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Home-based exercise program and fall-risk reduction in older adults with multiple sclerosis: phase 1 randomized controlled trial

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Abstract

Objective: To determine the feasibility, safety, and efficacy of a home-based exercise intervention targeting fall risk in older adults with multiple sclerosis.

Design: A randomized controlled pilot trial.

Setting: A home-based exercise program.

Intervention: Participants were randomly allocated to either a home-based exercise intervention group (n = 13) or a waiting list control group (n = 14). The exercise group completed exercises targeting lower muscle strength and balance three times a week for 12 weeks. The control group continued normal activity.

Measures: Fall risk (Physiological Profile Assessment scores), balance (Berg Balance Scale), and walking testing prior to and immediately following the 12-week intervention. Each outcome measure was placed in an analysis of covariance with group as the between-subject factor and baseline values as the covariate. Effect sizes were calculated.

Results: Twelve participants from the control group and ten from the exercise group completed the study. There were no related adverse events. Fall risk was found to decrease in the exercise group following the intervention (1.1 SD 1.0 vs. 0.6 SD 0.6) while there was an increase in fall risk in the control group (1.9 SD 1.5 vs. 2.2 SD 1.9). Effect sizes for most outcomes were large ($\eta^2 > 0.15$).

Conclusions: Home-based exercise was found to be feasible, safe, and effective for reducing physiological fall risk in older adults with multiple sclerosis. Our findings support the implementation of a larger trial to reduce fall risk in persons with multiple sclerosis.

Keywords

Balance, exercise, falls, gait, multiple sclerosis

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Introduction

Falls are common in persons with multiple sclerosis. Over 50% of persons with multiple sclerosis report falling over a six-month period[1,2] and a significant portion of those falls require medical attention for injuries.[3,4] Many people with multiple sclerosis who fall develop a fear of falling, resulting in further activity limitations, reductions in mobility, physical fitness, and increased risk of falling.[5,6] There is some evidence to suggest that falls are significantly more prevalent in older adults with multiple sclerosis[7] and the adverse effects of falls are believed to be worse in this population given the combined effects of advancing age and disease status.[8] Such consequences have clear implications for compromised quality of life and reduced independence in older adults with multiple sclerosis. Collectively, this opens the door for research on fall risk reduction, with the potential for significant advancement in the care of older persons with multiple sclerosis.

One of the primary issues that must be addressed in order to prevent falls, is to identify those specific factors that increase the risk of falls and that can be altered by intervention. Among persons with multiple sclerosis, balance and gait impairment, as well as muscle weakness, have all been implicated as risk factors in past and future falls.[1,7,9,10] Importantly, those physiological risk factors for falls are modifiable with targeted exercise training in persons with multiple sclerosis.[11–14] Despite the promise of physiologically targeted programs, there have been few interventions focusing on risk factors and falls in multiple sclerosis. These investigations have revealed that *supervised* exercise leads to a decline in fall incidence following intervention in persons with multiple sclerosis.[15,16]

For instance, one investigation reported that in middle-aged persons with multiple sclerosis (mean age = 46.6 years), *supervised* balance training sessions (n = 20) and motor control therapy (n = 11) both reduced the number of participants reporting more than one fall in the month following the intervention compared with a control group (n = 10) (16). Within that study, all participants received 10–12 45 minute supervised training sessions spread out over three weeks. Another investigation indicated that a 10-week *supervised* physiotherapy (group and individual) intervention (n = 111; mean age = 55 years old) resulted in a decrease in fall incidence three months following the intervention.[15] Participants received eight one-hour supervised training sessions spread over 10 weeks. One limitation of these interventions involves supervised delivery that presumably requires considerable resources to be implemented. Home-based exercise programs offer a potentially less costly alternative and there is growing evidence they are feasible alternatives in special populations, including persons with multiple sclerosis.[14,17,18] Moreover, home-based exercise programs could allow participants to minimize multiple sclerosis-related barriers to rehabilitation.[18] In the present study, we adopt a randomized control trial (RCT) design and test the feasibility, safety, and efficacy of a home-based exercise program targeting balance, walking, and lower limb muscle strength for reducing fall risk in older adults with multiple sclerosis.

Methods

All procedures were approved by the University of Illinois at Urbana-Champaign institutional review board. All participants provided written informed consent prior to taking part in the investigation. The study design was a two arm (home-based exercise vs. wait list control) RCT with assessments prior to and following the 12-week intervention (ClinicalTrials.org #NCT01837017).

Participants were recruited through the North American Research Committee on Multiple Sclerosis patient registry during the spring of 2012 (April–May). To be included in this study, participants had a neurologist-confirmed diagnosis of multiple sclerosis; ability to walk 25 feet independently or with a cane, crutch, or walker; comprehension of written and spoken English; self-reported a fall in the last 12 months; range in age from 50–75 years of age; live within a 125 mile radius; and had been relapse free for 30 days prior to participation. Fall status in the last 12 months was assessed with a single question (i.e. Have you fallen at least once in the last year?) during the screening telephone call.

Individuals were excluded if they were non-ambulatory, reported no falls in the last 12 months, were outside the age range, lived outside the catchment area, or had a relapse within 30 days of baseline assessment.

Participants underwent two assessments: baseline and postintervention. Postintervention assessment occurred in August 2012. Upon initial arrival to the laboratory, participants provided informed consent and completed demographic questionnaires concerning their health history and self-reported disability ($EDSS_{SR}$).[19] We note that the self-report EDSS has demonstrated validity based on good overall agreement (intraclass correlation coefficient (ICC) = 0.90) and correlation (r = 0.90) with the neurologist-administered EDSS and a non-significant difference in overall mean scores and distributions between EDSS versions.[19] Participants then underwent fall risk, mobility, and balance assessment.

After baseline assessment, participants were randomized into two groups (exercise and control) using a simple randomization method with a 1:1 allocation ratio (independent of baseline assessment) by computer-generated random numbers. Group allocation for each participant was concealed in opaque envelopes. The outcome assessors were blinded to group allocation.

The primary outcome measure of this investigation was fall risk score, as determined by the short form of the Physiological Profile Assessment.[20] Secondary measures included subcomponents of the Physiological Profile Assessment, mobility and balance outcomes and self-reported falls. The Physiological Profile Assessment is a standardized test battery that assesses vision (edge contrast sensitivity via the Melbourne edge detection test), lower limb proprioception, strength (isometric knee extension), postural sway, and cognitive function (simple hand reaction time). The outcome of each test was examined individually, as well as combined to generate an overall fall risk score.[20] Using this scale, higher scores are indicative of a person being at greater risk of falling. Recently, the Physiological Profile Assessment has been predictive of falls in persons with multiple sclerosis.[21]

Specific measures of walking speed, endurance, coordination, and self-reported walking function scale were used to assess overall mobility of each person. Walking speed was quantified with the timed 25-foot walk,[22] walking endurance was assessed with the 6-minute walk test,[23] and functional mobility was quantified with the Timed Up and Go Test.[24] The Multiple Sclerosis Walking Scale-12 was used as a self-reported measure of walking impairment.[25] Scores on the Multiple Sclerosis Walking Scale-12 range from 0 to 100, with higher scores being indicative of greater self-perceived walking impairment. All of these measures have been reliable (ICC ranging from 0.94 to 0.97) and valid in persons with multiple sclerosis.[26,27]

To assess balance (i.e. postural control), we conducted a clinical assessment (Berg Balance Scale[28]) and collected self-reports of balance confidence. The Berg Balance Scale was used as the clinical assessment of balance. Scores on the Berg Balance Scale range from 0 to 56, with higher scores indicating greater balance. The Berg Balance Scale has been reliable with ICCs[26] equal to 0.96 and valid in persons with multiple sclerosis.[16] The Activities-Specific Balance Confidence scale was used as a measure of balance confidence.[29] Scores on the Activities-Specific Balance Confidence scale range from 0 to 100, with higher scores indicating greater balance confidence. The Activities-Specific Balance Confidence scale has been reliable and valid in persons with multiple sclerosis.[29]

At baseline assessment, participants self reported falls in the three months prior to the intervention. During the intervention period, participants were contacted via telephone bi-weekly to access the incidence of falls and any other adverse events. A fall was defined as an event where the participant unintentionally came to rest on the ground or a lower level.[1]

The exercise protocol focused on improving balance, walking, lower limb/core muscle strength, and anti-spasticity—all measures previously described as potential determinants of falling in persons with multiple sclerosis.[9,10,30] During the orientation session, participants were taught a standardized series of exercises that focuses on balance, lower limb muscle strength, core muscle strength, and stretching. Participants were instructed to perform the exercises three times a week in their home as outlined in a manual that we provided. Balance exercises included standing and straight-line walking with as little assistance as possible. Lower limb muscle strength exercises included squats and leg abductions with an exercise band. Stretching exercises included ankle rotations, hamstring stretch, and inner groin stretch. Lastly, core muscle strength exercises included abdominal crunch and seated twist. Participants begin with one set of 8–10 repetitions per exercise and progressed to three sets of 8–12 repetitions. Each home-based exercise session was designed to last between 45 and 60 minutes. The exercise content was progressive in nature over the three-month period, with several levels of difficulty that participants could engage in, depending on ability and tolerance levels. Exercise progression focused on increasing the intensity of the exercise by maximizing the required effort (e.g. greater resistance) and/or minimizing the base of support (e.g. moving feet closer together). The intervention was based upon an exercise program that has been systematically developed over the past decade for implementation in a series of National Institute of Health (NIH) clinical trials with older adults.[31]

Subjects returned biweekly for exercise training led by a certified exercise leader for the first month (weeks 2 and 4) and once again in the second month (week 8) to ensure that exercises were being executed with correct form and at the appropriate intensity level. Compliance of at-home exercise was assessed with diaries that participants completed.

We used a wait-list control as recommended for developmental trials.[32] Participants in the control group completed the study measures before and after the intervention and subsequently received the intervention after the study completion. The data analysis was performed in SPSS v20 (IBM, Chicago, IL) and only participants who completed the intervention were included in analysis, consistent with a completers analysis for a Phase-I trial. Normality was assessed with the Shapiro-Wilk test. When normality was violated appropriate corrections (data was log transformed) were made. Postintervention between group differences were analyzed by analysis of covariance (ANCOVA) with baseline values as the covariate for variables with normal distributions. Effect sizes associated with F statistics are expressed as eta-squared (η^2). To examine the distribution of fallers across groups, an independent samples Kruskal–Wallis test was conducted. In an effort to determine if fall risk was associated with self-reported falls during the intervention, a rank-ordered (i.e. Spearman) correlation analysis was conducted. All analyses used two-sided tests, and p values equal or less than 0.05 were considered statistically significant.

Results

Participant flow is outlined in Figure 1. In brief, a total of 231 individuals were sent informational fliers detailing the study, 59 of which expressed interest and were screened for eligibility. Ultimately 27 participants enrolled in the investigation and were randomized into control (n = 14) and exercise (n = 13) groups. The mean age of the 27 participants who enrolled in the investigation was 60.0 SD 6.1 years (range 51–74) and 85% (n = 23) of the sample was female. Self-reported disability ranged from an $EDSS_{SR}$ score from 2.5 to 6.5 with a median of 5.0. The overall demographics of the sample are reported in Table 1. There were no group differences in age, gender, multiple sclerosis duration, assistive device use, or self-reported disability ($p > 0.05$).

After baseline assessment, there were five participants (three control, two exercise) who discontinued the study protocol. One fall-related injury, a fractured foot, occurred in the control group during the intervention. The other four withdrawals were based on multiple sclerosis-exacerbation (n = 1), travel-related issues (n = 1), and time commitment (n = 2). As a consequence, data from these participants was excluded from analyses (see Figure 1). There was no statistical difference between participants who withdrew and those that completed the intervention. On average, the exercise group completed 68.3% (n = 24.6 sessions) of the prescribed exercise sessions. In addition, 60% (n = 6) of persons in the exercise group reported including other forms of exercise, such as low impact walking and biking, in their weekly routine.

There was a significant between-group difference in the Physiological Profile Assessment fall

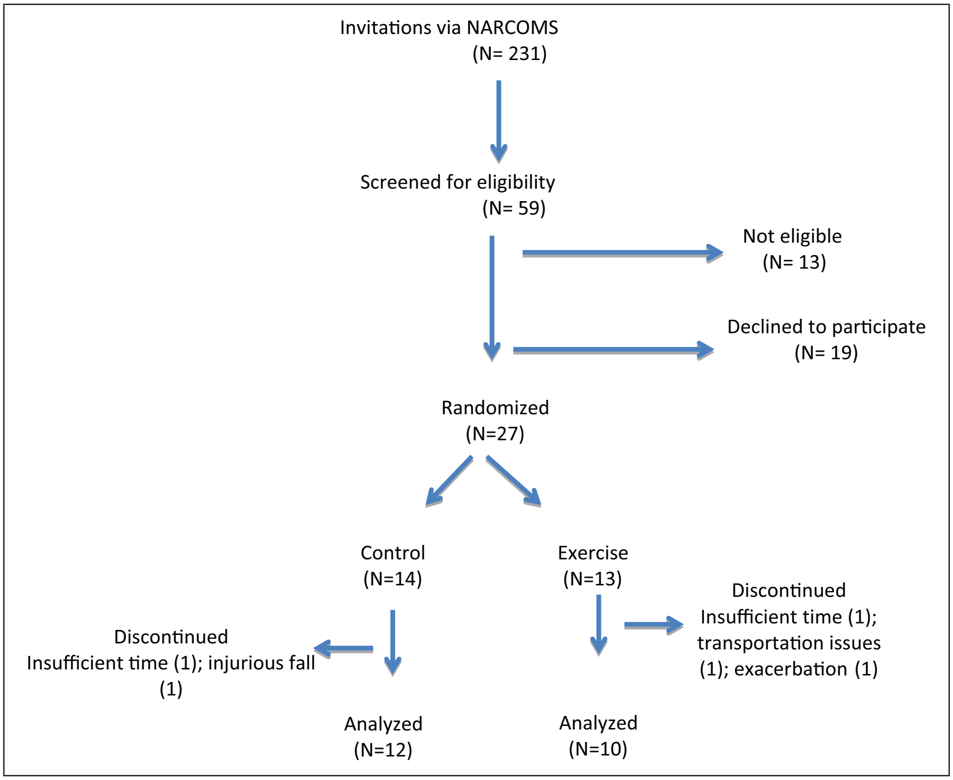

Figure 1. Participant flow.

Table 1. Participant demographics as a function of group.

Variable	Overall (n = 27)	Control (n = 14)	Exercise (n = 13)	p	d
Age (years)	60.0 (6.1)	60.1 (6.0)	60.1 (6.3)	0.47	0.33
MS type (RR/SP/PP)	20/4/3	10/3/1	10/1/2	0.83	–
MS duration (years)	15.8 (9.1)	17.7 (11.3)	13.9 (6.7)	0.39	0.41
Gender (female/male)	21/6	11/3	10/3	0.45	–
Assistive device (none/cane/walker)	13/6/8	7/3/4	6/3/4	0.84	-
$EDSS_{SR}$ (median, IQR)	5.0 (2.5)	5.5 (3.5)	5.5 (2.5)	0.60	-

MS, multiple sclerosis; RR, relapse remitting; SP, secondary progressive; PP, primary progressive; $EDSS_{SR}$, self-reported expanded disability status scale; IQR, interquartile range.

risk score at the end of the intervention when controlling for baseline differences [$F(1,21) = 4.4$; $p \leq 0.05$; $\eta^2 = 0.20$]. Overall, the exercise group had a significantly lower fall risk score than the control group (0.73 SD 0.6 vs. 1.9 SD 1.7) following the intervention.

We further examined changes in the subassessments of the Physiological Profile Assessment. There was a significant between-group difference in the postural sway assessment at the end of the intervention while controlling for baseline performance [$F(1,21) = 4.9$; $p \leq 0.05$; $\eta^2 = 0.21$]. The exercise

Table 2. Baseline–12 week comparisons of composite fall risk score and subcomponent score.

Outcome variable	Control (n = 12)			Exercise (n = 10)			Between-group analysis P
	Baseline	Post	% Change	Baseline	Post	% Change	
PPA composite score	1.9	2.2	13.6	1.1	0.6	–83.3	0.05
MET	19.7 (1.6)	20.4 (1.8)	3.4	20.8 (1.9)	20.9 (2.7)	0.0	0.47
Proprioception (degrees)	3.6 (1.7)	3.8 (1.0)	5.3	4.5 (2.7)	3.5 (1.2)	–28.6	0.27
Strength (kg)	12.8 (5.4)	14.4 (3.5)	15.3	11.8 (5.3)	12.2 (4.2)	3.3	0.68
Reaction time (ms)	291.8 (66.3)	287.1 (40.5)	–1.6	261.8 (52.1)	264.7 (56.5)	1.2	0.74
Postural sway (mm)	34.8 (14.5)	51.5 (15.7)	32.4	29.6 (14.8)	22.1 (8.1)	–25.4	0.04

PPA, Physiological Profile Assessment; MET, Melbourne Edge detection Test.

group had a significantly smaller postural sway along the anterio–posterior axis than the control group (22.1 SD 12.1 vs. 51.5 SD 11.6mm) following the intervention. No other subassessments were significantly different between groups at retest ($p \geq 0.05$) (see Table 2).

Examination of mobility-related outcomes indicated that there was a significant between-group difference in the timed 25-foot walk at the end of the intervention [$F(1,21) = 4.4$; $p \leq 0.05$; $\eta^2 = 0.20$] while controlling for baseline performance. The exercise group had a faster walk time than the control group (6.4 SD 1.4 vs. 8.4 SD 3.9s) following the intervention. We note that differences following the intervention appear to stem from worsening in the control group with minimal improvement in the exercise group. In contrast, there was no significant difference between groups in the Timed Up and Go Test [$F(1,21) = 1.4$; $p \geq 0.05$; $\eta^2 = 0.03$], 6-minute walk [$F(1,21) = 0.3$; $p \geq 0.05$; $\eta^2 = 0.02$], or multiple sclerosis walking scale-12 scores [$F(1,21) = 1.9$; $p \geq 0.05$; $\eta^2 = 0.10$] while controlling for baseline performance.

A significant group difference in balance confidence at retest was revealed [$F(1,21) = 5.3$; $p \leq 0.05$; $\eta^2 = 0.26$]. The exercise group had greater balance confidence than the control group (60.8 SD 20.2 vs. 55.1 SD 19.6) following the intervention while controlling for baseline values. There was a trend for group differences at retest in the Berg Balance scale [$F(1,21) = 3.7$; $p = 0.07$; $\eta^2 = 0.17$] with the control group having lower balance performance at retest (40.3 SD 15.7 vs. 50.2 SD 3.2). An examination of Table 3 reveals that postintervention differences between groups tend to be owing to a worsening in performance in the control group and the maintenance of performance in the exercise group.

Examination of the distribution of fallers revealed that there was no group difference in proportion of participants who had reported a fall prior to the intervention ($p = 0.185$). However, there was a greater proportion of fallers in the control group (94% fallers) compared with the exercise group (50% fallers) during the intervention. Additionally, there was a significant correlation between baseline Physiological Profile Assessment score and falls during the intervention (rho = 0.41; $p \leq 0.05$).

Discussion

The purpose of this investigation was to determine if a home-based exercise program was feasible, safe, and efficacious in reducing fall risk for older adults with multiple sclerosis. In this population of older adults with multiple sclerosis, home-based exercises lowered the risk of falls, as indicated by reductions in fall risk score characterized by a large effect size ($\eta^2 = 0.2$). There were subtle but significant group differences in balance confidence and walking speed following the exercise program that appear to stem from the maintenance of function in the exercise

Table 3. Baseline–12 week comparisons of mobility and balance-related outcomes.

Outcome variable	Control (*n* = 12)			Exercise (*n* = 10)			Between-group analysis *P*
	Baseline	Post	% change	Baseline	Post	% change	
T25FW (s)	6.9 (1.3)	8.4 (3.9)	–21.7	6.6 (1.3)	6.4 (1.4)	3.1	0.04
TUG (s)	10.9 (2.9)	15.6 (3.9)	–30.1	10.0 (2.1)	10.3 (2.1)	3.0	0.50
6MW (ft)	1058.9 (430.6)	1080.6 (367.0)	–1.9	1366.3 (279.4)	1377.5 (383.7)	–0.8	0.83
MSWS-12	65.5 (24.4)	63.9 (27.6)	2.0	63.2 (22.0)	55.1 (20.1)	–14.7	0.19
BBS	42.6 (14.6)	40.3 (15.7)	5.7	48.6 (4.1)	50.2 (3.2)	–3.3	0.07
ABC	64.7 (17.8)	55.1 (19.6)	17.4	59.3 (23.2)	60.8 (20.3)	–2.5	0.03

T25FW, timed 25-foot walk; TUG, Timed Up and Go; 6MW, 6-minute walk; MSWS-12, Multiple Sclerosis Walking Scale-12; BBS, Berg Balance Scale; ABC, Activity-specific Balance Confidence scale.

group, coinciding with declines in performance in the control group. Importantly, the majority of changes in walking and balance performance observed in the exercise group do not meet the criteria for clinically meaningful change.[27] Additionally, the home-based exercises were not related to any adverse events and appeared to be safe.

Physiological fall risk, as assessed by the Physiological Profile Assessment composite score, is classified from –2 to +4, with higher scores being predictive of increased risk. Within this range, a score of 0 to +1 is considered as "mild" falls risk, "moderate" between +1 and +2, and "marked" between +2 and +3.[20] In older adults, a fall risk score of one or greater is associated with a 61% risk of multiple falls, whereas a fall risk score of less than one is associated with a 12% risk of multiple falls.[33] Consequently, the sample's overall fall risk was in the moderate range and the 12-week home-based exercise program resulted in a significant decrease in fall risk. Strengthening this conclusion is an observational investigation of 148 persons with multiple sclerosis that reported an increasing fall risk score, as determined by the Physiological Profile Assessment, was associated with an increased risk of experiencing a fall in the next three months.[21] Indeed, within the current dataset, fall risk was moderately correlated with the recent number of falls.

The overall decrease in fall risk following home-based exercise is consistent with the growing body of research demonstrating the benefits of exercise in persons with multiple sclerosis.[16,34,35] To our knowledge, fall risk, as indexed by the Physiological Profile Assessment, has not been a target of other interventions in persons with multiple sclerosis, so direct comparisons are not possible. The observed decline in fall risk following home-based exercise is consistent with fall prevention in older adults without multiple sclerosis.[36] An investigation of previously hospitalized older adults (mean age = 80 years) reported that home-based exercise decreased physiological fall risk, based on the Physiological Profile Assessment composite score, by ~0.3 points.[36] The 1-point decrease in fall risk score observed in this investigation is considerably larger than previous reports. However, a recent investigation found a similar decrease in fall risk following a multifactorial intervention in older adults at marked risk of falls.[37] The authors suggested that individuals with the highest risk of falls have the greatest potential to minimize their risk with targeted exercise programs.[37]

Although it is logical to speculate that a decrease in physiological fall risk would result in a decrease in fall incidence, there are some reports demonstrating a reduction in fall risk scores but no change in fall incidence for older adults.[37] There is limited evidence that supervised exercise can actually reduce fall incidence in persons with multiple sclerosis.[16,35] Consistent with this notion, in the current study, the exercise group (on average) reported half as many falls as the control group during the intervention. However, these results should be viewed with caution given that this difference was based of self-recall of falls. Consequently, research determining if a home-based exercise program can reduce fall incidence in persons with multiple sclerosis is warranted.

Of the subcomponents that comprise the short form of the Physiological Profile Assessment, only balance was found to be significantly improved following the intervention. This improvement in postural control coincided with maintenance of balance confidence and walking speed. These observations are consistent with previous reports demonstrating improvements in balance following supervised[11,13,34] and unsupervised[18] exercise training in persons with multiple sclerosis. It is worthwhile to note that postural sway as assessed by posturography has been found to be predictive of falls in persons with multiple sclerosis.[38] This indirectly suggests that improvements in balance may contribute to a reduction in fall incidence following home-based interventions. Unfortunately, data on fall incidence following the intervention was not collected. So this assumption cannot be tested with the current dataset. Power analysis based on the current dataset indicates that a sample of approximately 100 persons with multiple sclerosis would be needed to determine if exercise-induced changes in fall risk and/or balance result in changes in fall incidence.

In contrast to our predictions, there were no improvements in lower leg strength following the intervention. This lack of effect of home-based exercise on leg strength is congruent with some previous research in older adults,[36] but not reports in persons with multiple sclerosis.[14] It is possible that the participants required training of greater duration and/or intensity to improve muscle strength. Consistent with this notion, home-based programs that lead to increases in strength utilized weighted vests,[14] while the current program used participants own body weight and resistance bands. Alternatively, given that muscle strength was only measured for knee extension, it is also permissible that strength changes may have occurred in muscle groups that may have had a carry-over effect for balance control (e.g. dorsiflexion strength). It is logical to speculate that the observed improvements in balance and maintenance of walking function following the intervention result in part from improvements in dorsiflexion strength.[39,40] Indeed, a recent study has highlighted that ankle strength, but not knee extension strength, was related to future falls in older adults.[41] However, a prospective investigation found that leg extension power was related to recurrent ($>2^+$) falls in women with multiple sclerosis.[9] Additional research examining the association between lower limb strength and falls in multiple sclerosis is warranted.

The home-based exercise program appears to be safe. There was only one fall-related injury (e.g. self-report fractured ankle) and this was for a control participant who was not engaged in the exercise program when she fell. A participant in the exercise group did have a multiple sclerosis exacerbation. But this is unlikely to have been related to the exercise program given the substantial evidence that exercise training is not associated with an increased risk of relapse in persons with multiple sclerosis.[42] There were no other reported adverse events.

In addition to being safe, the home-based exercise program had relatively good compliance, with ~68% of the exercise sessions being completed. This level of compliance is relatively consistent with community-based interventions in persons with multiple sclerosis, which reported compliance rates of 71%[12] and 80%.[15] However, other pilot trials of home-based exercise have reported 95% compliance,[14] suggesting that future trials could strive to further increase compliance. Although it is logical to speculate that home-based exercise programs are more cost effective than supervised interventions, no data was collected to test this assumption.

Despite the acceptable level of compliance, there were issues with recruitment rate and retention. Only 27 (45%) of the 59 individuals screened for eligibility were enrolled in the study and five individuals (18%) enrolled withdrew from the study. A main concern for individuals who chose not to participate and for some of the individuals that withdrew from investigation was transportation issues. Given that the catchment area was a 125 mile radius from the research laboratory, several of the potential participants raised concerns with transportation and time requirements. Future investigation may be well served to assess individuals closer to their residence and place the transportation burden on the research team as opposed to the participants.

Despite the novel findings, this intervention did have limitations. The small sample size and non-comprehensive measures of function limit the generalizability of the results. Additionally, although participants were asked not to mention their group allocation to the outcome assessors, occasionally participants did reveal their allocation to assessors at follow-up. As previously mentioned, muscle strength was only indexed in knee extension. Consequently, changes in strength in any other muscle group went undetected. Lastly, this investigation was focused on ambulant older adults with multiple sclerosis with a history of falling. It is not clear how the findings will generalize to other segments of the multiple sclerosis population.

There were also some observable group differences in baseline outcomes. In small phase I investigations such as this, perfect balance is difficult to accomplish even with appropriate randomization procedures. We accounted for these baseline differences in our analyses by using ANCOVA as suggested by CONSORT guidelines.[43] However future larger interventions will be more likely to minimize baseline differences.

Overall, this investigation revealed that a 12-week home-based exercise program targeting balance and lower limb strength is safe and reduces physiological fall risk in older adults with multiple sclerosis compared with a wait-list control. The results suggest that improvements in balance, but not muscle strength or spasticity, contribute to the reduction in fall risk. The observations are congruent with the growing literature demonstrating a positive benefit of exercise in persons with multiple sclerosis.[34] Future work determining if home-based exercise can reduce fall incidence in older adults with multiple sclerosis is warranted.

Clinical messages

- Delivery of exercise in a home context in people with multiple sclerosis is safe and feasible.
- Home-based exercise reduced fall risk in persons with multiple sclerosis.
- A sample of ~100 persons with multiple sclerosis would be needed to determine if home-based exercise results in a reduction in fall incidence.

Conflict of interest

None declared.

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