Journal of Physiotherapy 63 (2017) 94–100

Journal of PHYSIOTHERAPY

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

Research

A home program of strength training, movement strategy training and education did not prevent falls in people with Parkinson's disease: a randomised trial

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KEY WORDS

Parkinson's disease
Rehabilitation
Randomised trial
Physical therapy
Falls

ABSTRACT

Questions: For people with idiopathic Parkinson's disease, does a 6-week, comprehensive, home exercise program reduce falls and disability and improve health-related quality of life? Is the program cost-effective? **Design**: Randomised, controlled trial with concealed allocation and assessor blinding. **Participants**: One hundred and thirty-three community-dwelling adults with Parkinson's disease. **Intervention**: The experimental group completed a 6-week home program comprising progressive resistance strength training, movement strategy training and falls education. The control group completed 6 weeks of non-specific life skills training. Participants in both groups received weekly therapist-guided sessions for 6 consecutive weeks and a weekly self-directed home program. **Outcome measures**: The primary outcome was the rate of falls, documented for the 12-month period immediately after therapy. Secondary outcomes were disability and health-related quality of life, assessed before and after intervention and at a 12-month follow-up. **Results**: A total of 2255 falls were reported by the 12-month follow-up. The proportion of fallers in the experimental and control groups was 61 and 72%, respectively, which was not statistically significantly different (RR = 0.85, 95% CI 0.66 to 1.09). There was no significant between-group difference in the rate of falls (incidence rate ratio = 1.58, 95% CI 0.73 to 3.43). A survival analysis of participant time to first fall did not show a significant between-group difference (log-rank test $\chi^2 = 0.79$, $p = 0.37$). No significant between-group differences occurred for mobility, disability or quality of life. The mean cost of delivering the experimental intervention was AUD1596. **Conclusion**: A home program of strength and movement strategy training and falls education does not prevent falls when applied at the dose used in this study. Arguably, the dosage of therapy was insufficient. Future trials need to explore further therapy content, repetitions and duration, in order to optimise outcomes and cost-effectiveness. **[Morris ME, Taylor NF, Watts JJ, Evans A, Horne M, Kempster P, Danoudis M, McGinley J, Martin C, Menz HB (2017) A home program of strength training, movement strategy training and education did not prevent falls in people with Parkinson's disease: a randomised trial. *Journal of Physiotherapy* 63: 94–100]**

Introduction

Falls and movement disorders are both common and disabling in people living with idiopathic Parkinson's disease.[1,2] Over 60% of people with Parkinson's disease are predicted to fall at least once annually, and 50% are expected to have recurrent falls.[3,4] Falls lead to a loss of independence, reduced quality of life, and increases in morbidity, mortality, need for supported care, and care-giver burden.[1,5,6] The financial costs of falls are also substantial.[7] The annual direct costs of medical care for people with Parkinson's disease in the USA was USD12 164 higher than matched controls,[8] with falls being identified as a substantial contributor to increased costs.

Physiotherapy for people with Parkinson's disease aims to keep them moving, prevent falls, and enable them to remain living at home safely for as long as possible.[9–12] Pharmacological management of symptoms coupled with movement rehabilitation have shown promise for reducing falls and improving mobility.[9–17] Hospital and outpatient trials have reported positive effects for movement rehabilitation strategies such as cueing,[18] cognitive strategies that focus attention and avoid dual task interference[19] and progressive resistance strength training.[20] Despite this, exercises and movement rehabilitation therapy have received limited attention in the published literature.[4,11] This randomised, controlled trial aimed to compare the efficacy of an integrated physiotherapy exercise and rehabilitation program delivered in the

http://dx.doi.org/10.1016/j.jphys.2017.02.015

home with a placebo control group that received a non-specific life skills home-based program. The exercise program consisted of movement strategy training based on studies by Morris and Iansek,[18,21] progressive resistance strength training, and education on falls prevention and mobility. An integrated fall prevention program combining strengthening, cueing and education was provided, given the accumulating evidence for these interventions for Parkinson's disease.[11,18,19] The program was home based, so that participants would not have to travel and would presumably feel comfortable in their own premises.

Therefore, the research questions for this randomised, controlled trial were:

1. For people with idiopathic Parkinson's disease, does a 6-week, comprehensive, home exercise program reduce falls and disability and improve health-related quality of life?
2. Is the program cost-effective?

Method

Design

A randomised, controlled trial with concealed allocation, assessor blinding and intention-to-treat analysis was conducted in the Melbourne metropolitan region, Australia. A study protocol with more detailed eligibility criteria and intervention descriptions was previously published.[22] Blinded assessors who were registered physiotherapists performed all of the assessments.

Participants, therapists, centres

A total of 143 participants were assessed for eligibility and 133 were randomised into the study. Inclusion criteria were: idiopathic Parkinson's disease confirmed by a neurologist, modified Hoehn and Yahr (1967) stage $\leq$ IV,[23] Mini Mental State Examination score $\geq$ 24,[24] and community dwelling. Exclusion criteria were: other health conditions that preclude safe participation in the exercise program, insufficient English to follow instructions, and unwillingness to be assessed and treated at home. Eligible participants were randomly allocated to either the experimental group or the control group. Randomisation was stratified according to referral source, and performed by an independent entity using a computerised random number generator.

Intervention

Experimental group

The 6-week program included a weekly 60-minute individualised session delivered in the participant's home, supervised by a qualified and trained therapist who was guided by a physiotherapist. A physiotherapist also prescribed a weekly 60-minute unsupervised session via pre-printed, individualised worksheets that were explained to the participant by the treating therapist. Thus, the total dosage of therapy each week was 120 minutes for each of the 6 weeks.

People with Parkinson's disease are often very de-conditioned. Healthy adults typically receive up to 8 weeks of twice-weekly training to obtain strength gains. At the time of the trial design, 6 weeks of twice-weekly therapy was argued to be adequate for people with neurological impairments such as those with Parkinson's disease.[25,26] A position statement by the American Heart Association advised that 6-week interventions increased strength and endurance in people with cardiovascular problems.[27] The American College of Sports Medicine had similar advice with regards to progressive models of resistance training for healthy adults > 60 years of age.[28] Moreover, a 6-week home program was thought to be feasible for people with Parkinson's disease.

The experimental program comprised three individualised components: progressive resistance strength training, movement strategy training, and education about methods with which to prevent falls. When the allocated 60-minute session was insufficient to complete all activities, the strength-training component was prioritised. The unsupervised sessions repeated activities from the therapist-guided sessions, with modifications made for specific individual needs or safety. To evaluate adherence and compliance with the experimental intervention, each participant recorded the activities that were performed, as well as perceived exertion for each session (therapist-guided and unsupervised), on pre-printed forms. Participants were monitored for adverse events during the intervention and follow-up periods, and requested to report any muscle soreness or joint stiffness from previous sessions. If this occurred, they were also asked to report whether they required any health service due to the adverse event.

For the unsupervised sessions, participants received an information pack containing a booklet with illustrations and descriptions of exercises, and a Modified Rating of Perceived Exertion scale.[29] They also received an exercise log book, a document with answers to frequently asked questions on strength training, a booklet of falls prevention,[30] and a standard help sheet from Parkinson's Victoria, listing support and resources.

Progressive resistance strength training

The strength-training component of the experimental intervention focused on the major muscle groups that are essential for functional gait and balance (quadriceps, glutei, hip abductors, hamstrings, gastrocnemius, soleus and trunk muscles). Strength training of these muscles was incorporated within step-ups, heel raises, sit-to-stand movements, standing hip abduction exercises, and trunk extension and rotation exercises. The American College of Sports Medicine guidelines were used to develop the training protocols, to ensure that the training stimulus and progression of resistance were optimal.[28,31,32] At each session, the participant aimed to complete at least three different exercises, each performed for two sets of eight to 12 repetitions, with a 2-minute rest between sets. Participants were able to progressively increase resistance by using a weighted vest, a resistance band, weights, or by altering their starting positions. The therapists trained the participants to perform exercises safely and with correct form, and assisted them in using the Modified Rating of Perceived Exertion scale.[29]

Movement strategy training

The movement strategy training component of the experimental intervention was derived from previously established techniques for people with Parkinson's disease.[21,32] These included the use of visual, auditory, cognitive or proprioceptive cues and attentional strategies to facilitate the ability of participants to initiate and execute daily activities. Visual cues included the use of white markers on the floor to step over, as well as written instructions. Auditory cues included metronome cues and rhythmical cues from music. The activities selected for movement strategy training and their rate of progression were based on individual abilities, needs, the home environment, and caregiver support. The daily activities included: standing up and sitting down; moving from chair to chair; standing and reaching; walking; walking whilst carrying objects; turning; and bed mobility.

Falls education

The falls education component of the experimental intervention was based on a booklet published by the Commonwealth of Australia entitled *Don't Fall for It! Falls Can Be Prevented*.[30] The booklet is a guide for the prevention of falls in older people, and contains information and advice on aspects of falls and safety. Topics include: risk factors, keeping mobile, medication, vision, safety in the home, and feet and footwear. Each session of the experimental intervention reflected the booklet content, with particular emphasis put on material relevant to the individual.

Control group

The control group received a placebo intervention, which was a life skills program of equal length to the experimental intervention, and was delivered by trained allied health professionals, including occupational therapists, physiotherapists and speech pathologists. Weekly therapist contact times and self-directed homework sessions were of comparable length to the experimental group and consisted of guided education and discussion sessions on topics of interest that were selected by participants from a pre-defined syllabus. Available topics included relaxation, energy conservation, fatigue management, voice, communication, swallowing, diet, travel advice, and memory skills. None of the topics contained content related to physical activity, exercise, walking, or falls risk education. Participants in the control group were also provided with the standard help sheet from Parkinson's Victoria, and for ethical considerations, a generic falls information sheet.

Outcome measures

Primary outcome

The primary outcome measure was falls, defined as an unexpected event in which the participant comes to rest on the ground, floor or lower level.[33] All falls were monitored from the initial pre-intervention assessment until the follow-up assessment 12 months after the intervention, via monthly falls calendars returned via pre-paid mail. Each participant was required to record any falls incidents by marking the date on the calendar and indicating whether the fall was injurious (defined as any fall that required medical attention or healthcare utilisation). Telephone calls were made to remind participants to return their calendars and to investigate any injurious falls. Each injurious fall was followed up using a questionnaire to examine self-reported healthcare utilisation and out-of-pocket expenses.

Secondary outcomes

The secondary outcome measures were changes in motor disability and quality of life from the pre-intervention assessment to the post-intervention and 12-month follow-up assessments. Motor disability was scored using section III of the Movement Disorder Society Unified Parkinson's Disease Rating Scale (MDS-UPDRS).[34] The disease-specific Parkinson's Disease Questionnaire (PDQ-39)[35] was used to score quality of life, and the generic EuroQol-5D (EQ-5D-3L)[36] allowed quality of life comparisons with non-Parkinson's disease populations.[37] The EQ-5D-3L was converted to a single utility index using the UK adult weights,[38] which were based on the time trade-off method.

Economic evaluation

To determine the cost of the experimental intervention, the direct cost of implementing the experimental program was calculated, including the cost of travel, home visits, therapist training and equipment. The economic analysis assumed that the control group was a placebo intervention; therefore, no program delivery costs were attributed to the control group. A health system perspective was assumed, with the following outcomes of interest: number of falls prevented, injurious falls, and health-related quality of life.

Intention-to-treat analysis was undertaken. Costs were reported as 2016 Australian dollars (AUD), and unit costs from 2012 were inflated using the Australian Bureau of Statistics health inflation index. The questionnaire administered following an injurious fall included detail about medical, medical ancillary, diagnostic, and hospitalisation costs associated with falling events during the 12-month follow-up period. It was assumed that each person reporting an injurious fall would have a minimum of one visit to a general practitioner. Hospital activity costs were obtained from the National Hospital Cost Data Collection for 2012/2013. These included admitted same-day (average cost of a same-day admission), admitted overnight (average cost of an overnight admission), non-admitted emergency department, and sub-acute care. Unit costs for non-hospital services were based on the health service costs for fractures reported by Watts et al in the recent Osteoporosis Burden of Disease report.[39]

Data analysis

The primary outcome was analysed in several ways: the number of fallers during follow-up, the number of multiple fallers during follow-up, falls rate during follow-up, and time to first fall. A negative binomial regression model was used to compare the number of falls and the falls rate per person per year in the two groups, as this approach adjusts for varying durations of follow-up. Injurious falls were analysed using the same methods. Secondary outcome variables were compared between groups using analysis of covariance, with baseline scores and intervention group entered as independent variables.

Results

Flow of participants through the study

Of the 143 potential participants screened for eligibility, 10 were excluded and 133 were randomised (Figure 1). One patient in the experimental group and five in the control group did not receive interventions. The numbers who attended the 12-month assessment for testing of secondary outcomes were similar between groups, with 55 in the experimental group and 53 in the control group.

Baseline characteristics are reported in Table 1 and the groups appear to be well matched. The mean age of the 80 men and 53 women was 70.6 years (range 46 to 86). The majority of participants (66%) had mild Parkinson's disease, with a modified Hoehn and Yahr stage between I and II; 29% had moderate disease severity (stage III) and 5.3% severe disability (stage IV). More than half of the participants reported having had a fall in the previous 12 months. Freezing of gait was self-reported by 35% of the sample at baseline (taken from response to freezing of gait question of the UPDRS part II). All participants in the control group and all except three participants in the experimental group were taking medications specific to Parkinson's disease.

Falls during the 12-month follow-up

A total of 124 participants returned fall calendars after the intervention period: 64 in the experimental group and 60 from the control group. Table 2 summarises the data on fall rates. There

Table 1
Baseline characteristics of participants.

Characteristic	All (n = 133)	Exp (n = 67)	Con (n = 66)
Age *(yr)*, mean (SD)	71 (9)	71 (8)	71 (10)
Gender *(M:F)*, n (%)	80:53 (60:40)	45:22 (67:33)	35:31 (53:47)
MMSE *(0 to 30)*, mean (SD)	28.3 (1.6)	28.3 (1.5)	28.3 (1.8)
HY stage *(1 to 4)*, median (IQR)	2 (2 to 3)	2 (2 to 3)	2 (2 to 3)
HY stage *(1 to 4)*, n (%)			
1	13 (10)	7 (10)	6 (9)
2	73 (55)	40 (60)	33 (50)
3	38 (29)	16 (24)	22 (33)
4	7 (5)	4 (6)	3 (5)
Freezing of gait *(Y/N)*, n (%)[a]	46 (35)	25 (37)	21 (32)
Fallen in last year, n (%)	73 (55)	38 (57)	35 (53)
No PD medication, n (%)	3 (2)	3 (4)	0 (0)
Levodopa only, n (%)	68 (51)	32 (48)	36 (55)
Combination therapy, n (%)	58 (44)	32 (48)	26 (39)
Non-levodopa, n (%)	1 (1)	0 (0)	1 (2)
$\geq$ 4 prescription medications, n (%)	80 (60)	40 (60)	40 (61)
Psychotropic medications, n (%)	59 (44)	28 (42)	31 (47)

Con = control group, Exp = experimental group, F = female, HY = Modified Hoehn & Yahr scale, M = male, MMSE = Mini Mental State Exam, N = no, Y = yes, PD = Parkinson's disease.

[a] Taken from question 2.13 of Movement Disorders Society Unified Parkinson's Disease Rating Scale.

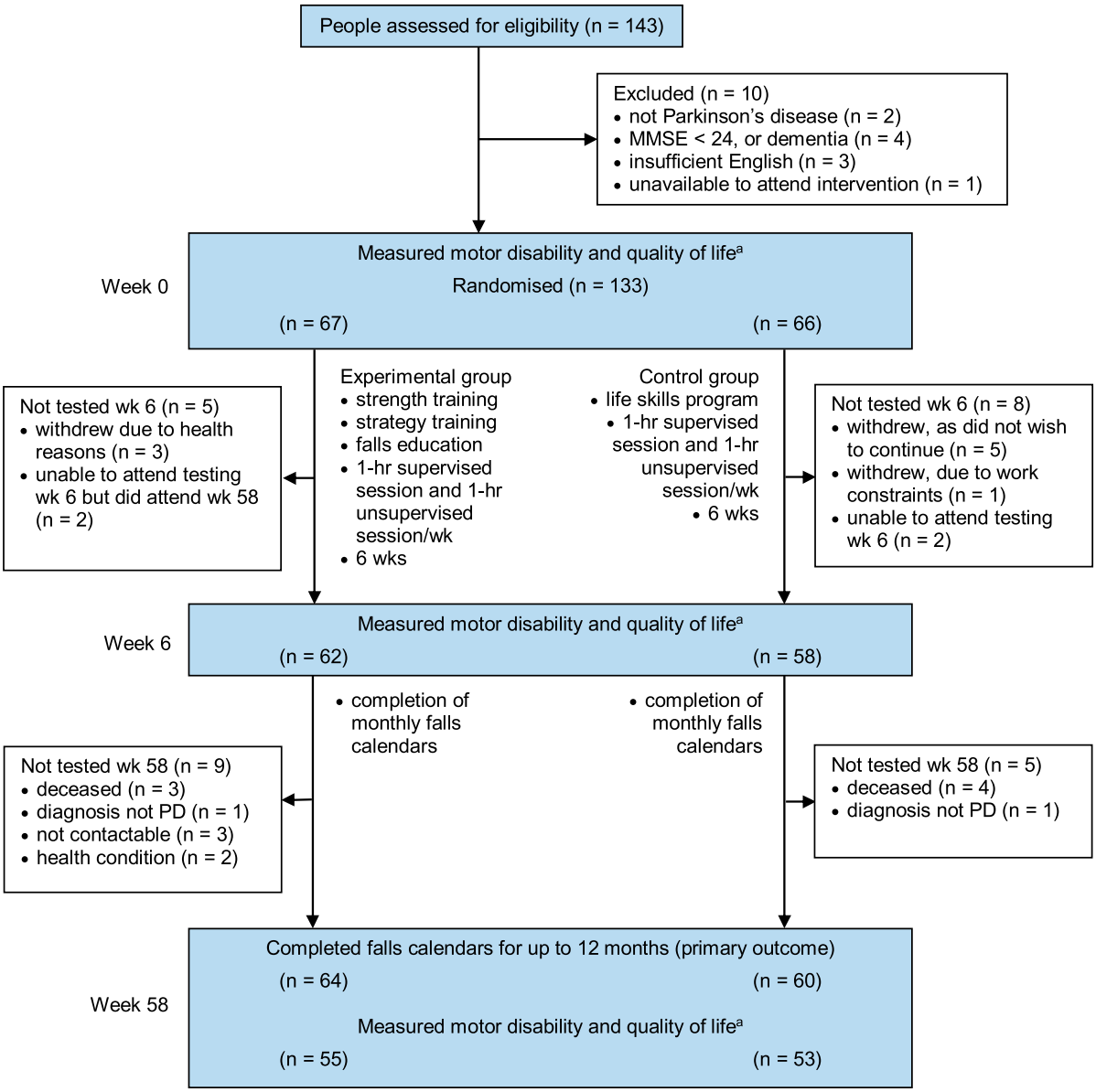

Figure 1. Design and flow of participants through the trial.
[a]Motor disability was measured with the Movement Disorders Society Unified Parkinson's Disease Rating Scale and quality of life was measured with the EuroQol-5D questionnaire and the Parkinson's Disease Questionnaire-39.
MMSE = Mini Mental State Examination, PD = Parkinson's disease.

were 2255 falls reported over the 12-month follow-up period: 1401 in the experimental group and 854 in the control group. In the experimental group, five participants reported > 100 falls over this period (range 176 to 275), compared with one participant in the control group, who reported 207 falls. There was no significant between-group difference in the rate of falls (incidence rate ratio [IRR] = 1.58, 95% CI 0.73 to 3.43). In the experimental group, 25 people did not fall and, in the control group, 17 did not fall.

There were 31 injurious falls. These were defined as a fall resulting in attendance to a health service, and were reported by 24 participants. There were eight injurious falls in the control group reported by eight participants and 23 injurious falls in the experimental group experienced by 16 participants. One participant in the experimental group reported five separate injurious falls. Detailed information was available from 22 participants for 27 of the injurious falls. Nine injurious falls resulted in a visit to a hospital, of which six then required at least a one-night stay in hospital. Seventeen participants consulted a general medical practitioner on 21 occasions following a fall. Three participants had a fracture due to a fall during the follow-up period: two from the experimental group and one from the control group. The affected sites included vertebrae, hip and ankle. The mean health service cost of an injurious fall was AUD1995 (SD 4097) and the median cost was AUD83. Amongst those who experienced an injurious fall, the mean cost of the injurious fall was lower in the experimental group compared with the control group; this difference was not significantly different (MD AUD3055, 95% CI −244 to 6355).

A survival analysis of participant time to first fall did not show any significant difference between the experimental and control groups (log-rank test $\chi^2 = 0.79$, $p = 0.37$) (Figure 2).

Changes in disability and health-related quality of life

Post-intervention measures of disability, as measured by the MDS-UPDRS (part I, II and III), and health-related quality of life (PDQ39, EuroQol VAS and EQ-5D-3L index score) are presented in Table 3. There were no significant between-group differences for the secondary outcome measures at the 12-month follow-up.

Economic analysis

The mean cost of delivering the intervention to participants in the experimental group was AUD1596 per person. The intention-to-treat analysis assumed that everyone completed the 6-week

Table 2
Number of falls and fallers in each group, and ratio of falls risk (95% CI) between groups.

Outcome measures	Exp (n=64)	Con (n=60)	Ratio of falls risk (95% CI)
All falls			
number of falls			1.58 (0.73 to 3.43) [a]
total	1401	854	
median (range)	1 (0 to 275)	1 (0 to 207)	
fallers, n (%)	39 (60.9)	43 (71.7)	0.85 (0.66 to 1.09) [b]
multiple fallers, n (%)	30 (46.9)	28 (46.7)	1.00 (0.68 to 1.45) [b]
Injurious falls			
number of falls			0.87 (0.24 to 3.10) [a]
total	23	8	
median (range)	0 (0 to 5)	0 (0 to 1)	
fallers, n (%)	16 (23.9)	8 (12.1)	1.97 (0.91 to 4.29) [b]
multiple fallers, n (%)	4 (6.0)	0 (0)	8.87 (0.49 to 161.52) [b]

[a] Incidence rate ratio.
[b] Relative risk.

program. The analysis included the costs of equipment, the training physiotherapists, travel, and treatment time in the home environment. The control group received placebo usual care; therefore, no program delivery costs were attributed to the control group. As there was no significant difference in outcomes between the experimental and control groups, an incremental cost-effectiveness ratio was not determined.

Compliance with the interventions

Regarding adherence, 66 participants in the experimental group and 61 in the control group attended one or more sessions. Adherence to the unsupervised sessions was high, with 62 of experimental group and 51 of control group participants receiving 5 to 6 weeks of therapy. Four participants in the experimental group and five in the control group attended three or fewer sessions. No adverse events related to the intervention were reported in the trial.

Discussion

This randomised trial found that 66% of people with Parkinson's disease experienced one or more falls during the testing period. There were no significant differences between groups in falls rates during the 12-month follow-up period after therapy. Similarly, there was little difference between groups at the 12-month follow-up for disability or health-related quality of life.

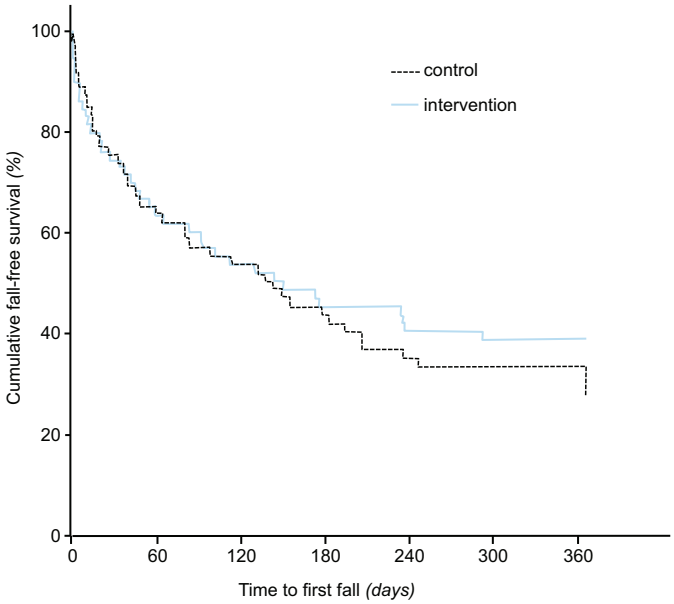

Figure 2. Kaplan-Meier survival curve showing time to first fall.

In relation to falls, the null findings of this placebo-controlled, randomised trial agree with several recent large clinical trials of movement rehabilitation, exercise therapy or physiotherapy for people with mild to moderately severe Parkinson's disease. For example, an Australian trial with 231 participants by Canning et al found that community-dwelling people with Parkinson's disease who received a 6-month home exercise program that included progressive resistance strength training and falls education had similar falls rates to those who received usual care.[40] Therapeutic exercises were performed for 40 to 60 minutes, three times a week, for 6 months. Likewise, a large cluster-randomised trial in the Netherlands with 699 participants reported similar falls rates and health outcomes in people with Parkinson's disease who received intensive community-based therapeutic exercises for 16 weeks compared to those who received standard care.[15] Goodwin et al conducted a pragmatic randomised trial in the UK, finding no difference in falls between those who received 10 weeks of therapy compared to usual care.[13] Likewise, the UK trial by Ashburn et al, with 142 participants, did not show significant differences in falls rates for those who received 6 weeks of physiotherapy compared to usual care.[4] A recent UK trial by Clarke et al reported that low-dose,

Table 3
Mean (SD) of groups and ANCOVA-adjusted mean difference (95% CI) between groups.

Outcome	Groups						ANCOVA-adjusted mean between-group difference (95% CI)
	Week 0		Week 6		Week 58		
	Exp (n=67)	Con (n=66)	Exp (n=62)	Con (n=58)	Exp (n=55)	Con (n=53)	Exp minus Con
UPDRS Part I non-motor aspects of experiences of daily living							
Questions 1.1 to 1.6 *(0 to 16)*	3.66 (3.27)	3.89 (3.84)	2.59 (2.45)	2.32 (2.56)	3.01 (2.59)	2.57 (3.31)	0.56 (−0.30 to 1.43)
Questions 1.7 to 1.13 *(0 to 28)*	8.04 (4.51)	7.57 (4.58)	6.91 (4.12)	7.07 (3.48)	7.65 (4.47)	7.32 (3.11)	0.45 (−0.82 to 1.72)
UPDRS Part II motor aspects of experiences of daily living *(0 to 61)*	15 (9)	16 (8)	13 (8)	15 (7)	14 (9)	16 (8)	1 (−1 to 3)
UPDRS Part III motor examination *(0 to 77)*	35 (15)	36 (15)	28 (14)	30 (13)	28 (13)	33 (15)	−2 (−7 to 2)
UPDRS Part IV motor complications *(0 to 24)*	4.00 (4.23)	3.37 (3.95)	3.81 (4.51)	3.85 (4.65)	3.70 (4.33)	3.52 (3.90)	−0.02 (−1.09 to 1.05)
PDQ-39 Summary Score Index *(0 to 100)*	23 (14)	24 (15)	21 (14)	20 (14)	22 (13)	22 (14)	1 (−2 to 5)
EQ-5D Visual Analogue Scale *(0 to 100)*	73 (15)	72 (16)	68 (15)	76 (12)	72 (17)	71 (14)	0 (−5 to 5)
EQ-5D Index Score *(0 to 1)*	0.67 (0.27)	0.63 (0.28)	0.66 (0.29)	0.65 (0.27)	0.67 (0.25)	0.64 (0.30)	0.01 (−0.08 to 0.11)

ANCOVA = analysis of covariance, Con = control group, EQ-5D = EuroQol 5D, Exp = experimental group, PDQ-39 = Parkinson's Disease Questionnaire, UPDRS = Unified Parkinson's Disease Rating Scale.

patient-centred, goal-directed physiotherapy and occupational therapy was not associated with significant gains; this was possibly related to the modest dosage of therapy.[41]

In contrast, a large US study of 200 participants by Li et al showed a significant reduction in falls for people who performed intensive therapy twice weekly for 6 months.[12] The intervention group showed beneficial results from intense practice of physical activities to improve balance, such as Tai Chi, highlighting the importance of dosage in therapy outcomes. Likewise, the randomised trial by Smania et al on 64 Italian participants found beneficial effects on falls for an intensive program of balance therapy delivered for 21 sessions of 50 minutes each.[42] Gao and colleagues explored the effects of regular Tai Chi on balance, mobility and falls in 37 Chinese people with Parkinson's disease compared to a control group of 39 people who received no intervention.[43] By the 6-month follow-up, 22% of the group who received 36 sessions of Tai Chi for 1 hour per session had experienced a fall compared with 49% of control participants. Along the same lines, in a study of 35 people with Parkinson's disease, Shen and Mak reported that 12 weeks of technology-assisted balance and gait training five times per week reduced falls to a greater extent than comparable dosages of strength training.[44] Our own recent randomised trial of outpatient physiotherapy to reduce falls in people with Parkinson's disease[17] showed a positive effect on fall reduction. This used similar intervention, including strength training, and movement strategies and fall education twice weekly, but had an 8-week duration.

Other Parkinson's disease physical rehabilitation trials of comparatively high intensity and duration have shown positive outcomes, highlighting the relevance of dosage to therapy outcomes. For example, Monticone et al reported that people with Parkinson's disease who received intensive in-patient rehabilitation within the context of a multi-disciplinary team showed significantly better balance, mobility and quality of life than people who received usual care of lower intensity.[45] As pointed out by Rochester and Espay,[16] many exercise and rehabilitation Parkinson's disease trials appear to have delivered relatively modest dosages of therapy. Some of these trials might not have delivered sufficient intensity to afford the physiological adaptations required to improve balance, mobility, strength and falls in people living with Parkinson's disease. The notable feature of the trial of 70 people by Monticone et al was that participants were admitted to hospital for a period of 8 weeks, where they received high-dosage physiotherapy for 90 minutes daily from expert clinicians.[45] They also confined their sample to people with comparatively mild Parkinson's disease, who are more likely to be responsive to physical therapy interventions. However, it is unclear whether the improvements in balance in the Monticone trial translated to reductions in falls. In sum, the literature shows that both the content of therapy and the dosage appear to be very important, as shown by the differential results for therapies that targeted motor disabilities in many investigations.[4,12,46]

As there was no between-group difference in the primary outcome (falls rate) or secondary outcomes, the appropriate economic method was a cost-minimisation analysis. The higher resource costs for the experimental group suggest that intervention should not be implemented in its current form. The resource component was relatively intensive, as it relied on physiotherapists attending individuals in their home environment. The low capital costs (weighted vests and steps were reusable across participants) meant that there were few opportunities to improve efficiency, for example if the scale (number of participants) was increased. Increasing the intensity of the intervention would require a significant improvement in the primary outcome in order for the intervention to be considered cost-effective from a health system perspective. In the current study, there were three fractures in 2255 falls, which is much less than previous hospital and outpatient clinic trials in Parkinson's disease.[3,4] It could be speculated that providing therapy in the familiar environment of the person's own home minimised the likelihood of injurious falls, although this needs to be confirmed with further research.

Despite being one of the largest trials of movement rehabilitation for falls in people with Parkinson's disease, the present study did have some limitations. The dosage of intervention was modest and, in particular, the length of the program was 6 weeks, which was comparatively short. This low dosage could have been a factor that contributed to the failure to find a difference between groups in people with mild to moderately severe Parkinson's disease. The combined therapy intervention was associated with a reduced falls rate for infrequent fallers, yet was not as effective for very high frequency fallers who fell > 100 times in the follow-up period. This result is consistent with Canning et al, who showed that exercise therapy was associated with fewer falls in patients with mild disease severity compared with those who were more severely affected.[40] It is possible that physiotherapy of much greater intensity is required for people with high levels of disability or very high fall rates. Moreover, there may be a need for supervised, centre-based programs for those with very severe disease compared to home-based therapy with less supervision for those with lower disease severity. This trial was entirely in people's homes. It cannot necessarily be generalised to interventions delivered in hospital, clinic or multi-disciplinary team settings. It is also possible that therapy provided in the early stages of disease progression is most helpful. Our experimental group did not receive balance training, as there was no evidence at the time of designing the trial that balance training reduced falls in Parkinson's disease. This too could be a topic of further research. Another limitation of this trial was that participants were only tested whilst 'on' their Parkinson's disease medication, and the relative contributions of movement rehabilitation and medication to therapy outcomes could not be separated.

To conclude, fall rates were not substantially different in a group that received 6 weeks of home physiotherapy compared to a control group. The higher resource costs of the experimental group intervention suggest that this particular program should not be implemented in its current form. The dosage of therapy in the experimental group might not have been high enough to enable people to achieve long-term gains. Alternatively, the combination of strength training, movement strategy training and falls education might have been too complex to successfully implement in a relatively short, home-based program. Future studies need to more successfully optimise the content and dosage of therapy, as well as tailoring treatment to individual needs.

What is already known on this topic: People with Parkinson's disease commonly fall, leading to injury, loss of independence and reduced quality of life. Movement rehabilitation strategies delivered in hospital and outpatient settings have benefits for people with Parkinson's disease.
What this study adds: A home program of strength and movement strategy training and falls education does not prevent falls when applied at the dose used in this study (6 weeks). The intervention did not significantly improve disability and health-related quality of life.

Ethics approval: Ethics approval was obtained from The University of Melbourne (0824406) and La Trobe University (FHEC08-145). All participants gave written informed consent before data collection.

Competing interests: Nil.

Source of support: National Health and Medical Research Council Project Grant 509129.

Acknowledgements: The authors wish to thank the people with Parkinson's disease who generously participated in this project.

Provenance: Not invited. Peer reviewed.

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