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Spinal-Flexibility-Plus-Aerobic Versus Aerobic-Only Training: Effects of a Randomized Clinical Trial on Function in At-Risk Older Adults

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Background. As exercise is associated with favorable health outcomes, impaired older adults may benefit from specialized exercise interventions to achieve gains in function. The purpose of this study was to determine the added benefit of a spinal flexibility-plus-aerobic exercise intervention versus aerobic-only exercise on function among community-dwelling elders.

Methods. We employed a randomized clinical trial consisting of 3 months of supervised exercise followed by 6 months of home-based exercise with telephone follow-up. A total of 210 impaired males and females over age 64 enrolled in this study. Of these, 134 were randomly assigned to either spinal flexibility-plus-aerobic exercise or aerobic-only exercise, with 116 individuals completing the study. Primary outcomes obtained at baseline, after 3 months of supervised exercise, and after 6 months of home-based exercise included: axial rotation, maximal oxygen uptake ($\dot{V}O_2$max); functional reach, timed-bed-mobility; and the Physical Function Scale (PhysFunction) of the Medical Outcomes Study SF-36.

Results. Differences between the two interventions were minimal. Overall change scores for both groups combined indicated significant improvement for: axial rotation (p=.0011), $\dot{V}O_2$max (p=.0001), and PhysFunction (p=.0016). Secondary improvements were noted for overall health (p=.0025) and reduced symptoms (p=.0008). Differences between groups were significant only for $\dot{V}O_2$max (p=.0014) at 3 months with the aerobic-only group improving twice as much in aerobic capacity as the spinal flexibility-plus-aerobic group. Repeated measures indicated both groups improved during the supervised portion of the intervention but tended to return toward baseline following the home-based portion of the trial.

Conclusions. Gains in physical functioning and perceived overall health are obtained with moderate aerobic exercise. No differential improvements were noted for the spinal flexibility-plus-aerobic intervention.

PHYSICAL activity is associated with decreased mortality, morbidity, and functional decline (1–5). Regular exercise has a beneficial impact on cardiovascular and musculoskeletal impairments and often translates into favorable gains in the performance of daily tasks (6–10). Most exercise interventions targeting improved physical functioning focus on strength, balance, gait, cardiorespiratory fitness, and extremity flexibility. Spinal flexibility has received less attention but is an important dimension of function. Spinal flexibility may decrease between 25% and 50% with age and is an essential prerequisite for normal movement (11). In a group of 79-year-olds, Bergstrom and associates (12) found that individuals with restricted spinal flexibility had significantly more difficulty in entering public transportation vehicles, increased use of walking aids, difficulty reaching above head, and more difficulty climbing stairs than those without spinal restrictions. Schenkman and colleagues (11) found positive associations between spinal flexibility and the ability to reach, turn, and go from a supine to sitting position. These results suggest that adequate spinal flexibility is an important dimension of physical performance. Although the mechanisms of such are unknown, lack of spinal flexibility may be a possible source of decline in the physical capabilities of older adults.

We conducted a randomized clinical trial that compared two programs: a spinal flexibility-plus-aerobic exercise versus aerobic-only exercise, among at-risk community-dwelling elders. Our primary outcomes included measures of impairment (spinal flexibility and cardiorespiratory fitness); functional limitations (functional reach and timed-bed-mobility); and disability (global physical functioning). We compared changes following 3 months of supervised exercise and following 6 months of home-based exercise. Our secondary goal was to examine changes in perceived symptomatology and in spinal flexibility and configuration (thoracic kyphosis and lumbar lordosis) resulting from the intervention. To assess the generalizability and potential biases of our results, we describe differences between individuals completing the study and those who declined to participate or withdrew.

Methods

The study was conducted at the Department of Veterans Affairs and Duke University medical centers in Durham, North Carolina. The protocol for the clinical trial was reviewed and approved annually by the Duke and VA institutional review boards.

Participants

Participants (n=486) were recruited through mailings and telephone calls to age-eligible persons from the Duke Aging Center Registry and by word of mouth (Figure 1). Of those contacted, 286 agreed to a telephone interview to determine initial eligibility. Our goal was to target individuals at risk for functional decline because of impaired cardiorespiratory fitness and/or spinal flexibility. Thus, individuals reporting regular exercise were considered "not at risk" for functional decline and were excluded. Nineteen of those interviewed were regular, vigorous exercisers; 57 declined further participation. The remaining 210 potential participants agreed to undergo more intensive screening to determine their eligibility for the study. They reported for a physical examination and provided informed consent and demographic information.

Further eligibility for the study was determined during three separate visits using the criteria presented in Table 1. These included a medical history and physical examination conducted by a board-certified geriatrician (RJS); a visit to the Postural Control Laboratory to assess flexibility, physical functioning, and self-reported functioning and disability; and a visit to the Exercise Testing Laboratory to assess cardiorespiratory fitness and screen for the presence of cardiovascular disease.

Of the 210 individuals who consented to enroll in the study, 24 dropped out during the screening process, 23 were excluded because they were not at risk for functional decline, and 29 were excluded for medical reasons. Every effort was made to be as inclusive as possible. A cardiologist (KGM) reviewed the exercise tests and excluded only those individuals with evidence of significant coronary disease. In some cases, individuals with late, minimal evidence of ischemia were allowed to participate at a reduced exercise intensity. Other individuals were allowed to participate if further evaluation of cardiovascular disease, undertaken at the individual's expense, proved negative. In total, 134 individuals were randomized to the exercise interventions.

Measures

Participants completed comprehensive functional and pyschosocial evaluations prior to randomization, after 3 months of supervised exercise program, and after 6 months of home-based exercise. The assessments were conducted on two separate days within a 7-day period at the participants' convenience. Data were collected in two sites (Postural Control Laboratory and Exercise Testing Laboratory) by technicians blinded to study assignment.

Postural control laboratory.—Spinal flexibility, physical performance, self-reported disability, and quality of life measures were obtained during a 3-hour visit. All measures were administered by two technicians following a computer-assisted structured protocol. *Impairment* in spinal flexibility was assessed using functional axial rotation (pointer), a measure not restricted to single plane movement that combines cervical, thoracic, and lumbar mobility (13). We averaged two trials measuring left and right axial rotation. *Functional limitation* was assessed by: (a) functional reach (maximal distance reached in standing without taking a step), the mean of three trials (14), and (b) timed-bed-mobility (total time to move from a supine position to a standing position at normal pace), the mean of two trials. Prior to testing, all technicians underwent rigorous training to establish inter- and intraindividual reliability. Interclass correlation coefficients ranged from 0.70 to 0.96 for flexibility and performance measures (15). *Disability* was assessed by self-administration of the Physical Functioning Scale (PhysFunction) of the Medical Outcomes Study SF-36 (16). The scale asks how present health limits ability to bathe, dress, walk, climb stairs, carry groceries, and perform moderate to vigorous activities (16, 17).

Other self-reported measures included a comorbidity disease and symptom index. The disease index, for 21 unique medical conditions, asked each person to respond in the affirmative or negative to the following question: "Since you were 55 has a doctor ever told you that you have had _________?" Diseases cited included angina, congestive heart failure, heart attack, stroke, Parkinson's disease, lung disease, arthritis, osteoporosis, depression, sleeping disorder, chronic pain syndrome, cancer, diabetes, visual diseases, and surgical procedures. The symptom index, for 22 unique symptoms, asked each subject to respond in the affirmative or negative to the following question: "Within the last month, do you currently have ______?" Symptoms cited included chest pain, shortness of breath, muscle weakness, fatigue, dizziness, nausea, balance problems, fear of falling, sadness, anxiety, visual problems, pain, cramps, numbness, incontinence, confusion, and difficulty sleeping at night. Individuals reporting the presence of a disease or symptom were then asked how it limited their function on a 4-point scale ranging from "not at all" to "quite a bit." Overall ratings of general quality of life (single-item question taking every aspect of life together and rating quality from excellent to poor) and health-related quality of life, Question 1 of the SF-36 (16), were also ascertained.

Exercise testing laboratory.—Cardiorespiratory fitness was assessed via a symptom-limited maximal exercise tolerance test performed in a fasting or near-fasting state. A practice exercise test was administered to each participant to screen for cardiovascular disease and to determine if the subject exceeded the fitness limits of our study design. The practice test was performed on a Marquette Series 1000 treadmill (Marquette Electronics, Milwaukee, WI) using a protocol developed by our laboratory for older adults. All subsequent exercise tests used a modified protocol specific to the individual's baseline fitness that was repeated at baseline and at each follow-up. Maximal oxygen consumption was obtained from the oxygen consumption recorded at the peak workload. Weight was measured in pounds and height in inches, without shoes, for estimation of body mass index during this visit.

Intervention

Overview.—Upon completion of all baseline assessments, eligible participants (n=134) were randomly assigned to one of two treatment groups. Computer-generated randomization assignments were contained in envelopes that were unsealed after baseline data collection was completed. Block randomization occurred on the basis of gender and high (>13 inches) versus low (≤13 inches) functional reach. A cutpoint of 13 inches was selected for stratification based on previous research, indicating that 13 inches was an approximate mean value of community dwellers (18). Spouses and close friends who carpooled were randomized together in order to minimize contamination between the interventions.

For the supervised component of the study, both groups met for one-hour sessions, 3 days a week for 3 months at the VA Medical Center. Each session consisted of approximately 10 min-

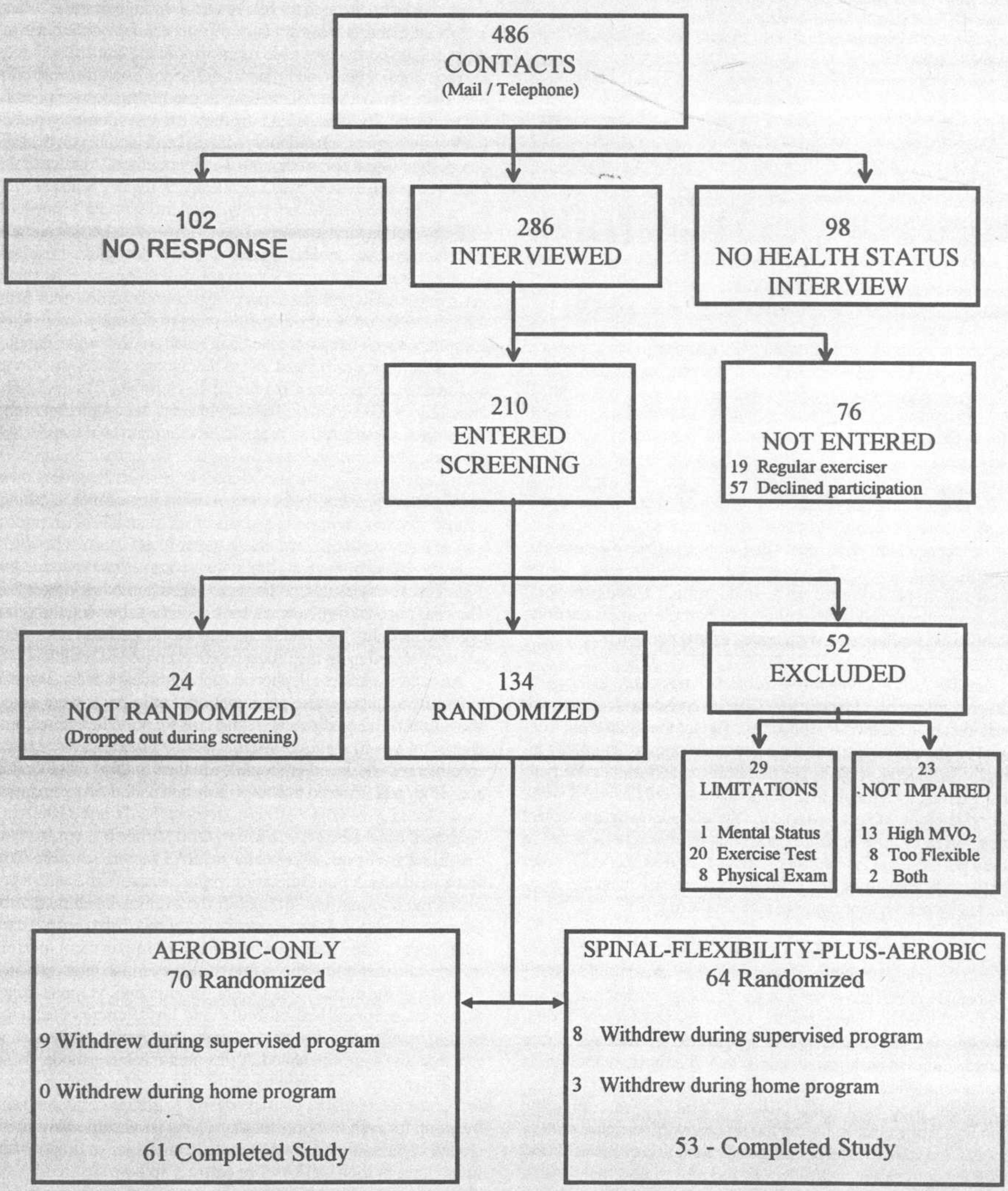

Figure 1. Progress through the stages of the clinical trial.

Table 1. Exclusion Criteria

Determined From the Telephone Interview
Age, < 65 years
Currently regular, vigorous exerciser
Determined From Medical History and Physical Examination
Score < 7, Short Portable Mental Status Questionnaire
Less than 20/100 corrected vision
Unstable angina
Congestive heart failure within last 12 months
Myocardial infarction within previous 6 months
Unstable chronic obstructive pulmonary disease requiring Prednisone in last 12 months
Cerebrovascular accident or fixed hemiparesis resulting in nonfunctional upper extremity
Uncontrolled hypertension with diastolic > 100 mmHg
Active progressive neurologic diagnosis, <4/5 motor strength or loss of light touch
Lower extremity amputation, must have great toe
Determined From Laboratory Assessments
Peak oxygen uptake: > 27 ml/kg/min (males); > 25 ml/kg/min (females)
Axial rotation: > 120 degrees (combined left and right sides)

utes of warm-up and stretching exercises, 40 minutes of intervention exercises, and 5 to 10 minutes of cool-down exercises. Participants were asked to exercise at home on the weekend for a fourth session to prepare for the home component of the study.

Participants in both groups were required to complete 36 sessions before advancing to the 6-month home-based program. To accommodate vacations, illness, or unscheduled events, missed sessions could be made up at their convenience during the 3-month period or for up to an additional 4 weeks beyond the 3-month period. Participants not completing 36 sessions within a 16-week period were coded as low compliers.

Aerobic-only intervention.—Subjects randomized to the aerobic-only intervention were offered two exercise modalities, brisk walking and/or stationary bicycling. The intervention was structured such that exercise was done in two contiguous 20-minute intervals. In general, subjects began exercising at 5-minute intervals with gradual increments in time and intensity over a 4- to 8-week period until the subject was able to tolerate continuous exercise at approximately 70% of his/her heart rate reserve. Throughout the study period, exercise intensity was increased as needed in order for the individual to remain at the desired exercise intensity, as indicated by heart rate or rating of perceived exertion.

Spinal flexibility-plus-aerobic intervention.—Subjects randomized to the spinal flexibility-plus-aerobic intervention followed the protocol described above for a single 20-minute bout of aerobic exercise followed by approximately 20–30 minutes of spinal flexibility exercises. The exercises were designed to promote spinal mobility in different positions starting with very supported positions in supine, sidelying, and prone, and progressing through less supported and more demanding positions of quadruped, sitting, and standing. For example, during the first week of exercise, participants focused on deep breathing and relaxation of the neck and trunk by doing a series of slow, relaxed movements that isolated hip abduction and adduction, internal and external shoulder rotation, and cervical rotation. During Week 2, in addition to Week 1 exercises, segmental movement of the spine and upper quadrant was emphasized from a sidelying position with exercises emphasizing thoracic movement. Week 3 added exercises focusing on spinal flexion and extension from a prone position. New exercises were added each week to gradually increase spinal and extremity range of motion through the relaxation of synergistic muscles and lengthening of soft tissue structures. For each of the different positions, suggestions were made for incorporating learned activities into activities of daily living, such as efficiently getting on or off a bed, rising from a seated position, or promoting correct posture while driving. To enhance learning these exercises correctly, participants where given a handbook with text and pictures on the first day of the program. Participants were encouraged to refer to the handbook when exercising independently on the weekend (19).

Preparations for home-based program.—Each participant was asked to exercise one day on the weekend during the hospital-based program to prepare for the home-based portion of the study. Participants were loaned exercise bicycles and exercise mats from the sixth week on, for the entire duration of the study, to facilitate compliance with the programs. Each week an exercise leader discussed the "homework" and offered encouragement, suggestions, and advice to maximize compliance. Exercise diaries were maintained by the participants. Two weeks prior to completion of the supervised portion of the program, an exercise leader spent approximately 20 minutes discussing a home program plan with each participant. The planner offered suggestions regarding optimizing exercise compliance in terms of exercise times, clothing, partners, inclement weather, and what to do if an illness occurred.

Home-based program.—Following completion of the second assessment of measures, participants began home-based exercise. They exercised 4 days a week for 6 months following the same exercise modality they had been assigned. Target heart rates were adjusted according to their most recent exercise test results.

An exercise leader telephoned each participant every 2 weeks to inquire about exercise participation. Participants were asked about health and medication changes, self-reported exercise compliance on a 1–10 scale, number of exercise sessions, average time spent per session, whether they were in their training range or not, and if they remembered to do warm-up and cool-down exercises.

Statistical Analyses

All analyses were conducted using SAS System software (20). First, to assess if randomization was effective, differences between the intervention groups for the average baseline demographic and physical variables were examined. Next, our primary analyses assessed change in measures of impairment, performance, and disability due to one of two exercise interventions. For each of the primary outcomes (axial rotation, $\dot{V}O_2$max, functional reach, timed-bed-mobility, and PhysFunction), change scores (baseline to 3 months, 3 months to 9 months, and baseline to 9 months) were calculated. A repeated-measures model using intention to treat as a grouping factor was used to calculate the effect of the intervention, both overall (both groups combined) and by group for each outcome measure. That is, all subjects were included in the analyses irrespective of compliance or dropout status so long as they had baseline testing. To help ensure that the obtained intervention effect was not due to confounding, a model was created to estimate the effect of the intervention controlling for baseline age, sex, race, education, level of compliance during the home program, body mass index, total number of comorbid diseases, and high or low baseline functional reach.

Several secondary analyses were performed: (a) we examined whether changes in overall health and symptomatology and/or structural configuration of the spine occurred as a result of the interventions, and (b) we compared baseline demographic and physical functioning between individuals completing the study and those who declined to participate or withdrew, in order to evaluate selection bias.

Results

The characteristics of the 134 randomized study participants are shown in Table 2. Race and gender distributions were similar to those of the counties from which they were recruited. Recruits for this study reported higher education levels than the average for the surrounding counties. The most prevalent self-reported medical conditions in this sample were arthritis (49%), cardiovascular diseases (40%), orthopedic problems including joint replacement, broken bones, and osteoporosis (38%), cataracts (37%), and history of cancer (19%). There were no statistically significant differences between the groups at baseline for the variables listed.

A total of 17 subjects withdrew from the study during the supervised portion of the protocol (8 spinal flexibility-plus-aerobic, 9 aerobic-only). All but 10 of the remaining participants (91%) attended all 36 sessions. Exercisers attending sessions were within their prescribed exercise range heart rates 69% of the time. Of the 117 subjects who entered the 6-month home program, 97% completed the home portion of the program and the final testing. The three subjects who did not complete final testing stopped because of health reasons (stroke, cancer, surgery). Home exercisers reported being compliant with their programs on average 67% of the time on the basis of their exercise diaries and telephone interviews.

Primary Outcomes

Changes in impairment, performance and disability.—The changes in the primary study measures are presented in Table 3. Overall, for both groups combined, the omnibus tests of time were significant for axial rotation (p=.0011), $\dot{V}O_2$max (p=.0001), and PhysFunction (p=.0016). However, in follow-up tests of the individual time periods, we discovered that these changes were driven by improvement that occurred during the supervised portion of the project. P values for the individual time periods are indicated in Table 3. There were no significant differences in physical performance tests over time (functional reach p=.279; timed-bed-mobility p=.640). Differences between intervention were significant only for $\dot{V}O_2$max (Time × Group interaction, p=.0014), possibly indicating a dose-response effect of 20 versus 40 minutes of aerobic exercise. These results were essentially unchanged after controlling for age, sex, race, education, level of compliance, body mass index, total number of comorbid diseases, and high or low functional reach.

Secondary Outcomes

Changes in symptomatology.—As indicated in Table 4, participants in both groups reported significant improvements in overall health (p=.0025), total number of symptoms reported (p=.0008), and the effect of symptoms on functional limitations (p=.0002). There were no changes in self-reported overall quality of life, total number of diseases reported, or the effect of diseases on functional limitations.

Changes in structural configuration and regional measures of spinal flexibility.—There were no differences between groups for any of the measures of structural configuration examined. Overall changes were observed for cervical rotation (p=.001) and lumbar (flexion plus extension) range of motion (p=.04) but not for cervical extension and lumbar or thoracic kyphosis.

Effect of supervision.—The effect of the supervised component of the intervention was potent. As indicated in Figure 2, the

Table 2. Baseline Comparison of Groups

Variable	Spinal Flexibility-Plus-Aerobic n = 64	Aerobic n = 70
Gender: % female	69%	70%
Race: % African American	30	21
Marital status: % married	48	60
Mean age	71.9 ± 5.8	71.9 ± 4.6
Mean years of education	13.8 ± 3.0	13.7 ± 2.6
Mean number of diseases reported	4.1 ± 2.3	3.7 ± 2.3
Mean body mass index	27.9 ± 4.4	28.3 ± 4.2

Table 3. Changes in Impairment, Performance, and Disability

	Baseline	3 Months	9 Months	Groups Combined* p value 0–3 mos	p value 0–9 mos
Impairment Measures					
Axial rotation (degrees)					
SF+	103.18 ± 9.77	106.90 ± 12.08	104.42 ± 13.73	.0111	.944
Aer	103.78 ± 12.33	106.88 ± 13.57	104.32 ± 13.91		
$\dot{V}O_2$max (ml/kg/min)					
SF+	18.78 ± 4.11	19.50 ± 4.57	18.95 ± 4.36	†	.071
Aer	18.19 ± 4.32	20.19 ± 4.87	19.11 ± 5.19		
Functional Limitation Measures					
Functional reach (inches)					
SF+	13.42 ± 2.42	13.88 ± 2.26	14.04 ± 2.46	.657	.260
Aer	13.60 ± 2.26	13.67 ± 2.14	13.95 ± 2.39		
Timed-bed-mobility (seconds)					
SF+	5.42 ± 2.07	5.26 ± 1.98	5.37 ± 1.78	.639	.816
Aer	4.91 ± 1.56	4.83 ± 1.13	5.06 ± 1.75		
Disability Measure					
Physical functioning (mean, 0 = low functioning–100 = high functioning)					
SF+	71.64 ± 20.60	79.68 ± 17.01	73.41 ± 21.94	.0035	.687
Aer	76.57 ± 18.42	79.70 ± 18.54	78.67 ± 19.56		

Notes: SF+ = spinal flexibility-plus-aerobic group; Aer = aerobic-only group.

*No between-group differences were noted except for $\dot{V}O_2$max; therefore, reported p values indicate overall significance of change over time compared to baseline for both groups combined. All results are based on intention-to-treat analysis and include control for group, Group × Time interaction, age, race, years of education, no. of chronic diseases, body mass index, baseline high or low functional reach, and no. of weeks participants complied to exercise program during the home phase of the protocol.

†Significant Group × Time interaction (p = .0114); aerobic-only group improved twice as much as spinal flexibility-plus-aerobic group.

Table 4. Changes in Quality of Life and Symptoms

	Baseline	3 Months	9 Months	Groups Combined* p value 0–3 mos	Groups Combined* p value 0–9 mos
General quality of life (mean, Likert scale: 1 = Excellent–5 = Poor)					
SF+	2.33 ± 0.71	2.25 ± 2.25	2.38 ± 0.74	.3944	.4172
Aer	2.17 ± 0.80	2.10 ± 0.74	2.19 ± 0.87		
Health-related quality of life (mean, Likert scale: 1 = Excellent–5 = Poor)					
SF+	2.70 ± 0.71	2.37 ± 0.73	2.51 ± 0.83	.0009	.3762
Aer	2.37 ± 0.73	2.21 ± 0.77	2.38 ± 0.85		
Effect of disease on functional limitations† (1 = Not at all–4 = Quite a bit)					
SF+	4.84 ± 4.40	4.38 ± 3.67	4.53 ± 4.32	.8469	.2073
Aer	4.19 ± 3.88	4.08 ± 3.48	4.69 ± 3.96		
Total number of symptoms (mean)					
SF+	4.63 ± 3.27	4.02 ± 3.39	4.70 ± 4.05	.0001	.0567
Aer	4.87 ± 3.52	3.56 ± 2.55	4.05 ± 2.92		
Effect of symptoms on functional limitations† (1 = Not at all–4 = Quite a bit)					
SF+	4.63 ± 7.87	7.39 ± 7.05	9.23 ± 8.26	.0001	.1999
Aer	8.80 ± 7.38	5.63 ± 4.70	7.30 ± 5.75		

Notes: SF+ = spinal flexibility-plus-aerobic group; Aer = aearobic-only group.

*No between-group differences were noted, therefore, reported p values indicate overall significance of change over time compared to baseline for both groups combined. All results are based on intention-to-treat analysis.

†The effect of diseases or symptoms on limitations were calculated as the total score times the number of individual diseases or symptoms reported.

impairment and disability measures improved, and reported symptoms were reduced between baseline and the 3-month testing periods. Following completion of the home-based program, there was an attenuation of the effect of the intervention. For every variable examined, with the exception of functional reach, this pattern of change was the same. Changes were observed in the desired direction following participation in the hospital-based component of the program followed by a gradual return to near-baseline levels following completion of the home program.

Selection bias.—Comparisons between those recruited individuals who declined to participate, those who started but did not complete, and those who completed the 12-week supervised portion of the program indicated few differences. Decliners were significantly older than participators (74.3 years vs 71.5 years, p=.007). Baseline $\dot{V}O_2$max was significantly lower for those who did not complete the 12-week supervised portion of the program compared to those who did complete the program (16.29 ml/kg/min vs 18.56 ml/kg/min, p=.018). There were no other differences among the variables examined between the three groups.

Discussion

We hypothesized a priori that the spinal flexibility-plus-aerobic arm of the clinical trial would yield significant improvements in performance measures above and beyond those expe-

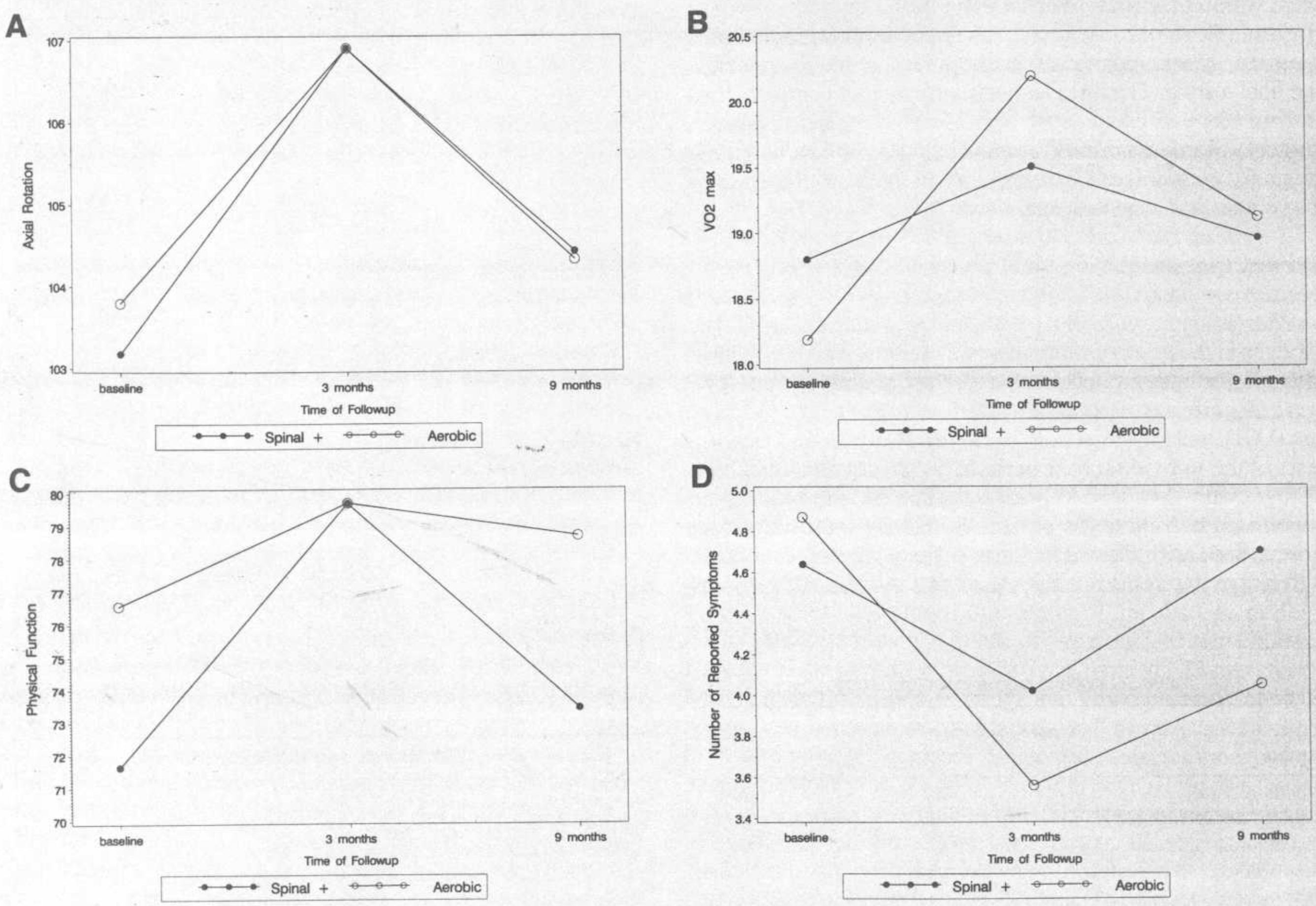

Figure 2. Illustrations of influence of supervision on change scores: (A) Change in axial rotation; (B) change in $\dot{V}O_2$max; (C) change in physical functioning; and (D) change in total reported symptoms.

rienced by participants involved in a more traditional, aerobic exercise intervention. We further hypothesized that improved performance measures would result in reduced self-reported disability. However, we found that participants in this clinical trial benefited from both exercise interventions. The differences between the two interventions were negligible. Therefore, we will limit much of our discussion to overall effects.

The primary measures of impairment, axial rotation and $\dot{V}O_2$max, improved significantly for both groups. Changes in axial rotation were small and may have resulted from a general improvement in overall physical activity experienced by both groups. It is possible that the spinal flexibility-plus-aerobic group was underdosed in the spinal flexibility exercises. Among Parkinson's patients, a similar program with patients treated individually by a physical therapist for 40 minutes three times a week resulted in statistically and significant differences when compared to a placebo group (21).

In our study the only between-group effect was noted for aerobic capacity and most likely indicates a dose response. Percent changes for $\dot{V}O_2$max were 3.8% and 10.9% for individuals undergoing 20 minutes or 40 minutes, respectively, of aerobic exercise during the study. A meta-analysis conducted by Green and Crouse (22) indicated an average 14% improvement in cardiorespiratory fitness for older adults following endurance training. In comparison, participants in our study had a substantially lower mean baseline oxygen consumption than those in the Green and Crouse analysis (18.8 vs 24.1 ml/kg/min) and most likely had more comorbidities than the average individual included in the Green meta-analysis (22). It is encouraging to note that our participants, who had impaired cardiorespiratory fitness and coexisting morbidities, were able to achieve meaningful gains in aerobic capacity.

There were no overall changes in any of the performance measures. This finding was unexpected given that we had previously observed improvement in functional reach following exercise training in a pilot study conducted prior to this intervention trial (23). The exercises employed in the pilot study involved active challenges to balance by having participants work on rocking platforms and balance beams. The current intervention involved active movement in a relaxed manner designed to increase flexibility, followed by incorporation of these movements into daily activities. Balance control was not specifically challenged. A change in functional reach, a measure of balance control, may require more specific balance training than the one provided by our intervention.

There was a trend toward attenuation of gains during the unsupervised portion of the program. Furthermore, compliance to the intervention was diminished during this same period. The reported compliance during the home-based program was similar to rates reported by others (24). We are unable to determine if reduced compliance is due to reduced social support, lack of supervision, exacerbation of a preexisting condition, or some other unmeasured factor.

We limited our study sample to individuals we considered at risk for functional decline on the basis of impaired cardiorespiratory fitness and spinal flexibility. The average cardiorespiratory fitness of our randomized sample was equivalent to the aerobic capacity the Social Security Administration uses as one of its criteria for disability (25). Our participants averaged 2.5 coexisting diseases, and 32% reported limitations in performing moderate activities (data not shown). Despite our efforts, participants in this study were younger than recruited individuals who refused to participate. Those who completed the study were more aerobically fit at baseline than those who did not complete the study. Our exploratory analyses (data not shown) implied that the interventions were more beneficial to the targeted population (i.e., the frailer individual). Individuals in the lowest percentile of aerobic capacity improved the most on measures of impairment and disability.

In summary, our data provide further evidence that moderate exercise is associated with gains in physical functioning that are accompanied by gains in overall quality of life and reduced symptoms. The least aerobically fit individuals appeared to benefit the most. Given the negligible differences between groups and the relative low cost of a simple aerobic intervention, health care practitioners should note that qualitative gains can be obtained with relatively moderate effort on the part of their clients.

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