

Group exercise can improve participants' mobility in an outpatient rehabilitation setting: a randomized controlled trial

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Objective: To establish the effects of group exercise on mobility and strength.

Design: Randomized controlled trial.

Setting: Two public hospital outpatient rehabilitation services.

Participants: One hundred and seventy-three people (mean age 74.9 years, SD 10.8) with impaired mobility were randomized and 159 people (92%) completed the trial.

Interventions: Five-week, twice-weekly 'circuit-style' group exercise programme run by a physiotherapist ($n=85$) and a no-intervention waiting list control group ($n=88$).

Main outcome measures: Three aspects of mobility: balance while standing and stepping (Step Test, semi-tandem and tandem stance times); sit-to-stand ability (rate and minimum height) and gait (6-metre and 6-minute walk tests). Lower limb muscle strength (knee flexion and extension).

Results: At retest, exercise participants had improved significantly more than their control counterparts on measures of balance while stepping, sit to stand and gait. Exercise participants averaged 1.6 more steps on the 15-second Step Test (95% confidence interval (CI) 0.5 to 2.8, $P=0.005$), walked an average of 0.12 m/s faster (95% CI 0.05 to 0.2, $P=0.002$) and took 2.5 fewer steps in 6 metres (95% CI -4.2 to -0.8 , $P=0.004$). Exercise participants also averaged 0.04 more sit-to-stands/second, (95% CI 0.003 to 0.08, $P=0.037$) and walked an average of 30.9 metres further in 6 minutes (95% CI 9.4 to 52.4, $P=0.005$). There were no clinically important or statistically significant between-group differences at retest for the measures of strength (knee extension and flexion), balance while standing or minimal sit-to-stand height.

Conclusion: This short-duration circuit class programme improved mobility, but not strength.

Introduction

The International Classification of Functioning, Disability and Health (ICF) from the World Health Organization describes how people live with a health condition and includes domains

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which describe body functions and structures, activities and participation in society.¹ Mobility is a one such domain and is described as 'moving by changing body position or location or by transferring from one place to another, by carrying, moving or manipulating objects, by walking, running or climbing, and by using various forms of transportation'.

Up to one-third of people aged 65 years and older report some difficulty with mobility tasks² and over one-quarter of non-disabled older people develop mobility disability within three years.³ Stroke and other age-related conditions exacerbate mobility problems. Up to 60% of people who have suffered a stroke experience mobility limitations two years later.⁴ Illnesses and injuries leading to hospitalization and restricted activity are associated with increased need for assistance with mobility and other tasks.⁵ Impaired lower extremity physical functioning is a risk factor for falls,⁶ nursing home admission and mortality.⁷

There is now evidence from randomized controlled trials (RCTs) that, among people with mobility impairments, well-designed exercise programmes can prevent decline in mobility and other skills.^{8,9} It has been suggested¹⁰ that in order to most efficiently enhance mobility, exercises chosen should involve practice of tasks of daily living such as standing up, balanced standing, reaching, walking and stair climbing or components of these tasks. Such interventions have now been found to be beneficial in RCTs among several different population groups, including those following stroke,¹¹⁻¹⁴ traumatic brain injury¹⁵ and hip fracture¹⁶ as well as those with some functional impairments,¹⁷ disability,¹⁸ or at risk of falls.^{19,20} Several of these^{11,12,20} have adopted a circuit-style or workstation format where participants attend exercise stations sequentially with greater supervision for the more challenging stations.

In the geographical areas surrounding our two public hospitals we identified that, for community-dwelling older people with impaired mobility, there were few opportunities for exercise specifically targeting performance of mobility and other tasks. To address this gap we established, as part of the hospital physiotherapy outpatient services, small-group circuit-style exercise classes for older

people with impaired mobility. The exercises were designed to improve performance on mobility tasks such as standing up, stepping up and walking.

Evaluation of translation of evidence into practice is a complex issue. If it is clear that a particular intervention will work in clinical or public health practice, further evaluation with an RCT is not generally considered necessary.²¹ However, an exercise programme in mobility-impaired older people may well be less effective in a 'real-world' clinical setting than a research setting due to pressure on resources and the inclusion of a broad range of clients (i.e. not just those who seek out exercise opportunities). Thus we conducted an RCT to evaluate the effectiveness of a circuit class for community-dwellers with impaired mobility in a clinical setting. Such an evaluation has not, to our knowledge, previously been undertaken. Effects of this exercise programme on mobility and lower-limb muscle strength were evaluated. We chose to assess effects on strength as well as mobility as in a previous study among people after hip fracture we found some effects on strength from exercises resisted by body weight alone.²²

Methods

Design

This was a randomized controlled trial. After agreeing to participate in the trial, participants were randomized using sequentially numbered opaque sealed envelopes into either a five-week programme of exercise classes or a no-intervention control group. The computer-generated blocked randomization schedule and envelopes were prepared by the first author who was not involved in recruitment.

In the week before the exercise classes, all subjects participated in an initial assessment which took approximately 30 minutes. Participants were then reassessed at the end of the trial. Baseline and retest assessments were conducted at participating hospitals by registered physiotherapists and trained research assistants. Retest assessments were undertaken without reference to initial assessment values but assessors were aware of group allocation. The control group participants were offered the five-week exercise programme immediately following

the trial period, but did not undergo a further assessment after this programme. Ethical approval was granted by the South Western Sydney Area Health Service Research Ethics Committee and the South Eastern Sydney Area Health Service Research Ethics Committee and informed consent was obtained from all participants prior to their participation.

Participants

We encouraged physiotherapists and other health professionals at the participating hospitals and general practitioners and medical specialists in the surrounding areas to make referrals to our classes designed for people with mobility impairments. Referral criteria were (a) a mobility impairment (e.g. difficulty with walking, standing up or stair climbing) from any cause, (b) unsuitability for available community exercise options due to this impairment and (c) no contraindication to exercise. All those referred to the classes were considered for inclusion in the trial. Exclusion criteria for the trial were: currently receiving other rehabilitation intervention and a severe respiratory or cardiac disease or other health condition which would contraindicate safe exercise.

All those who had been referred to the exercise classes were contacted regarding participation in the classes and the trial. It is estimated that 50% of those approached agreed to participate in the classes and the trial. The main reasons for non-participation were: being unwilling to commit to the 10 sessions; other medical conditions; other commitments on exercise class days; feeling that they did not require exercise or had done sufficient exercise during recent inpatient rehabilitation stays (around 50% of participants had been rehabilitation unit inpatients at the participating hospitals in the six months preceding the trial).

One hundred and seventy-three community-dwelling people met the inclusion criteria and agreed to participate in the trial (Figure 1).

Participants were screened using the Physical Activity Readiness Questionnaire²³ and the participants' general practitioners were informed about the study in case there were medical contraindications to participation in the programme. No participants were excluded on these grounds.

Intervention

Exercise subjects participated in 1-hour exercise classes conducted twice-weekly over a five-week period. The exercise programme was designed to provide repetitive, task-related exercises that could feasibly be continued by individuals in their homes. Exercise stations were: sitting to standing, walking over and around small obstacles such as foam blocks, stepping in different directions, heel raises, stepping up sideways onto a 5- to 15-cm block, stepping forwards onto a 5- to 15-cm block, standing on one leg and tapping the other leg forwards onto a block, and use of a treadmill or exercise bicycle (more details available from the authors).

The programme used a 'circuit' design with eight different exercise stations for up to eight participants. Participants moved from one exercise station to the next at 3- to 4-minute intervals. For each participant, the number of repetitions and level of exercise difficulty at each station was prescribed and upgraded by the class leader. Carers were encouraged to attend classes and to provide assistance where possible. Participants were also asked to complete a daily home exercise programme of similar exercises to those in the classes. Over the period of the study, the classes were led by seven different physiotherapists. Assistance was provided by physiotherapy assistants, students or hospital volunteers so that each class had two leaders. Classes were usually attended by 6–8 people.

Measurement tools

Test of mobility and strength were undertaken and participants were asked to rate their impression of the exercise programme.

Three important components of mobility were assessed: balance while standing and stepping, sit-to-stand performance and gait.

(i) Balance while standing and stepping

Step Test performance was assessed for both legs by recording the number of times a participant was able to place one foot onto and off a 5-cm block in 15 seconds without support.²⁴ The examiner stood alongside the participant.

Standing balance was assessed in semi-tandem and tandem stance positions. The time each position could be maintained was recorded.

(ii) *Sit-to-stand*

The time taken to stand up five times as quickly as possible from a 55-cm plinth was recorded and converted to a rate (stands per second). Participants started with their feet on the floor at hip width and thighs parallel and kept their arms folded while standing up. Minimum sit-to-stand height without hand support was also recorded.

Participants sat on an electrically powered height-adjustable plinth with their feet placed under their knees and arms folded. Participants were asked to stand from progressively lower heights without moving their elbows away from their body, moving their feet or pushing on the plinth with the back of their legs. The assessment measure was the minimal height from which the participant could successfully stand as measured from the floor to the top of the plinth. This test has good inter-rater reliability (ICC (1,1)=0.92 (95% CI 0.85–0.96)²⁵).

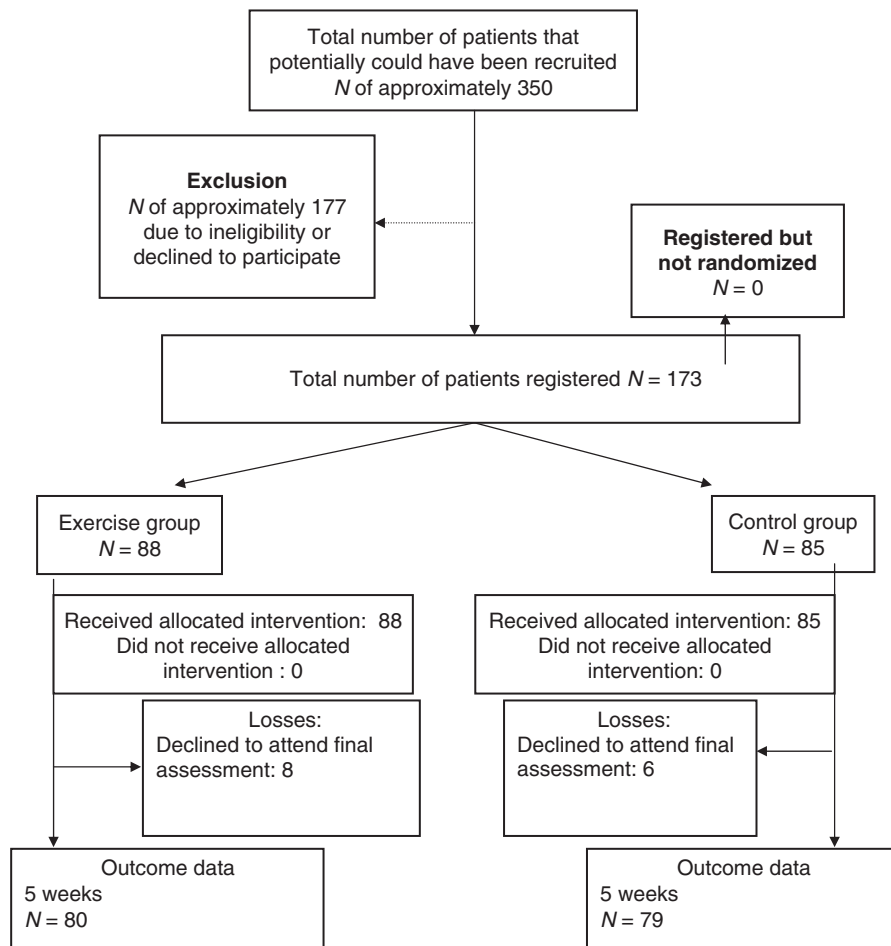


Figure 1 Flow diagram.

(iii) Gait

Participants were asked to walk 6 metres quickly but safely with the least supportive walking aid possible. The time taken was recorded with a stop watch and the number of steps taken during the trial was recorded with a hand-held counter. Walking endurance was measured by the 6-minute walking distance test in an indoor area (i.e. the total distance walked in 6 minutes).²⁶ The participant was instructed to walk as quickly as they could and encouraged to walk continuously for the 6 minutes, but if unable to do so, rest periods were included in the 6 minutes. The examiner walked beside the participant and gave encouragement at the end of each minute. For the majority of participants, heart rate monitors were used during the tests.

Isometric strength of the quadriceps and hamstrings muscles was measured with a hand-held dynamometer (JTech Medical, Salt Lake City, UT, USA). Participants sat on a tall chair and the test pad was placed 5 cm above the ankle joint. The angles of the hip and knee joints were 90 degrees. The participant attempted to flex or extend the knee with maximal force for 2–3 seconds while the examiner resisted this movement by matching the force generated. The greatest force of three trials was recorded.

Using a series of four-point scale items, participants were asked to rate their impression of the exercise programme in terms of overall usefulness, discomfort, difficulty, effects on walking and standing up abilities, and likelihood of continuing the exercises.

Statistical analysis

The data were analysed on an intention-to-treat basis, using SPSS statistical software. Between-group comparisons of five-week test performance scores were undertaken using linear regression (ANCOVA) models with baseline scores included as covariates.²⁷ For variables that were not normally distributed, change scores (i.e. difference between initial and final test performance) were used in the models.²⁸ Power calculations revealed that 80 subjects per group would be sufficient to detect 20% between-group differences in muscle strength, step test, minimum sit-to-stand height and 6-minute walk tests (power 80%, alpha 5%).

Results

Participants had an average age of 74.9 years (SD 10.8) and 99 (57%) of the participants were women. Fifty-two per cent of participants had neurological problems, 20% orthopaedic problems and 19% generalized mobility impairments. Tables 1 and 2 show the demographic, health and physical performance measures at the beginning of the trial. The groups were similar in all measures.

Final assessments were completed by 159 participants (92%). No major adverse events occurred during the exercise classes. Eighty-two per cent of participants reported that the classes had helped them moderately or greatly, 66% felt that their standing up ability had improved moderately or greatly and 71% felt their walking had improved to this extent. Twelve per cent indicated that the exercises caused a moderate or great amount of discomfort and 21% found the exercises greatly or moderately difficult. Eighty per cent felt they would continue doing the exercises at home.

After the intervention period exercise participants had better mobility than their control counterparts, when initial performance was considered. As shown in Table 2, between-group differences were clinically important and statistically significant for measures of balance while stepping (Step Test for each leg), sit-to-stand rate and the gait measures (6-metre velocity, number of steps taken in 6 metres and 6-minute test).

However there were no clinically important or statistically significant between-group differences at retest for the measures of strength (knee extension and flexion), minimal sit-to-stand height or semi-tandem and tandem stance time (see Table 2).

Table 1 Descriptive data by group

	Control <i>n</i> = 85	Exercise <i>n</i> = 88
Age, mean (SD)	76.4 (10.2)	73.4 (11.1)
Sex: female, <i>n</i> (%)	50 (58.8)	49 (55.7)
Primary problem		
Neurological, <i>n</i> (%)	42 (49.4)	48 (54.5)
Orthopaedic, <i>n</i> (%)	16 (18.8)	18 (20.7)
Decreased mobility, <i>n</i> (%)	18 (21.2)	15 (17.0)
Medical, <i>n</i> (%)	4 (4.7)	5 (5.7)
Medications, mean (SD)	4.5 (3.0)	4.2 (3.2)
Comorbidities, mean (SD)	2.4 (1.8)	2.2 (1.6)

Table 2 Post-intervention between-group comparisons

Outcomes	Control group (<i>n</i> = 85 at baseline and 79 at 5 weeks) mean (SD)	Exercise group (<i>n</i> = 88 at baseline and 80 at 5 weeks) mean (SD)	Mean difference at 5 weeks, adjusted for initial scores (95% CI)	<i>P</i> -value
Balance while standing and stepping				
Step Test better leg (reps)				
Baseline	8.3 (6.0)	7.8 (5.4)	1.5 (0.4 to 2.6)	0.006
5 weeks	8.2 (5.5)	9.3 (5.6)		
Step Test worse leg (reps)				
Baseline	6.6 (5.4)	6.0 (5.0)	1.6 (0.5 to 2.8)	0.005
5 weeks	7.3 (5.2)	8.5 (5.4)		
Semi-tandem stance (seconds) ^a				
Baseline	10 (2)	10 (0)	0.1 (-0.9 to 1.1)	0.862
5 weeks	10 (1)	10 (0)		
Tandem stance (seconds) ^a				
Baseline	3 (10)	4.7 (10)	0.8 (-0.5 to 2.1)	0.236
5 weeks	4 (10)	8.3 (8)		
Sit-to-stand				
Stand up rate (stand/seconds)				
Baseline	0.29 (0.17)	0.27 (0.16)	0.04 (0.003 to 0.08)	0.037
5 weeks	0.30 (0.17)	0.33 (0.16)		
Minimum sit to stand height (mm)				
Baseline	449 (89)	445 (98)	-9 (-28 to 9)	0.327
5 weeks	441 (90)	429 (92)		
Gait				
6-metre gait velocity (m/s)				
Baseline	0.81 (0.43)	0.70 (0.38)	0.12 (0.05 to 0.2)	0.002
5 weeks	0.77 (0.45)	0.79 (0.42)		
Steps taken in 6-metre walk ^{a,b}				
Baseline	12.0 (6.0)	14.5 (6.0)	-2.5 (-4.2 to -0.8)	0.004
5 weeks	15.0 (8.0)	14.0 (5.0)		
6-minute distance (m)^c				
Baseline	227.3 (122.8)	194.6 (108.1)	30.9 (9.4 to 52.4)	0.005
5 weeks	222.0 (138.8)	223.5 (126.6)		
Strength (N)				
Knee extension better leg (N)				
Baseline	143 (63)	135 (52)	-3 (-15 to 9)	0.659
5 weeks	141 (59)	134 (50)		
Knee extension worse leg (N)				
Baseline	111 (54)	109 (49)	-1 (-14 to 12)	0.859
5 weeks	123 (53)	121 (56)		
Knee flexion better leg (N)				
Baseline	90 (45)	81 (36)	-2 (-10 to 6)	0.660
5 weeks	90 (42)	81 (34)		
Knee flexion worse leg (N)				
Baseline	82 (45)	69 (34)	4 (-4 to 12)	0.368
5 weeks	79 (41)	72 (36)		

^aSkewed distribution, medians and interquartile ranges are presented and between-group differences are those for the change from baseline to five weeks.

^bMissing data for three control participants at baseline and five-week assessment and one exercise participant at five-week assessment.

^cMissing data for one exercise participant at baseline.

Discussion

This trial found that it is possible to improve mobility with a short-term exercise programme conducted in a clinical setting.

Balance during stepping as measured by the Step Test improved significantly more in exercise participants than control participants. Balance while standing as measured by the tandem stance tests did not show between-group differences. Our classes had a greater focus on training balance while undertaking tasks such as stepping and sit-to-stand and walking rather than a focus on balance while standing still. The finding that abilities practised showed greater improvements suggests the importance of task specificity in the response to practice. The relative importance of measures of standing balance and stepping balance in the prediction of falls is not yet clear.

Despite the lack of between-group difference in the minimal chair height test, sit-to-stand rate did improve in our trial. Sit-to-stand performance is influenced by multiple sensorimotor and psychological processes in addition to lower limb strength and thus represents a particular skill.^{29,30} The improvements in this measure in the intervention group therefore may have been mediated by improved balance and coordination, endurance and confidence. These factors also underpin 6-minute walk test performance in frail older people,³¹ and improvements in these measures may also have been the mediating factors in improved 6-minute walk performance in the exercisers.

Both strength and balance training have been suggested to be vital components of exercise programmes for older people.³² Muscle weakness has been identified as a major cause of disability among older people and is a strong risk factor for falls.³³ We did not focus on progressive strength training of individual muscle groups in the current trial. Rather, resistance was provided by moving the body weight during task-related exercises (e.g. standing up, stepping up). Unlike our previous study among people after hip fracture,²² there were no between-group differences in strength outcomes in the present study. Thus it

seems that resistance from body weight alone was insufficient to enhance strength but that improved mobility is possible without improved strength in this population. Several other RCTs have found that resistance training can be feasibly included in task-related exercise programmes.^{17,18,34}

It has been argued that studies of health care interventions should involve participants and staff from standard health care settings rather than highly selected participants and specialized staff often found in tightly controlled research settings and that the translation of research evidence into everyday clinical practice is facilitated by this type of 'pragmatic' trial.³⁵ We feel that the results of our trial can be readily translated into clinical practice as it was conducted among consecutive people referred to the newly established exercise classes in our public hospital physiotherapy departments and all interventions were given by hospital-employed physiotherapy staff.

The size of gains seen from the relatively low-intervention dose (i.e. only 10 exercise classes) appear to be clinically important and are likely to reflect useful changes in mobility for exercise class participants.

An inherent limitation in a trial of this type is that participants cannot be blinded to their treatment condition. Thus, the exercise participants were aware that they were receiving the intervention, and it is possible that part of the improvement noted at retest in this group may have been due to increased motivation and effort expended in the tests at retest. As funding did not allow a frequency-matched social intervention for the control group we also cannot rule out the role of social aspects of the programme in the benefits seen.

An important limitation of this study is the possibility of experimenter bias, as a result of the investigators who assessed the participants not being blind to treatment status. We attempted to minimize this with standardized instructions. It is also acknowledged that the follow-up time was short. As such, it is unknown whether there were any long-term effects of these exercise classes. Further research could include longer follow-up

periods for these short-duration classes and also examine the effects of longer term exercise programmes in this population on physical outcomes as well as falls.

Unfortunately we did not keep records of class attendance or home exercise completion to estimate the compliance with this programme. However 80% of people indicated that they planned to continue exercising which gives some indication of level of participant interest in the programme.

We used a range of outcome measures as there appear to be individual variations in the manifestation of mobility impairment in older people. As the various aspects of mobility may be differently affected in different older people, it is difficult for a single measure to adequately describe performance in a range of tasks. We were also interested in whether the programme affected the various aspects of mobility differently. We are aware that the statistical significance of between-group differences seen may be affected by multiple testing. However the size and direction of between-group differences is not affected by multiple testing and most of these differences would remain statistically significant if a more stringent test was applied ($P < 0.01$).

In conclusion, the findings indicate that mobility can be improved with a short duration circuit-class programme. This programme appears to be an efficient and effective means of service delivery for the mobility-impaired population. We therefore recommend that exercise classes for people with movement difficulties should be offered routinely by outpatient rehabilitation services.

Clinical messages

- Short duration task-related circuit-class exercise programmes can improve mobility (balance while stepping, sit to stand and gait) when delivered in a public hospital outpatient rehabilitation setting by physiotherapy staff.
- This programme involved resistance from body weight only and did not increase strength.

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