giving the care-recipient the choice to select their participating care-partner then explaining the study and the importance of dyadic participation to the care-partner, re-contacting potential dyads who were not initially ready to enroll and reassessing their interest) to ensure

Table 3
Physical activity outcomes at baseline and following PAT-MS intervention among the participants who completed the 12-week program.

Physical activity	Baseline		Post-intervention		η_p^2	F-value	Effect (*d*)
	PAT-MS Mean (SD)	Wait-list Mean (SD)	PAT-MS Mean (SD)	Wait-list Mean (SD)			
Sedentary time							
Minutes, n (SD)	630.0 (59.3)	611.1 (92.8)	570.1 (69.7)	638.2 (69.3)	0.428	10.468†	1.16
% wear time, n (SD)	74.2 (5.0)	72.0 (11.2)	67.2 (5.5)	72.6 (11.1)	0.368	8.139*	0.94
LPA							
Minutes, n (SD)	212.8 (47.0)	223.6 (86.9)	260.7 (45.8)	240.1 (110.2)	0.112	1.762	0.47
% wear time, n (SD)	25.0 (5.2)	26.2 (11.2)	30.8 (5.1)	26.4 (11.0)	0.276	5.345*	0.68
MVPA							
Minutes, n (SD)	6.3 (5.9)	15.9 (13.8)	17.3 (19.9)	9.3 (6.2)	0.361	7.905*	1.78
% wear time, n (SD)	0.7 (0.7)	1.8 (1.7)	2.1 (2.4)	1.0 (0.7)	0.356	7.742*	1.83
Steps/day, n (SD)	3020.1 (713.5)	3947.0 (1887.8)	4280.2 (1170.6)	3775.7 (1780.6)	0.322	6.657*	1.10
GLTEQ	10.3 (9.1)	19.8 (17.6)	28.0 (11.7)	20.9 (13.5)	0.303	6.093*	1.24

Note: η_p^2: partial eta-squared. LPA: Light physical activity; MVPA; Moderate-to-vigorous physical activity; GLTEQ: Godin Leisure Time Exercise Questionnaire; * indicates significance at $p < 0.05$, † indicates significance at $p < 0.01$.

"buy-in" from care-partners, and to maximize recruitment. It is possible that while increasing our reach across Canada, our online recruitment strategy may have reduced our ability to make personal connections with potential participants, thereby negatively influencing recruitment.

Onsite recruitment (e.g., potential participants are approached by an onsite researcher during their routine clinic visits or clinic staff ("site champion") across participating sites providing recruitment letters to potential participants) tends to yield higher recruitment rates than online outlets [49,51]. However, we could not recruit onsite due to restrictions to in-person clinic visits during the COVID-19 lockdown. Going forward, we will revisit our original plan to recruit through local MS clinics in Canada. Here, we plan to incorporate strategies recommended by Sygna et al. [49], and Whitlatch et al. [51], (e.g., having a "clinical site champion" who would ensure internal commitment and support the research team to meet the recruitment goals). We will also consider peer-to-peer participant recruitment strategies by leveraging study ambassadors who can share their positive experiences participating in this pilot study with their peers. In addition, we will increase efforts to develop new connections and strengthen existing partnerships with support organizations that provide services for people with MS and/or their care-partners. Consideration will be given to using survey panels (e.g., Qualtrics Panel or Survey Sampling International) for recruitment. Such panels have been successfully used in previous behavioural intervention research [54]. We believe that a multi-site and multi-pronged strategy, ideally with solid partnerships, will provide a significant opportunity to optimize community-based and clinic recruitment [55,56].

Retention: Our retention rate was 80%, comparable to previous PA studies in MS and dyads with other chronic health conditions [57,58]. Of note, modifying assessment procedures, wherein participants completed surveys online, and were sent accelerometers via postal services, may have been more convenient, thus promoting retention. Other common strategies, such as financial incentives and schedule flexibility, were also included in this pilot study to encourage retention.

Safety: There were no serious AEs related to PAT-MS. Two participants reported mild AEs non-related to the intervention over the 12-week study period. The overall rate, severity and characteristics of both AEs reported in this study are consistent with findings from exercise interventions for persons with MS [59]. This finding suggests that PAT-MS is safe for people with advanced MS and their care-partners.

Participant satisfaction: Most participants were satisfied with the intervention content, facilitator, and delivery method. Given that people with MS and their care-partners, as well as health and social care providers, were involved in identifying, prioritizing and refining key content, delivery, and practical/logistical aspects of PAT-MS [42], this finding is not surprising and highlights the importance of a patient-informed approach to intervention development [60].

Participant adherence: Participant adherence to PAT-MS was slightly higher than other PA interventions in the chronic disease [61] and aging [62] literature, where 77% adherence, regardless of condition, has been reported. Beyond apparent condition-specific differences across studies, there are at least three possible reasons for the higher adherence rates in the current study. First, the dyadic nature of PAT-MS may have influenced adherence. We know that care-recipient care-partner dyads participating in behavioural PA interventions support one another (increasing perception of social support) [63] and hold one another accountable (increasing intervention adherence) [64–66], while implementing behaviour changes [65–67]. Second, we incorporated several theoretically-grounded strategies (e.g., freedom to select an enjoyable activity and set own goals for increasing participation, support in engaging in chosen activity with advice and encouragement by a trained facilitator) reported to promote participant adherence in behavioural PA interventions for persons with disabilities [68–71]. Finally, restrictions in other activities or areas of life during the COVID-19 pandemic may have increased participant adherence to PAT-MS. The disruption to activities, reduced access to services, and subsequent concerns about physical and mental health deterioration due to reduced PA among persons with MS and their care-partners [72,73] support this possibility.

Treatment effect: Exploration of within-group effect sizes demonstrated improvement in self-reported and objective PA (moderate to large effect sizes) from baseline to post-intervention in the intervention condition. Thus, PAT-MS may be beneficial for reducing sedentary behaviour and increasing moderate-to-vigorous PA and steps/day in people with advanced MS and their care-partners. This finding is important, given recent survey data indicating an overall global reduction in PA during the pandemic among people with MS, particularly those with advanced disability [73]. Specifically, among 3725 survey respondents across 11 countries, about 60% met MS guidelines for PA before the pandemic (mild disability: 64.43%; moderate disability: 51.53%; advanced disability: 39.34%). During the pandemic, a ~10% reduction in PA in all disability groups (mild disability: 54.76%; moderate disability: 42.47%; advanced disability: 29.48%) was noted. These data further support the efficacy of PAT-MS in this population, particularly in the post-COVID-19 pandemic era. However, given the small sample size (n = 16 completed this study), our findings should be considered exploratory.

4.1. Limitations

The present study had some limitations. First, because of the COVID-19 pandemic, our sample size was smaller than initially planned. Replicating our analyses in a larger sample may be necessary. Second, we did not collect data on the race and/or ethnicity of our sample, which, in addition to our small sample size, limits our ability to examine the extent to which MS dyads from different racial and ethnic backgrounds respond and/or adhere to PAT-MS. In addition, the online

delivery approach may have made it difficult for older people or those less familiar with e-health interventions to participate, which may have introduced a bias. Finally, given the restrictions to in-person clinic visits, we were unable to obtain physician-confirmed MS phenotype and disease severity, and captured this information through self-report. Thus, we must acknowledge the inherent bias that is introduced with the use of self-reported data.

5. Conclusion

We conducted a randomized controlled feasibility trial of PAT-MS, the first dyadic behavioural intervention aimed at promoting PA in persons with advanced MS and their care-partners. This trial provided valuable information for the design of future studies and further development of PAT-MS. A subsequent RCT will amend the intervention, trial design and processes according to findings from this feasibility trial, and allow us to test proposed methodologies and lessons learned.

Funding

This work was supported through a Consortium of Multiple Sclerosis Centres Pilot Grant (to Fakolade, Finlayson, Freedman and Pilutti). Fakolade's time on this project was supported by a Post-doctoral Fellowship Award (EGID 3277) from Multiple Sclerosis Canada (formerly Multiple Sclerosis Society of Canada). The statements in this work are solely the responsibility of the authors and do not necessarily reflect the position, ideas, or opinions of the Consortium of Multiple Sclerosis Centres or Multiple Sclerosis Canada.

Authors' contributions

Afolasade Fakolade: Conceptualization, Methodology, Funding acquisition, Writing – original draft, Writing – review and editing. **Zain Awadia:** Investigation, Data curation, Formal analysis, Writing – review and editing. **Katherine Cardwell:** Investigation, Data curation, Formal analysis, Visualization, Writing – review and editing. **Odessa McKenna**: Investigation, Writing – review and editing. **Myriam Venasse:** Project administration, Writing – review and editing. **Taylor Hume:** Investigation, Data curation, Writing – review and editing. **Julia Ludgate:** Investigation, Data curation, Writing – review and editing. **Mark Freedman:** Conceptualization, Methodology, Funding acquisition, Writing – review and editing. **Marcia Finlayson:** Conceptualization, Methodology, Funding acquisition, Writing – review and editing. **Amy Latimer-Cheung:** Conceptualization, Methodology, Writing – review and editing, Supervision. **Lara Pilutti:** Conceptualization, Methodology, Funding acquisition, Writing – review and editing, Project administration, Supervision.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data will be made available on request.

Acknowledgements

We thank the people with MS and their care-partners for their participation. We also thank Rebecca Cooney, Carol J. Farran, and Joanne Lambley for their contribution to developing the PAT-MS intervention manual.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.conctc.2023.101222.

References

[1] P. Browne, D. Chandraratna, C. Angood, H. Tremlett, C. Baker, B.V. Taylor, A. J. Thompson, Atlas of multiple sclerosis 2013: a growing global problem with widespread inequity, Neurology 83 (11) (2014) 1022–1024.
[2] C. Walton, R. King, L. Rechtman, W. Kaye, E. Leray, R.A. Marrie, N. Robertson, N. La Rocca, B. Uitdehaag, I. van der Mei, Rising prevalence of multiple sclerosis worldwide: insights from the Atlas of MS, Multiple Sclerosis J. 26 (14) (2020) 1816–1821.
[3] N. Amankwah, R.A. Marrie, C. Bancej, R. Garner, D.G. Manuel, R. Wall, P. Finès, J. Bernier, K. Tu, K. Reimer, Multiple sclerosis in Canada 2011 to 2031: results of a microsimulation modelling study of epidemiological and economic impacts, Chronic Diseas. Injuries in Canada 37 (2) (2017) 37–48.
[4] J. Kesselring, S. Beer, Symptomatic therapy and neurorehabilitation in multiple sclerosis, Lancet Neurol. 4 (10) (2005) 643–652.
[5] H. Tremlett, D. Paty, V. Devonshire, Disability progression in multiple sclerosis is slower than previously reported, Neurology 66 (2) (2006) 172–177.
[6] N.G. LaRocca, Impact of walking impairment in multiple sclerosis, Patient: Patient-Centered Outcomes Res 4 (3) (2011) 189–201.
[7] B.S. Giesser, Primer on Multiple Sclerosis, Oxford University Press, 2016.
[8] L. Hillman, Caregiving in multiple sclerosis, Phys. Med. Rehabil. Clin 24 (4) (2013) 619–627.
[9] K.I. Pakenham, Benefit finding in multiple sclerosis and associations with positive and negative outcomes, Health Psychol. 24 (2) (2005) 123–132.
[10] O. McKenna, A. Fakolade, K. Cardwell, L.A. Pilutti, A continuum of languishing to flourishing: exploring experiences of psychological resilience in multiple sclerosis family caregivers, Int. J. Qual. Stud. Health Well-Being 17 (1) (2022), 2135480.
[11] S. Gupta, A. Goren, A.L. Phillips, M. Stewart, Self-reported burden among caregivers of patients with multiple sclerosis, Int. J. MS Care 14 (4) (2012) 179–187.
[12] K. Cardwell, O. McKenna, J. Steffener, L. Pilutti, A. Fakolade, Profiles of resilience in multiple sclerosis family care-partners: a Canadian cross-sectional study, Multiple Sclerosis J.–Experiment., Translat. Clinic. 8 (4) (2022), 20552173221138935.
[13] Q. Li, A.Y. Loke, A literature review on the mutual impact of the spousal caregiver–cancer patients dyads:'communication','reciprocal influence', and 'caregiver–patient congruence', Eur. J. Oncol. Nurs. 18 (1) (2014) 58–65.
[14] D. Appleton, N. Robertson, L. Mitchell, R. Lesley, Our disease: a qualitative meta-synthesis of the experiences of spousal/partner caregivers of people with multiple sclerosis, Scand. J. Caring Sci. 32 (4) (2018) 1262–1278.
[15] P. Schulz, L. Zimmerman, P. Johansson, M. Hertzog, S. Barnason, Physical activity patterns in rural-residing spousal caregivers and cardiac surgery patients in the first 6 months post-surgery, Online J. Rural Nurs. Health Care 14 (2) (2014) 123–144.
[16] K.M. Godwin, P.R. Swank, P. Vaeth, S.K. Ostwald, The longitudinal and dyadic effects of mutuality on perceived stress for stroke survivors and their spousal caregivers, Aging Ment. Health 17 (4) (2013) 423–431.
[17] M.E. Ware, K.K. McCully, Impact of marriage on physical activity behavior in women with multiple sclerosis, Disabil. Rehabil. 40 (20) (2021) 5941–5949.
[18] E. Arden-Close, N. McGrath, Health behaviour change interventions for couples: a systematic review, Br. J. Health Psychol. 22 (2) (2017) 215–237.
[19] S. Nizamani, R. McFarlane, C.R. Knight-Agarwal, S. Somerset, Couples-based Behaviour Change Interventions to Reduce Metabolic Syndrome Risk. A Systematic Review, Diabetes & Metabolic Syndrome: Clinical Research & Reviews, 2022, 102662.
[20] A. Fakolade, M. Finlayson, T. Parsons, A. Latimer-Cheung, Correlating the physical activity patterns of people with moderate to severe multiple sclerosis disability and their family caregivers, Physiother. Can. 70 (4) (2018) 373–381.
[21] R.M. Carr, A. Prestwich, D. Kwasnicka, C. Thøgersen-Ntoumani, D.F. Gucciardi, E. Quested, L.H. Hall, N. Ntoumanis, Dyadic interventions to promote physical activity and reduce sedentary behaviour: systematic review and meta-analysis, Health Psychol. Rev. 13 (1) (2019) 91–109.
[22] F.J. Keefe, J. Blumenthal, D. Baucom, G. Affleck, R. Waugh, D.S. Caldwell, P. Beaupre, S. Kashikar-Zuck, K. Wright, J. Egert, Effects of spouse-assisted coping skills training and exercise training in patients with osteoarthritic knee pain: a randomized controlled study, Pain 110 (3) (2004) 539–549.
[23] A.-E. Prick, J. de Lange, E. Scherder, J. Twisk, A.M. Pot, The effects of a multicomponent dyadic intervention on the mood, behavior, and physical health of people with dementia: a randomized controlled trial, Clin. Interv. Aging 11 (2016) 383–395.
[24] A.-E. Prick, J. de Lange, J. Twisk, A.M. Pot, The effects of a multi-component dyadic intervention on the psychological distress of family caregivers providing care to people with dementia: a randomized controlled trial, Int. Psychogeriatr. 27 (12) (2015) 2031–2044.
[25] A.P. Canonici, L.P.d. Andrade, S. Gobbi, R.F. Santos-Galduroz, L.T.B. Gobbi, F. Stella, Functional dependence and caregiver burden in Alzheimer's disease: a controlled trial on the benefits of motor intervention, Psychogeriatrics 12 (3) (2012) 186–192.

[26] D. Lowery, A. Cerga-Pashoja, S. Iliffe, I. Thuné-Boyle, M. Griffin, J. Lee, A. Bailey, R. Bhattacharya, J. Warner, The effect of exercise on behavioural and psychological symptoms of dementia: the EVIDEM-E randomised controlled clinical trial, Int. J. Geriatr. Psychiatr. 29 (8) (2014) 819–827.
[27] A. Fakolade, A.J. Walters, J. Cameron, A.E. Latimer-Cheung, L.A. Pilutti, Healthy together: a systematic review of theory and techniques used in health interventions for persons with chronic neurological conditions and their caregivers, Patient Educ. Counsel. 103 (4) (2020) 788–803.
[28] A. Fakolade, J. Lamarre, A. Latimer-Cheung, T. Parsons, S.A. Morrow, M. Finlayson, Understanding leisure-time physical activity: voices of people with MS who have moderate-to-severe disability and their family caregivers, Health Expect. 21 (1) (2018) 181–191.
[29] K. Skivington, L. Matthews, S.A. Simpson, P. Craig, J. Baird, J.M. Blazeby, K. A. Boyd, N. Craig, D.P. French, E. McIntosh, A new framework for developing and evaluating complex interventions: update of Medical Research Council guidance, BMJ 374 (Sep 30) (2021), 374:n2061, https://doi.org/10.1136/bmj.n2061.
[30] N. Bleijenberg, M. Janneke, J.C. Trappenburg, R.G. Ettema, C.G. Sino, N. Heim, T. B. Hafsteindóttir, D.A. Richards, M.J. Schuurmans, Increasing value and reducing waste by optimizing the development of complex interventions: enriching the development phase of the Medical Research Council (MRC) Framework, Int. J. Nurs. Stud. 79 (2018) 86–93.
[31] A. O'Cathain, L. Croot, E. Duncan, N. Rousseau, K. Sworn, K.M. Turner, L. Yardley, P. Hoddinott, Guidance on how to develop complex interventions to improve health and healthcare, BMJ Open 9 (8) (2019), e029954.
[32] E. Toomey, S.B. Coote, Physical rehabilitation interventions in nonambulatory people with multiple sclerosis: a systematic review, Int. J. Rehabil. Res. 35 (4) (2012) 281–291.
[33] L. Thabane, J. Ma, R. Chu, J. Cheng, A. Ismaila, L. Rios, R. Robson, M. Thabane, L. Giangregorio, C. Goldsmith, A tutorial on pilot studies: the what, why and how, BMC Med. Res. Methodol. 6 (10) (2010) 1, https://doi.org/10.1186/1471-2288-10-1.
[34] L. Tickle-Degnen, Nuts and bolts of conducting feasibility studies, Am. J. Occup. Ther. 67 (2) (2013) 171–176.
[35] Y.C. Learmonth, R.W. Motl, Important considerations for feasibility studies in physical activity research involving persons with multiple sclerosis: a scoping systematic review and case study, Pilot and Feasibil. Studies 4 (1) (2017) 1.
[36] A. Fakolade, J. Cameron, O. McKenna, M.L. Finlayson, M.S. Freedman, A. E. Latimer-Cheung, L.A. Pilutti, Physical activity together for people with multiple sclerosis and their care partners: protocol for a feasibility randomized controlled trial of a dyadic intervention, JMIR Res. Protocols 10 (6) (2021), e18410.
[37] A.M. Orkin, P.J. Gill, D. Ghersi, L. Campbell, J. Sugarman, R. Emsley, P.G. Steg, C. Weijer, J. Simes, T. Rombey, H.C. Williams, J. Wittes, D. Moher, D.P. Richards, Y. Kasamon, K. Getz, S. Hopewell, K. Dickersin, T. Wu, A.P. Ayala, K.F. Schulz, S. Calleja, I. Boutron, J.S. Ross, R.M. Golub, K.M. Khan, C. Mulrow, N. Siegfried, J. Heber, N. Lee, P.R. Kearney, R.K. Wanyenze, A. Hróbjartsson, R. Williams, N. Bhandari, P. Jüni, A.-W. Chan, A.M. Orkin, P.J. Gill, D. Ghersi, L. Campbell, J. Sugarman, R. Emsley, P.G. Steg, C. Weijer, J. Simes, T. Rombey, H.C. Williams, J. Wittes, D. Moher, D.P. Richards, Y. Kasamon, K. Getz, S. Hopewell, K. Dickersin, T. Wu, A.P. Ayala, K.F. Schulz, S. Calleja, I. Boutron, J.S. Ross, R.M. Golub, K. M. Khan, C. Mulrow, N. Siegfried, J. Heber, N. Lee, P.R. Kearney, R.K. Wanyenze, A. Hróbjartsson, R. Williams, N. Bhandari, P. Jüni, A.-W. Chan, V. Kiermer, J. Corrigan-Curay, J. Concato, Guidelines for reporting trial protocols and completed trials modified due to the COVID-19 pandemic and other extenuating circumstances, JAMA 326 (3) (2021) 257.
[38] S.M. Eldridge, C.L. Chan, M.J. Campbell, C.M. Bond, S. Hopewell, L. Thabane, G. A. Lancaster, CONSORT 2010 statement: extension to randomised pilot and feasibility trials, Pilot and feasibility studies 2 (1) (2016) 64.
[39] M.A. Hertzog, Considerations in determining sample size for pilot studies, Res. Nurs. Health 31 (2) (2008) 180–191.
[40] R.H. Browne, On the use of a pilot sample for sample size determination, Stat. Med. 14 (17) (1995) 1933–1940.
[41] T. Edwards, L.A. Pilutti, The effect of exercise training in adults with multiple sclerosis with severe mobility disability: a systematic review and future research directions, Multiple Sclerosis Relat. Disorder. 16 (2017) 31–39.
[42] A. Fakolade, O. McKenna, R. Kamel, M.S. Freedman, M. Finlayson, A.E. Latimer-Cheung, L.A. Pilutti, Prioritizing components of a dyadic physical activity intervention for people with moderate to severe multiple sclerosis and their care partners: a modified e-delphi study, Int. J. MS Care 25 (1) (2023) 8–14.
[43] US Department of Health and Human Services, Common Terminology Criteria for Adverse Events (CTCAE) Version 5.0, Natl Inst Health Natl Cancer Inst, 2017.
[44] D. Wong, N. Grace, K. Baker, G. McMahon, Measuring Clinical Competencies in Facilitating Group-Based Rehabilitation Interventions: Development of a New Competency Checklist, Clinical rehabilitation, 2019, 0269215519831048.
[45] A.J. Bellg, B. Borrelli, B. Resnick, J. Hecht, D.S. Minicucci, M. Ory, G. Ogedegbe, D. Orwig, D. Ernst, S. Czajkowski, Enhancing treatment fidelity in health behavior change studies: best practices and recommendations from the NIH Behavior Change Consortium, Health Psychol. 23 (5) (2004) 443–451.
[46] G. Godin, R. Shephard, Godin leisure-time exercise questionnaire, Med. Sci. Sports Exerc. 29 (1997) 36–38.
[47] K.N.L. Avery, P.R. Williamson, C. Gamble, E. O'Connell Francischetto, C. Metcalfe, P. Davidson, H. Williams, J.M. Blazeby, Informing efficient randomised controlled trials: exploration of challenges in developing progression criteria for internal pilot studies, BMJ Open 7 (2) (2017), e013537.
[48] J. Cohen, Statistical power analysis for the behavioral sciences, Routledge (2013).
[49] K. Sygna, S. Johansen, C.M. Ruland, Recruitment challenges in clinical research including cancer patients and caregivers, Trials 16 (1) (2015).
[50] C. Quinn, S.B. Dunbar, P.C. Clark, O.L. Strickland, Challenges and strategies of dyad research: cardiovascular examples, Appl. Nurs. Res. 23 (2) (2010) e15–e20.
[51] C.J. Whitlatch, S. Orsulic-Jeras, J. Johnson, Challenges to and strategies for recruiting chronic care dyads into intervention research, Chron. Illness 17 (3) (2021) 232–241.
[52] S.M. Szabo, C.J. Whitlatch, S. Orsulic-Jeras, J.D. Johnson, Recruitment challenges and strategies: lessons learned from an early-stage dyadic intervention (innovative practice), Dementia 17 (5) (2018) 621–626.
[53] C.D. Etkin, C.J. Farran, L.L. Barnes, R.C. Shah, Recruitment and enrollment of caregivers for a lifestyle physical activity clinical trial, Res. Nurs. Health 35 (1) (2012) 70–81.
[54] N.L. Watson, K.E. Mull, J.L. Heffner, J.B. McClure, J.B. Bricker, Participant recruitment and retention in remote eHealth intervention trials: methods and lessons learned from a large randomized controlled trial of two web-based smoking interventions, J. Med. Internet Res. 20 (8) (2018), e10351.
[55] L. Brkic, L. Shaw, F. Van Wijck, R. Francis, C. Price, A. Forster, P. Langhorne, C. Watkins, H. Rodgers, Repetitive arm functional tasks after stroke (RAFTAS): a pilot randomised controlled trial, Pilot and Feasibil. Studies 2 (1) (2016).
[56] R.H. Da-Silva, S.A. Moore, H. Rodgers, L. Shaw, L. Sutcliffe, F. van Wijck, C.I. Price, Wristband Accelerometers to motiVate arm Exercises after Stroke (WAVES): a pilot randomized controlled trial, Clin. Rehabil. 33 (8) (2019) 1391–1403.
[57] D. Kinnett-Hopkins, R. Motl, Results of a feasibility study of a patient informed, racially tailored home-based exercise program for black persons with multiple sclerosis, Contemp. Clin. Trials 75 (2018) 1–8.
[58] S. Bannon, E.G. Lester, M.V. Gates, J. McCurley, A. Lin, J. Rosand, A.-M. Vranceanu, Recovering together: building resiliency in dyads of stroke patients and their caregivers at risk for chronic emotional distress; a feasibility study, Pilot and Feasibil. Studies 6 (1) (2020).
[59] L.A. Pilutti, M.E. Platta, R.W. Motl, A.E. Latimer-Cheung, The safety of exercise training in multiple sclerosis: a systematic review, J. Neurol. Sci. 343 (1–2) (2014) 3–7.
[60] B. Bonevski, M. Randell, C. Paul, K. Chapman, L. Twyman, J. Bryant, I. Brozek, C. Hughes, Reaching the hard-to-reach: a systematic review of strategies for improving health and medical research with socially disadvantaged groups, BMC Med. Res. Methodol. 14 (1) (2014) 1–29.
[61] T. Bullard, M. Ji, R. An, L. Trinh, M. Mackenzie, S.P. Mullen, A systematic review and meta-analysis of adherence to physical activity interventions among three chronic conditions: cancer, cardiovascular disease, and diabetes, BMC Publ. Health 19 (1) (2019).
[62] K.A. Martin, A.R. Sinden, Who will stay and who will go? A review of older adults' adherence to randomized controlled trials of exercise, J. Aging Phys. Activ 9 (2) (2001) 91–114.
[63] T. Badger, C. Segrin, S.M. Dorros, P. Meek, A.M. Lopez, Depression and anxiety in women with breast cancer and their partners, Nurs. Res. 56 (1) (2007) 44–53.
[64] L.L. Northouse, D.W. Mood, A. Schafenacker, J.E. Montie, H.M. Sandler, J. D. Forman, M. Hussain, K.J. Pienta, D.C. Smith, T. Kershaw, Randomized clinical trial of a family intervention for prostate cancer patients and their spouses, Cancer, Interdiscipl. Int. J. Am. Cancer Soci. 110 (12) (2007) 2809–2818.
[65] H. Badr, C. Yeung, M.A. Lewis, K. Milbury, W.H. Redd, An observational study of social control, mood, and self-efficacy in couples during treatment for head and neck cancer, Psychol. Health 30 (7) (2015) 783–802.
[66] M.A. Lewis, R.M. Butterfield, Antecedents and reactions to health-related social control, Pers. Soc. Psychol. Bull. 31 (3) (2005) 416–427.
[67] M.A. Lewis, K.S. Rook, Social control in personal relationships: impact on health behaviors and psychological distress, Health Psychol. 18 (1) (1999) 63.
[68] L.A. Hale, C. Smith, H. Mulligan, G.J. Treharne, "Tell me what you want, what you really really want….": asking people with multiple sclerosis about enhancing their participation in physical activity, Disabil. Rehabil. 34 (22) (2012) 1887–1893.
[69] C.J. Farran, C.D. Etkin, A. Eisenstein, O. Paun, K.B. Rajan, C.M.C. Sweet, J. J. McCann, L.L. Barnes, R.C. Shah, D.A. Evans, Effect of moderate to vigorous physical activity intervention on improving dementia family caregiver physical function: a Randomized controlled trial, J. Alzheimer's Dis. Park. 6 (4) (2016) 253–262.
[70] Y.C. Learmonth, D. Kinnett-Hopkins, R.W. Motl, Capitalising on the opinions of persons with multiple sclerosis to inform the main trial–participant opinions from participation in a feasibility study, a qualitative extension study, Disabil. Rehabil. 41 (25) (2019) 3071–3078.
[71] T.L. Williams, J.K. Ma, K.A. Martin Ginis, Participant experiences and perceptions of physical activity-enhancing interventions for people with physical impairments and mobility limitations: a meta-synthesis of qualitative research evidence, Health Psychol. Rev. 11 (2) (2017) 179–196.
[72] H. Correia, P. Martin-Lynch, M. Finlayson, Y.C. Learmonth, Exploring COVID-19 experiences for persons with multiple sclerosis and carers: an Australian qualitative study, Health Expect. 26 (2) (2023) 785–794.
[73] L. Pedullà, C. Santoyo-Medina, K. Novotna, L. Moumdjian, T. Smedal, E.C. Arntzen, M.L. van der Linden, Y. Learmonth, A. Kalron, F. Güngör, U. Nedeljkovic, D. Kos, J. Jonsdottir, S. Coote, A. Tacchino, Physical activity in multiple sclerosis: meeting the guidelines at the time of the COVID-19 pandemic, J. Neurol. Phys. Ther. (2023), https://doi.org/10.1097/NPT.0000000000000430.