A comparison of community-based resistance exercise and flexibility exercise for seniors

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Progressive resistance training has positive effects on the health of elderly people, however exercise programs for seniors frequently focus on other forms of exercise. This study is a randomised trial with a blinded assessor comparing a community based progressive resistance training program (n = 20) with a flexibility program (n = 20), both one hour twice weekly for 10 weeks. Outcomes were strength, gait, balance and quality of life. Progressive resistance training had a greater effect than flexibility training on right sided quadriceps strength (mean difference between groups = 7.7%; 95% CI 3.6-11.8%, $p < 0.003$ MANOVA), left sided quadriceps strength (mean difference = 9.9%; 95% CI 5.6-14.2%, $p < 0.003$ MANOVA), left sided biceps strength (mean difference = 15.2%; 95% CI 11.7-19.2%, $p < 0.003$ MANOVA), functional reach (mean difference = 11.7%; 95% CI 7.1-16.3%, $p < 0.003$ MANOVA) and step test (mean difference = 8.6%; 95% CI 3.8-13.4%, $p < 0.003$ MANOVA). Neither group had improvements in SF36 quality of life measures. Results suggest progressive resistance training produces greater strength, gait and balance improvements in elderly people than a flexibility exercise program. **[Barrett C and Smerdely P (2002): A comparison of community-based resistance exercise and flexibility exercise for seniors. *Australian Journal of Physiotherapy* 48: 215-219]**

Key words: Aged; Exercise; Physical Fitness; Quality of Life

Introduction

Progressive resistance training has positive effects on the strength (Fiatarone et al 1994), bone density (Nelson et al 1994), depressive symptoms (Singh et al 1997), metabolic profile, risk factors for diabetes and heart disease (Honkola et al 1997, Wallace et al 1997), risk factors for falls (Lord et al 1994) walking endurance (Ades et al 1996) and balance (Fiatarone et al 1994, Nelson et al 1994) of elderly people. Despite these benefits, to date there are few safe and effective progressive resistance training programs that are available and affordable to seniors. Exercise programs for seniors often focus on flexibility, balance and light aerobic exercise.

The purpose of this paper was to determine whether a community-based progressive resistance training program using free weights could significantly improve strength, mobility and quality of life of community-dwelling elderly people. We hypothesised that the evidence-based progressive resistance training protocol would produce greater strength, gait and balance improvements than a flexibility focused program. We also hypothesised that the flexibility group might produce different benefits such as bodily pain reduction due to its expected positive effect on musculoskeletal flexibility.

Method

Subjects and study design Forty-four healthy elderly subjects responded to an advertisement in the local paper and flyers distributed to recreational clubs and community groups. Respondents over 60 years of age were screened using American College of Sports Medicine (1998) guidelines prior to participation. Subjects were excluded if their general practitioner recommended against participation for health reasons or if for any reason they were unable to participate in a class situation. Subjects were allocated to either a progressive resistance training group or a control group which was a non-specific exercise program with a focus on flexibility. Both groups attended a one-hour class twice per week for 10 weeks at a community venue. Subjects attended an information session where they were informed that the exercise programs were part of a research program but were not given specific information about differences in content by the assessor. Those consenting to the study were then assessed. At a different time, another researcher allocated subjects to each group using a computer generated random number list (from a list of participants). Subjects were informed after allocation by letter or phone of the time and venue of their exercise class. The last participant to be allocated was allocated to the flexibility group to ensure equal numbers. The classes were held at the same venue but at least an hour apart. The assessor was blinded to the group allocation and class times and the allocation process was concealed.

Approval for the project was granted from the South East Health Human Research Ethics Committee Southern Section, and subjects gave written informed consent prior to participation.

Assessment The same assessor assessed subjects within two weeks prior to and two weeks after completion of the program. The assessor was a senior physiotherapist trained in the measurement techniques. Assessment included age, height and weight, medical history, falls history and current medications.

Table 1a. Exercises included in PRT program

Upper Limb	Lower Limb
Overhead press	Hip extension
Lateral shoulder raise	Hip abduction
Overhead tricep	Calf raise
Single row	Squat
Upright row	Sit-to-stand
Bicep curl	Hamstring curl

Table 1b: Stretching included in flexibility program

Upper Limb	Lower Limb
Biceps	Hamstrings
Triceps	Quadriceps
Rhomboid	Hip flexors
Trapezius	Calf
	Gluteus
	Hip adductors

Table 2. Mean (95% CI) of baseline clinical data

Characteristic	Progressive Resistance Training	Flexibility Training
Male (%)	25	25
Age (years)	66.6 (63.9 to 69.2)	69.6 (66.6 to 72.5)
Medications (number)	1.7 (1.2 to 2.2)	1.3 (0.8 to 1.8)
Height (cm)	167.7 (163.6 to 171.8)	166.2 (161.9 to 170.5)
Weight (kg)	80.5 (73.0 to 87.8)	69.0 (61.9 to 76.1)

Strength, gait and balance For all tests, subjects were given one attempt to warm up and practise the movement, and then two attempts were recorded with the best attempt used for analysis.

Isometric strength was assessed bilaterally using a handheld dynamometer[(a)]. Biceps strength was measured in sitting, elbow at 90 degrees, shoulder in neutral and wrist supinated with the dynamometer held by the assessor just proximal to the wrist (Wadsworth 1992). Quadriceps strength was measured in sitting with the knee and hip at 90 degrees (Bohannon 1986) with the assessor stabilised by holding onto a stable fixture. The dynamometer was placed on the distal tibia anteriorly and posteriorly respectively, slightly above the level of a line drawn between the malleoli. Time taken to stand and sit five times in a row to full standing alignment was also used to assess leg strength (Csuka and McCarty 1985).

The Functional Reach Test (Duncan et al 1990) and the Step Test (Hill et al 1996) were used as measures of balance. Both tests have proven reliable and valid measures of balance in the healthy elderly population.

Quality of life The SF36 Health Survey (Ware 1993) which measures self-reported quality of life, was administered to subjects before and after the training period. The survey has eight sub-scales reflecting physical, emotional, mental and social functioning, and has been validated in the elderly population.

Setting and intervention The exercise groups were conducted at two recreational clubs. Two fitness instructors who received training from the physiotherapist delivered the exercise programs. Progressive resistance training and flexibility groups were divided between instructors to eliminate trainer bias. Each class comprised a maximum of 10 participants.

Progressive resistance training group Progressive resistance training included a warm-up of stretching and walking (five minutes), eight to 10 resistance exercises for the upper and lower limb (45 minutes) (Table 1a), followed by stretching (five minutes). Free weights were used as resistance in the form of hand-held dumbbells and ankle cuff weights available in 0.5kg increments, with exercise intensity approximated using the Borg rate of perceived exertion scale (RPE) (Borg 1982). For the first two sessions, subjects trained at "light" to "somewhat hard" on the RPE, completing one to two sets of eight repetitions. For the remainder of the sessions, subjects completed two to three sets, at "hard" to "very hard" on the RPE. Subjects were cautioned to increase intensity with respect to joint pain or other health limitations, and weights were progressed and recorded during the program under the supervision of the instructor.

Flexibility control group The flexibility control group included mainly stretches for the major muscle groups (Table 1b) (25 minutes) as well as some light cardiovascular exercise (20 minutes) and very low intensity strengthening (15 minutes). It included some exercises that were in the progressive resistance training program, for example squats and biceps curls, performed at higher repetitions without weights or with very light weights that were not progressed.

Statistical analysis Data have been included on an intention-to-treat basis and were analysed using SPSS for Windows 10.1 (SPSS 1990). For analysis of strength, force values (N) were divided by body weight (N), to give

Table 3. Mean (SD) of pre and post program data, percentage change from baseline and difference between groups.

Measurement		Progressive Resistance Training			Flexibility Training			
		Before	After	% Change‡	Before	After	%Change	% Change Difference (95% CI)
Quadriceps strength	Right	0.33 (0.07)	0.37 (0.08)*	14.0 (2.7)	0.38 (0.10)	0.41 (0.10)	6.3 (0.10)	7.7 (3.6 - 11.8)
(force(N)/body weight (N))	Left	0.32 (0.07)	0.37 (0.07)*	18.1 (2.8)	0.37 (0.09)	0.40 (0.08)	8.2 (3.0)	9.9 (5.6 - 14.2)
Biceps strength	Right	0.22 (0.06)	0.25 (0.06)*	13.5 (2.3)	0.27 (0.08)	0.28 (0.08)	15.7 (3.2)	-2.2 (-6.9 - 1.9)
(force(N)/body weight (N))	Left	0.22 (0.05)	0.26 (0.05)*	15.7 (2.5)	0.27 (0.08)	0.27 (0.07)	0.52 (2.0)	15.2 (11.7 - 19.2)
Sit to stand (s)		11.6 (2.7)	10.2 (2.3)*	11.5 (1.6)	10.2 (1.5)	9.2 (1.2)*	9.6 (2.3)	1.9 (-0.9 - 4.7)
Functional reach (cm)		33.8 (4.8)	37.6 (3.3)*	12.7 (3.1)	33.2 (5.1)	33.4 (5.8)	0.97 (2.8)	11.7 (7.1 - 16.3) ¶
Step Test (n)		14.0 (3.1)	18.0 (3.1)*	32.1 (3.8)	16.5 (3.0)	20.2 (3.1)*	23.5 (2.5)	8.6 (3.8 - 13.4) ¶
10m fast walk (s)		5.4 (1.2)	4.9* (1.1)	8.8 (1.8)	5.1 (0.8)	4.7 (0.9)	6.6 (2.3)	2.2 (-0.7 - 5.1)
SF36 physical functioning		71.0 (18.0)	73.8 (19.0)	2.8 (10.9)	76.5 (17.2)	78.5 (16.9)	2.0 (10.6)	0.8 (-2.6 - 4.2)
SF36 role-physical		55.0 (46.3)	72.5 (42.1)	17.5 (29.4)	76.2 (33.9)	76.3 (35.8)	0 (42.1)	17.5 (5.7 - 29.3)
SF36 bodily pain		66.6 (29.8)	76.7 (22.6)	10.1 (21.5)	79.7 (18.1)	73.6 (26.8)	-6.1 (22.4)	16.2 (8.7 - 23.6)
SF36 general health		70.9 (14.9)	74.0 (16.1)	3.2 (12.5)	74.3 (15.4)	77.2 (14.6)	2.9 (11.0)	0.3 (-3.5 - 4.1)
SF36 vitality		44.3 (17.0)	53.5 (21.7)	9.3 (18.8)	60.3 (16.3)†	63.5 (13.1)	3.3 (8.0)	6.0 (1.3 - 10.7)
SF36 social functioning		80.0 (26.0)	87.5 (22.2)	7.5 (16.4)	94.4 (13.1)	91.2 (14.1)	-3.1 (14.6)	10.6 (5.4 - 15.8)
SF36 role-emotional		81.7 (33.3)	78.3 (36.3)	-3.3 (28.4)	83.3 (29.6)	86.7 (27.4)	3.3 (30.4)	-6.6 (-15.9 - 2.7)¶
SF36 mental health		72.8 (17.8)	76.8 (19.1)	4.0 (10.7)	76.8 (13.8)	78.4 (13.9)	1.6 (8.9)	2.4 (-0.7 - 5.5)

‡ Percentage change from baseline

† Significantly different from PRT group at baseline ($p < 0.003$, *t*-test)

* Significantly different from baseline ($p < 0.003$, paired *t*-test)

¶ Significantly different change between groups ($p < 0.003$, MANOVA, SF36 subscale-vitality entered as covariate)

force/body weight (%) to reduce variability between subjects. Group characteristics for age, height, weight, medication number and initial test scores were compared at baseline using independent sample *t*-tests. Gender was compared using Chi-square tests. Given the large number of variables in the baseline analysis, the level of significance was altered using the Bonferroni adjustment such that $p < 0.003$ was regarded as significant.

For analysis of change from baseline values for each group, initial and final strength, gait, balance and SF36 scores were analysed using paired samples *t*-tests. For differences between groups, percentage improvement in strength, gait and balance were compared using multivariate ANOVA. For the SF36 survey, differences between initial and final transformed scores were compared between groups using multivariate ANCOVA. Variables found to be significantly different between the two groups at baseline were entered as covariates in the analysis.

Results

Subject characteristics Forty subjects finished the program and were reassessed. Subject details for all components of the study are presented in Table 2, and initial test scores presented in Table 3. No subject experienced falls in the 12 months preceding the study. This was not included in any subsequent analysis or reporting. There were no differences in sex distribution, age, height and medication number between the groups. Only SF36 vitality ($p < 0.003$) was significantly better in the flexibility group than the progressive resistance training group.

Of the 44 subjects initially assessed, two subjects from the progressive resistance training group and two from the flexibility group dropped out during the study. Reasons for dropping out were aggravation of osteoarthritic knees (n = 2 from progressive resistance training group), transport difficulties (n = 1) and other commitments (n = 1). The rate of return of SF36 surveys was 100% from those completing the program.

Strength, gait and balance Means and 95% CIs for differences between groups as well as values and percentage improvements from baseline are presented in Table 3. The progressive resistance training group improved significantly compared to baseline in all physical measurements (see Table 3). The flexibility group improved significantly compared with baseline in sit-to-stand and step tests, but not in the other physical measurements (see Table 3).

Using multivariate analysis of variance of percent change from baseline to correct for baseline differences (using the SF36 sub-scale–vitality as covariate), progressive resistance training had a greater effect than flexibility training on right sided quadriceps strength (mean difference between groups = 7.7%; 95% CI 3.6 to 11.8%, $p < 0.003$ MANOVA), left sided quadriceps strength (mean difference = 9.9%; 95% CI 5.6 to 14.2%, $p < 0.003$ MANOVA), left sided biceps strength (mean difference = 15.2%; 95% CI 11.7 to 19.2%, $p < 0.003$ MANOVA), functional reach (mean difference = 11.7%; 95% CI 7.1 to 16.3%, $p < 0.003$ MANOVA) and step test (mean difference = 8.6%; 95% CI 3.8 to 13.4%, $p < 0.003$ MANOVA) (see Table 3).

Quality of life On the SF36 Health Survey, neither group improved significantly from baseline in any subscale at the $p < 0.003$ level (see Table 3). Post hoc power was determined to be at a level $\beta = 0.9$, suggesting a Type II error is possible.

Discussion

The time and cost limitations of community exercise programs indicate the importance of comparing the advantages of different types of programs and the results they produce. The target group, elderly people, often find it difficult to travel to venues for exercise and can less easily afford multiple exercise programs, so exercise outcomes should be achieved as efficiently as possible. While subjects in this study reported that they enjoyed both exercise programs, physical outcomes were better in the progressive resistance training group. Our results suggest progressive resistance training produces greater strength, balance and gait improvements than a non-specific flexibility exercise group. This implies that it is important to include relatively high intensity strength training in exercise programs for older adults. There were no changes in the quality of life measures in either group. However, post hoc sample size analysis suggests the possibility of Type II statistical errors.

Our program adopted current guidelines to minimise stresses on joints, including avoidance of locking the joint during repeated exercise, using closed-chain instead of open-chain quadriceps exercises and performing exercises in a pain-free range. Despite this, two subjects dropped out after only a few sessions due to aggravation of arthritic knees. Previous studies have found that pain in both rheumatoid arthritis (Hakkinen et al 1999, Komatireddy et al 1997) and osteoarthritis (Ettinger et al 1997) is reduced with progressive resistance training, though training intensity was lower in these studies. Fransen et al (2001) found improved pain and physical function in subjects with knee osteoarthritis with a group exercise program. Since the majority of elderly people suffer from some form of arthritis, further study should investigate the best intensity and rate of progression of resistance training for arthritic joints, as well as which specific exercises should be avoided or modified.

The results of this study support the value of a community based progressive resistance training program using free weights compared with a flexibility focused exercise program in improving physical outcomes of community dwelling older people. Further studies with larger numbers may show changes in quality of life measures. Future research should investigate the best resistance training exercises to lessen pain and improve function in arthritic joints.

Footnote [(a)] Powertrack II Commander, Australasian Medical and Therapeutic Instruments Pty Ltd, Albany Creek, Queensland, Australia.

Acknowledgements The authors would like to thank Dr Catherine Sherrington for her kind review of the draft manuscript and Professor Laurie Howes for statistical advice and analysis. The authors also acknowledge that this entire project was funded by a grant from the Commonwealth Department of Veterans' Affairs, Value Added Veterans' Services scheme.

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