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Comparative Effects of Two Physical Activity Programs on Measured and Perceived Physical Functioning and Other Health-Related Quality of Life Outcomes in Older Adults

Abby C. King, Leslie A. Pruitt, Wayne Phillips, Roberta Oka, Annette Rodenburg, and William L. Haskell

Stanford Center for Research in Disease Prevention, Stanford University School of Medicine, Palo Alto, California.

Background. Although inactivity is an important contributor to impaired functioning and disability with age, little is known concerning how improvements in physical functioning and well-being in older adults vary with the type of physical activity undertaken.

Methods. One hundred three adults age 65 years and older, recruited via population-based methods, were randomized to 12 months of community-based, moderate-intensity endurance and strengthening exercises (Fit & Firm) or stretching and flexibility exercises (Stretch & Flex). A combination of class- and home-based exercise formats was used. Measured and self-rated physical performance along with perceived functioning and well-being were assessed pre- and postintervention.

Results. Fit & Firm subjects showed greater 12-month improvements in both measured and self-rated endurance and strength compared to Stretch & Flex subjects. Stretch & Flex subjects reported greater improvements in bodily pain, and Stretch & Flex men evidenced greater improvements in flexibility relative to Fit & Firm subjects. Although overall exercise adherence was high in both exercise conditions (approximately 80%), subjects in both conditions showed better adherence to the home- versus class-based portions of their exercise prescriptions.

Conclusions. Community-based programs focusing on moderate-intensity endurance and strengthening exercises or flexibility exercises can be delivered through a combination of formats that result in improvement in important functional and well-being outcomes. This represents one of the first studies to report significant improvements in an important quality of life outcome—bodily pain—with a regular regimen of stretching and flexibility exercises in a community-based sample of older adults.

ADULTS over age 65 represent one of the fastest growing population segments in the United States (1), as well as worldwide (2). They also account for the greatest proportion of chronic disease burden and disability, resulting in annual health care costs averaging over $3,000 per person (3,4). While the loss of independence and well-being stemming from impaired functioning constitutes the most distressing aspect of aging for many older adults (5), a growing literature underscores the fact that a significant proportion of disability accompanying aging is preventable (3).

Inactivity is among the most important factors contributing to impaired functioning and disability with age (5). A significant relationship has been reported between increases in regular exercise and improvements in physical fitness as measured by aerobic capacity and strength in older adults (6–8). Yet, the relationship between regular physical activity and functional status, including physical tasks performance as well as perceived functioning and well-being, remains to be fully explicated (6–8). In particular, relatively little is known concerning how physical functioning and well-being in older adults vary with the type and format of physical activity undertaken (6,9,10).

The purpose of this study was to evaluate the effects of two different community-based physical activity regimens—one emphasizing endurance and strengthening exercises (Fit & Firm) and the other emphasizing stretching and flexibility exercises (Stretch & Flex)—on one-year physical performance outcomes as well as perceived functioning and well-being in a sample of community-dwelling, sedentary women and men aged 65 years and older. A program of endurance and strengthening exercises was targeted in light of the documented effects and potentially synergistic relationships among those forms of exercise and an array of positive health outcomes in older adults, including improvements in cardiovascular disease risk factors, musculoskeletal function, and reduced risk of falling (11). Similarly, a program focusing on stretching and flexibility exercises was targeted in light of the documented decreases in flexibility (i.e., joint range of motion) accompanying aging (12,13), and its relationship to declines in physical function and health status (14,15). We hypothesized that measured and self-rated physical performance outcomes related to endurance and strength would improve significantly more in response to the Fit & Firm regimen relative to the Stretch & Flex regimen after one year, whereas the Stretch & Flex regimen would result in improved flexibility outcomes relative to the Fit & Firm regimen. Because of the dearth of information comparing such regimens on perceived functioning and well-being (quality of life) outcomes (16), no directional hypotheses were posited for those outcomes. Additional objectives of the study were to explore the effectiveness of a combination of physical activity formats (i.e., class-based and home-based) in promoting one-year adherence to each of the physical activity regimens being investigated, and to evaluate any differential intervention effects by gender. To enhance the representativeness of the study sample, population-based recruitment strategies were used in the target community (17).

Methods

Subjects

Subjects were 103 older adults (67 women; 36 men) who agreed to participate in a randomized clinical trial evaluating the effectiveness of different types of physical activity on physical functioning and health-related quality of life. Eligibility criteria included: current resident of Sunnyvale, California; age 65 years or older; absence of cardiovascular disease or stroke (determined by medical history, clinical examination, and electrocardiograms recorded at rest and during exercise); regularly active no more than twice a week during the preceding 6 months; free of musculoskeletal problems that would prevent participation in moderate levels of physical activity; stable on all medications during the previous 6-month period; and willingness to accept random assignment. An appropriate institutional review board approved the project.

The major recruitment strategy used was a random digit dial telephone survey of Sunnyvale residents (population = 117,229), supplemented with city-wide promotion (18). All age-eligible contactees were asked to complete a 20-minute telephone interview adapted from two previous national surveys (19,20). Respondents who met initial eligibility requirements subsequently underwent extensive physical assessment and completed a battery of health-related quality of life questionnaires. Following stratification on sex, subjects determined to be eligible at baseline were randomly assigned to one of two conditions using a computerized version of Efron's procedure, which promotes equivalent cell sizes throughout the course of randomization (21): (a) moderate-intensity endurance and strengthening exercises (Fit & Firm), or (b) stretching and flexibility exercises (Stretch & Flex). An interim, abbreviated assessment was undertaken at 6 months, and the final assessment occurred 12 months after randomization.

Overview of Interventions

For both conditions, subjects were encouraged to participate in two exercise classes each week and to exercise on their own at home at least twice a week. Exercise classes lasted one hour, but the suggested duration of the home-based sessions was 40 minutes (attained in a progressive fashion). Participants received individualized instruction and information prior to beginning their exercise program. The class size was limited to 10–15 people and was conducted at a local YMCA. Classes were monitored regularly to assure quality and consistency of content.

Fit & Firm classes.—Each class consisted of a 5–10 minute warmup, a 40–50 minute aerobic and strength training section, and a 5–10 minute cooldown. The major component of the class consisted of a combination of aerobic, strength, and muscle-toning exercises. These were conducted in an interval or circuit type format allowing for rest between sets. Muscle groups emphasized included the chest, back, shoulders, quadriceps, calves, abdominals, biceps, and triceps. Instructors used a variety of exercises from each muscle group starting with the larger muscles. Music was used to increase enjoyment. A Step Tech (Formula Ventures, North Miami Beach, FL; model 7055-00) was used to help the more fit subjects elevate their heart rates during the aerobic component. The resistive bands on the Step Tech and homemade hand weights were used to improve strength. Classes started slowly and progressively became more challenging in order to build endurance and strength. Subjects were instructed to assess their heart rates at least once during each class to be sure that they were reaching their target heart rates, which were set at 60–75% of their heart rate reserve based on their most recent treadmill test.

Fit & Firm home sessions.—Subjects were instructed to exercise for at least 40 minutes at their target heart rate at least twice a week at home. The exercise mode consisted primarily of brisk walking. A videotape of the class was provided, together with information on exercise format and technique. (All participants enrolled in the study had ready access to either their own or a rentable videotape player.) Subjects were instructed on how to use either small hand weights or resistive bands at home.

Stretch & Flex classes.—Each class consisted of a 5–10 minute warmup, a 40-minute stretching section, and 5–10 minutes of relaxation exercises. Stretching exercises focused on the neck, shoulders, upper back, chest, waist, lower back, hamstrings, calves, and hands. Instructors used a variety of exercises for each muscle group. Music was used to increase enjoyment. Subjects were instructed to take their heart rates at least once during each class to ensure that they were not significantly elevating their heart rate.

Stretch & Flex home sessions.—Participants were instructed to stretch for 40 minutes twice a week at home, using the stretching routine presented in the class. A videotape of the class was provided, together with information on exercise format and technique.

Telephone counseling.—Participants in both conditions were contacted by a trained health educator weekly during the first month of the intervention, every other week for the next two months, and monthly for the remainder of the year. The purpose of these calls, the content of which was based on social cognitive theory (22) and the Transtheoretical model (23), was to encourage participation in the exercise program, provide problem-solving strategies to overcome barriers to exercise adherence, and remind participants to return their exercise logs. The telephone calls lasted an average of 12–15 minutes.

Measurement Procedures

The measurement battery targeted six conceptually discrete domains of functioning: measured functional capacity/endurance, upper-body strength, lower-body strength, flexibility, self-rated physical performance, and perceived functioning and well-being (i.e., health-related quality of life).

Domain 1: Functional capacity and endurance.—At baseline, 6, and 12 months, all participants performed an ECG-monitored, symptom-limited, graded treadmill exercise test (GXT) using a Balke-type protocol with workloads increasing by approximately 1.0 to 2.0 metabolic equivalents every 2 minutes (24). Oxygen uptake during exercise was determined using a semiautomatic computer-based system described previously (25). Maximal oxygen uptake ($\dot{V}O_2max$) was defined as the highest value determined during the last 2 minutes of exercise. Reasons for termination of the GXT were based on American College of Sports Medicine criteria (26). Test completion was evaluated according to objective criteria (i.e., a respiratory exchange ratio greater than or equal to 1.1 and plateauing of heart rate and/or oxygen uptake). Changes in functional capacity and endurance were evaluated using $\dot{V}O_2max$, treadmill exercise duration, and submaximal heart rate at the end of the third 2-minute stage (treadmill speed at 2 miles per hour; grade at 12.5% incline).

Domains 2–4: Upper-body strength, lower-body strength, and flexibility measured through tasks simulating activities of daily living.—Three discrete functional tasks that simulated common activities of daily living and were relevant to the interventions being targeted were used to assess upper-body strength (lift and reach task), lower-body strength (chair sit to stand task), and flexibility (sit and reach task). Protocols for these tasks were based on those used in previous studies, modified for a healthy community-dwelling population (27–29). Assessment staff were blind to each subject's condition assignment. Intertester and one-week test–retest reliabilities for these measures were evaluated on a subgroup of participants ($n = 29$) at the beginning of the study. Each component of the test battery was found to have excellent intertester reliability [r values > .90; (30)]. In addition, the measures showed adequate stability between the one-week assessment points [r values for the lift and reach and chair sit to stand tasks > .85; r value for the sit and reach task = .75; (30)].

1. *Upper-body strength (lift and reach).* While seated at a standard height desk, participants were asked to repeatedly lift a weight onto and off a shelf placed on the desk and located at shoulder level immediately in front of them. A 10-pound weight was used for women and a 20-pound weight was used for men. The number of repetitions that were completed in one minute was recorded.

2. *Lower-body strength (chair sit to stand).* Participants were asked to repeatedly stand up from and sit down into a standard height chair without the use of their arms. The maximum number of repetitions in one minute was recorded. All participants in the current sample were able to do at least one chair sit to stand at baseline.

3. *Flexibility (sit and reach).* Using an Accuflex I Sit and Reach box (Novel Products, Rockton, IL), a baseline reach score was initially set for each subject while keeping the head and back against the wall. Differences between baseline and furthest reach forward score were noted, with the best (highest) of three trials recorded as the final score.

Domain 5: Self-rated physical performance.—Participant ratings of physical performance were obtained using two measures: the Colorado Walking Impairment Scale and a Self-efficacy for Physical Performance Scale.

1. The *Colorado Walking Impairment Scale* (31) was used to evaluate subject ratings of difficulty they experienced walking different distances, walking at different speeds, and symptoms experienced that limited walking (walking impairment). Items for each of the three sections were averaged and, for the walking distance and walking speed sections, assigned a predetermined weight (31). Regensteiner and colleagues (31) found that the walking distance score derived from the questionnaire correlated 0.68 ($p < .05$) with peak treadmill walking time, and increases in walking speed following an exercise conditioning program correlated with changes in treadmill walking time ($r = 0.51, p < .05$).

2. The *Self-Efficacy for Physical Performance Scale*, a 26-item measure developed at Stanford along with other exercise self-efficacy scales (32) with guidance from Dr. Albert Bandura (22), was used to assess subjects' confidence in being able to currently perform several different types of daily activities. Confidence level was rated on a scale of 0 (not at all confident) to 100 (absolutely confident) (22). The scale is divided into four subscales: confidence in one's ability to walk up from one to four flights of stairs; confidence in one's ability to lift objects weighing from 10 to 60 pounds; confidence in one's ability to accomplish different daily activities without undue fatigue or pain; and confidence in being able to walk distances ranging from half a block to 4 miles without slowing down or stopping to rest. Items within each subscale were averaged to obtain a subscale score.

Domain 6: Perceived functioning and well-being.—The domain of perceived functioning and well-being (health-related quality of life) was assessed using scales obtained from the Medical Outcomes Study [MOS; (33,34)]. It included rated physical functioning, general bodily pain, emotional well-being, energy/fatigue, and sleep problems. Additional health-related quality of life constructs that were assessed using standard scales were sense of mastery (35) and self-esteem (36–38). These scales have been used with diverse groups of older adults (16) and have excellent reliability and validity in the MOS (34), as well as in other populations of middle- and older-aged adults (39). They have been shown to be able to differentiate levels of exercise participation in postmenopausal women and same-aged men (40,41).

The scales constituting the perceived functioning and well-being domain were first factor analyzed to determine the most parsimonious method of representing these variables (41). Two factors, physical health and psychological well-being, were identified using an oblique rotation (42). Perceived physical functioning and pain loaded significantly on the physical health index (i.e., were most strongly associated with a factor representing physical health concerns), and emotional well-being, energy/fatigue, sleep problems, sense of mastery, and self-esteem loaded significantly on the psychological well-being index. These two standardized and summed index scores (41) were considered as the primary dependent variables representing the perceived functioning and well-being domain. If an index score reached statistical significance, between-group analyses were subsequently undertaken on its component scales for descriptive purposes.

Assessment of Exercise Adherence

Participants completed brief exercise logs on a daily basis to track the type, frequency, and duration of their exercise sessions. Logs were returned to the staff at the end of each month using the self-addressed stamped envelopes provided. If a log was not returned, information was obtained by telephone. Average monthly adherence rates across the 12-month period were calculated as a percentage of exercise sessions prescribed for the month. Class attendance was visually confirmed by the instructor.

Exercise adherence rates were determined for all participants randomized. For any month in which adherence data were unavailable, a conservative approach was taken whereby the participant was assigned a zero for that month (43).

Approximately 20% of study participants were randomly selected to wear a solid-state portable microprocessor (Vitalog Corp., Redwood City, CA) that recorded heart rate and body movement continuously for a 3-day period during the active intervention phase of the study. This device provides a valid and reliable indicator of adherence to prescribed home exercise (43–45). As an additional validity check on reported physical activity levels, participants completed the CHAMPS physical activity questionnaire for seniors at baseline and 12 months (40,46). This instrument has been found to provide a valid and reliable estimate of energy expenditure in older adults.

Statistical Analyses

Analysis of variance (ANOVA) procedures were used to evaluate between-group differences at baseline and with respect to exercise adherence (47). Analysis of covariance (ANCOVA) procedures were used to assess changes during the one-year period in each of the six conceptually discrete functioning domains (47). In analyzing change, main effects for group assignment and gender along with interactions of those two variables were evaluated, with baseline levels of the dependent variables serving as covariates. Tukey's Studentized Range Test and the Least-Squares Means procedure were used to compare group means for all significant ANOVA and ANCOVA effects, respectively (48). Alpha level for all tests was set at .05. A one-tailed test of significance was applied for those outcomes (i.e., functional capacity/endurance, upper-body strength, lower-body strength, flexibility, and self-rated physical performance) for which directional hypotheses had been posited. A two-tailed test of significance was applied for the perceived functioning and well-being domain.

To reduce the potential proliferation of Type I error within each domain, one testing instrument or protocol was used for three of the six discrete functioning domains (upper-body strength, lower-body strength, and flexibility). For the self-rated physical performance domain, which utilized more than one testing instrument, a multivariate analysis of covariance (MANCOVA) was initially used as an omnibus test incorporating the two self-rated physical performance instruments. Subsequent ANCOVA procedures were planned for each instrument contingent upon the MANCOVA reaching statistical significance. Similarly, as described earlier, planned ANCOVA procedures were undertaken on the individual scales constituting the two-factor analytically derived perceived functioning and well-being indices only if an index achieved overall statistical significance (41). In addition, because it was conceivable that both of the physical activity interventions could lead to changes in the perceived functioning and well-being domain (which prevented us from proposing directional hypotheses for this one domain), within-group analyses were undertaken for descriptive purposes only. Finally, the functional capacity/endurance domain was assessed, as described earlier, using a standard treadmill exercise testing protocol from which three variables of relevance to this domain were measured ($\dot{V}O_2$max, treadmill exercise duration, and submaximal heart rate). Because these three variables (a) measure somewhat different aspects of functional capacity and endurance (49), (b) may be disaggregated in some populations including older adults (50), and (c) have traditionally been presented separately in the exercise science literature (51), they were analyzed separately in the current study.

Results

Subjects

Of the 1,347 age-eligible individuals originally contacted through the random-digit-dial telephone survey and the 184 individuals who responded to the citywide promotion (1,531 total), 795 (52%) were considered ineligible based on a telephone interview (73% of these were excluded based on study medical exclusions; 22% were already physically active based on study eligibility criteria; 5% had plans to move from the area within the next two years); 588 (38%) refused study participation; 26 (2%) were excluded for medical reasons discovered during the baseline evaluation (primarily evidence of ischemia during the treadmill test); and 19 (1%) were judged to be too physically active at the baseline evaluation. The remaining 103 individuals (67 women; 36 men) were randomized.

Eligible individuals who refused study participation and those enrolled in the study were comparable on ethnicity, gender, marital status, smoking status, rated health status, and prior exercise experience (all p values > .10). Study enrollees were somewhat younger (mean = 70 ± 4 years versus 72 ± 5 years, $p < .0003$) and better educated (mean = 15 ± 3 years versus 14 ± 3 years, $p < .0001$) than eligible nonenrollees. A greater percentage of enrollees reported being currently employed (51%) as well as involved in volunteer work (52%) relative to eligible nonenrollees (39% and 33%, respectively; p values < .025). Enrollees also reported more stress, drinking alcohol less often per week, a fewer number of friends, a greater body mass index [BMI; reported body weight (kg) divided by height (m^2)], and being more worried about their weight than eligible nonenrollees (p values < .01). In addition, a greater percentage of study enrollees reported currently taking prescription medications (74%) relative to eligible nonenrollees (60%; $p < .01$). A greater percentage of enrollees reported an interest in learning more about exercise programs and other lifestyle changes (95%) relative to nonenrollees (73%; $p < .001$).

Ninety-five percent of the study sample were Caucasian, 4% were Asian, and 1% were Hispanic. Twelve percent were current smokers, and 55% were currently married. The average BMI measured at baseline was 27.2 ± 4.4 for women and 27.1 ± 3.2 for men. Additional baseline descriptive data for persons enrolled in the study are shown in Table 1. Subscale scores are included to allow for comparisons with other study populations. Participants were comparable across the two study conditions on all major variables of interest, substantiating the success of the randomization procedure. As expected, men had significantly greater baseline $\dot{V}O_2$max and treadmill exercise duration levels and lower submax heart rates on the treadmill than women (p values < .0009). Compared to women, men also reported a significantly greater baseline walking speed score on

Table 1. Descriptive Statistics (Means and Standard Deviations) at Baseline and 12-Month Changes for Variables of Interest, by Condition Assignment and Gender

Variables	Fit & Firm		Stretch & Flex	
	Women	Men	Women	Men
n	33	17	29	17
Age (years)	70.7 (4.0)	68.1 (3.4)	70.6 (4.4)	70.6 (4.0)
Education (years)	15.2 (3.0)	16.6 (4.3)	14.7 (2.1)	14.8 (2.0)
Domain 1: Functional Capacity/Endurance				
$\dot{V}O_2$max (ml/kg/min)	18.1 (3.9)	23.2 (4.2)	17.1 (2.8)	23.8 (3.2)
12-month change:	1.2 (3.0)	1.7 (2.8)	0.8 (2.3)	1.5 (2.4)
Treadmill duration (min)	10.0 (3.6)	14.3 (3.6)	9.7 (4.1)	13.2 (3.5)
12-month change:	1.4 (3.0)	2.5 (2.8)	1.1 (1.9)	1.5 (1.5)
Submax heart rate (beats/min)	122.7 (20.3)	102.4 (16.8)	122.8 (18.3)	103.6 (12.3)
12-month change:*	−9.1 (16.8)	−3.9 (10.8)	−5.0 (10.9)	1.6 (10.6)
Domain 2: Upper-body Strength				
Lift and reach task (reps/min)	19.6 (5.0)	21.4 (4.9)	18.8 (3.7)	21.8 (4.2)
12-month change:*	0.9 (5.0)	1.4 (3.4)	0.8 (3.8)	−2.1 (7.4)
Domain 3: Lower-body Strength				
Chair sit to stand task (reps/min)	18.3 (5.6)	22.9 (4.8)	18.7 (6.2)	24.4 (7.0)
12-month change:	1.4 (4.0)	1.1 (3.4)	−0.2 (5.5)	1.0 (4.8)
Domain 4: Flexibility				
Sit and reach task (inches)	14.0 (3.2)	12.6 (4.7)	14.3 (3.5)	10.4 (2.6)
12-month change:†	1.1 (2.0)	−1.1 (5.4)	0.5 (4.4)	1.5 (2.0)
Domain 5: Self-Rated Physical Performance				
Colorado Walking Impairment subscales:				
Walking distance score	83.0 (27.5)	84.5 (24.3)	71.5 (35.5)	90.0 (23.6)
12-month change:‡	5.6 (27.5)	9.0 (19.8)	−5.6 (34.0)	−8.5 (31.4)
Walking speed score	53.7 (18.9)	62.3 (24.0)	48.1 (16.1)	67.1 (22.7)
12-month change:	−0.6 (22.3)	0.7 (25.1)	−1.1 (16.1)	−7.2 (24.6)
Walking impairment score	3.6 (0.4)	3.4 (0.6)	3.8 (0.2)	3.6 (0.5)
12-month change:	−0.1 (0.5)	0.1 (0.5)	−0.1 (0.4)	−0.1 (0.4)
Physical Performance Self-Efficacy subscales:				
Strength self-efficacy score	65.6 (21.0)	88.3 (17.4)	54.6 (18.8)	90.9 (17.3)
12-month change:*	4.9 (16.5)	5.0 (11.4)	1.9 (23.4)	−1.1 (10.5)
Walking self-efficacy score	67.4 (14.6)	75.1 (17.6)	59.0 (18.3)	82.0 (8.7)
12-month change:‡	3.9 (16.8)	7.3 (9.3)	1.2 (18.0)	−1.2 (9.9)
Stair-climbing self-efficacy score	87.5 (18.0)	94.0 (10.0)	80.0 (23.1)	98.3 (2.7)
12-month change:‖	2.5 (17.4)	0.8 (6.2)	−0.7 (22.5)	−4.1 (13.4)
Daily activities self-efficacy score	88.7 (11.7)	92.5 (8.3)	87.9 (16.9)	95.6 (4.8)
12-month change:	1.6 (10.7)	3.5 (6.3)	2.3 (11.6)	−1.2 (9.9)
Domain 6: Perceived Functioning and Well-being§:				
Bodily pain score	58.0 (21.5)	52.8 (26.7)	56.6 (23.5)	63.3 (20.6)
12-month change:‖	−7.0 (29.6)	−2.8 (21.9)	7.3 (26.3)	9.4 (26.7)
Physical functioning score	80.6 (17.9)	85.0 (10.5)	76.6 (15.3)	87.5 (15.5)
12-month change:	0.0 (20.1)	0.4 (11.9)	3.3 (13.3)	−4.2 (13.5)
Emotional well-being score	80.2 (13.1)	82.9 (12.5)	79.5 (17.5)	81.6 (12.7)
12-month change:	1.8 (11.2)	0.0 (8.2)	5.4 (11.4)	1.3 (13.8)
Energy/fatigue score	59.1 (20.5)	58.3 (18.3)	59.8 (20.9)	61.4 (20.4)
12-month change:	3.2 (12.7)	7.5 (7.3)	2.9 (17.8)	0.0 (16.1)
Sleep problems score‖	71.5 (17.4)	68.2 (16.0)	72.3 (18.0)	74.3 (14.9)
12-month change:	−0.6 (10.3)	4.0 (10.6)	4.7 (9.7)	−0.5 (7.6)
Sense of mastery score	68.6 (22.0)	74.4 (17.9)	72.9 (20.3)	77.2 (16.6)
12-month change:	−3.0 (15.7)	0.5 (13.2)	1.5 (10.5)	−2.7 (13.4)
Self-esteem score	80.1 (13.7)	80.1 (17.2)	78.5 (17.9)	84.2 (13.4)
12-month change:	−0.5 (12.1)	2.5 (11.3)	2.5 (9.5)	−0.1 (8.6)

*Fit & Firm condition different from Stretch & Flex condition at $p < .03$ (one-tailed test).

†Condition × Gender interaction significant at $p < .03$ (one-tailed test).

‡Fit & Firm condition different from Stretch & Flex condition at $p < .003$ (two-tailed test).

§All Perceived Functioning and Well-being subscales are converted to a 0–100 range.

‖For the Bodily Pain and Sleep Problems scales, an increase represents improvement.

the Colorado Walking Impairment Scale ($p < .0009$), significantly higher baseline self-efficacy levels related to lifting objects, walking distances, stair-climbing, and accomplishing daily activities (p values $< .04$), and better baseline performance on the lift and reach and chair sit to stand tasks (p values $< .01$). Women, in contrast, showed greater flexibility on the sit and reach task ($p < .002$). The only gender difference found at baseline for the perceived functioning and well-being scales was a higher score on the perceived physical functioning scale for men relative to women ($p < .02$).

Outcomes of interest were obtained for 93% of the sample at 12 months (comparable percentages for Fit & Firm [93.4%] and Stretch & Flex [92.0%]). Comparable return rates were obtained for women (92.5%) and men (94.4%). Changes on the outcomes of interest are presented in Table 1, along with results from the between-group and within-group analyses.

Exercise Adherence

Exercise adherence rates across the 12-month period were calculated for all subjects randomized and are presented in Table 2. Adherence to the exercise prescription was high for both study conditions, averaging 79 ± 43% for the Fit & Firm condition and 80 ± 39% for the Stretch & Flex condition (difference not significant). For both conditions, exercise adherence was significantly higher for the home-based portion of the exercise prescription (Fit & Firm: 92 ± 50%; Stretch & Flex: 92 ± 43%) relative to the class-based portion of the exercise prescription (Fit & Firm: 65 ± 27%; Stretch & Flex: 68 ± 29%). For home versus class comparison: paired-comparison t test = 5.2, $p < .0001$, two-tailed test.

For the 18 participants randomly chosen to wear the Vitalog heart rate monitor during the course of the study, computer-analyzed heart rate recordings characterized the number of minutes spent in the participant's prescribed (or, in the case of Stretch & Flex subjects, projected based on their baseline treadmill test) moderate-intensity exercise heart rate range and the longest uninterrupted bout of exercise within this range (43). Of the 12 participants in the Fit & Firm condition, 10 (83%) showed heart rate and motion sensor evidence of an exercise bout of at least 20 minutes in duration (range, 24–59 minutes) on the days that they reported engaging in a prescribed home exercise session. In contrast, only one of the six participants in the Stretch & Flex condition showed heart rate and motion sensor evidence of an exercise bout in or above the Fit & Firm target heart rate range. These data provide additional support for the integrity of condition assignment to either the Fit & Firm or Stretch & Flex conditions.

Similarly, ANCOVAs conducted on the 12-month CHAMPS physical activity questionnaire indicated that Fit & Firm participants were expending almost twice as many calories per kilogram of body weight per day in moderate and more vigorous physical activities (baseline-adjusted mean = 1.30 cal/kg/day) relative to Stretch & Flex participants (adjusted mean = 0.69; $F[4,97] = 9.73, p < .002$).

Domain 1: Changes in functional capacity and endurance.—Participants assigned to the Fit & Firm group showed significantly greater 12-month improvements in submax heart rate (i.e., fewer beats/minute at a submaximal work load) during treadmill exercise testing than Stretch & Flex participants ($F[4,91] = 3.59, p < .03$, one-tailed test). There were no significant differences in $\dot{V}O_2$max or treadmill exercise test duration change between the two groups (all groups improved with the exception of women in the Stretch & Flex group). Nor was there a significant interaction effect with gender for any of the treadmill performance variables. As expected, men had higher $\dot{V}O_2$max levels than women at 12 months ($F[4,91] = 4.22, p < .02$, one-tailed test).

Domain 2: Changes in upper-body strength.—Participants assigned to the Fit & Firm condition showed significantly greater 12-month improvements in the lift and reach task compared to Stretch & Flex participants ($F[4,95] = 3.93, p < .025$, one-tailed test). No significant effects were observed for gender or for the Gender × Condition interaction.

Domain 3: Changes in lower-body strength.—No significant between-group effects were observed for the chair sit to stand task. Men had higher 12-month scores on this task than women ($p < .015$, one-tailed test).

Domain 4: Changes in flexibility.—A Gender × Group interaction was found for the sit and reach task ($F[4,91] = 3.67, p < .029$, one-tailed test), with men assigned to Stretch & Flex showing a greater increase in flexibility relative to men assigned to Fit & Firm, while the reverse pattern was observed for women (i.e., Fit & Firm women showed a pattern of somewhat greater increases than Stretch & Flex women, although this did not reach statistical significance; see Table 1). There was also a significant main effect for gender ($p < .003$, one-tailed test), with women demonstrating greater flexibility at 12 months than men.

Domain 5: Changes in self-rated physical performance.—The MANCOVA evaluating overall between-group differences on the two measures constituting the self-rated physical performance domain—including the three subscales contained in the

Table 2. Exercise Adherence Rates, by Condition Assignment and Gender, Across the 12-Month Intervention Period

Variables	Fit & Firm		Stretch & Flex	
	Women	Men	Women	Men
n	33	17	29	17
Mean Exercise Adherence Rate (%):	80.5 (32.8)	76.6 (31.5)	75.5 (31.0)	88.2 (19.3)
Class adherence rate:*	67.1 (24.2)	60.3 (32.3)	64.7 (31.7)	74.4 (21.8)
Home adherence rate:	92.2 (54.5)	92.8 (42.5)	86.3 (44.4)	102.0 (40.8)

Note: Values represent mean (SD).

*For both exercise conditions, home adherence > class adherence at $p < .0001$ (two-tailed test).

Colorado Walking Impairment Scale and the four subscales contained in the Self-Efficacy for Physical Performance Scale —was significant ($F[7,99] = 2.46$, $p < .01$, one-tailed test). Planned ANCOVAs were subsequently conducted on the three Colorado walking impairment and four self-efficacy subscales.

1. *Colorado Walking Impairment subscales.* There was a significant main effect for group on the walking distance subscale, with Fit & Firm participants reporting greater improvement in their ability to walk distances relative to the Stretch & Flex participants ($F[4,99] = 9.60$, $p < .002$, one-tailed test). No significant between-group differences were observed for the walking speed or walking impairment subscales. Similarly, no gender-related main or interaction effects were found.

2. *Self-Efficacy for Physical Performance subscales.* There was a significant main effect for group with respect to self-efficacy related to strength, with Fit & Firm participants reporting greater improvement in their confidence for lifting increasingly heavy objects relative to Stretch & Flex participants ($F[4,99] = 3.66$, $p < .03$, one-tailed test). In addition, men reported greater 12-month self-efficacy for being able to lift objects relative to women ($p < .005$). Similarly, there was a significant main effect for group on the self-efficacy for walking subscale, with Fit & Firm participants reporting greater increases in their confidence for walking a range of distances relative to Stretch & Flex participants ($F[4,99] = 7.81$, $p < .003$, one-tailed test). No significant between-group or gender effects were found for the self-efficacy for stair climbing or accomplishing daily activities subscales.

Domain 6: Changes in perceived functioning and well-being.—There was a significant main effect for group for the self-rated Physical Health Index, with Stretch & Flex participants reporting greater improvements on this index relative to Fit & Firm participants ($F[4,98] = 4.85$, $p < .03$, two-tailed test). Planned ANCOVAs were conducted subsequently on the two MOS-derived scales contained in this index—the physical functioning scale and the two-item general bodily pain scale. The ANCOVA on the pain scale indicated that Stretch & Flex participants reported significantly greater improvements in daily pain levels (signified by an increased score) relative to Fit & Firm participants ($F[4,98] = 12.29$, $p < .0007$, two-tailed test) (see Figure 1; note that within-group changes observed in the Stretch & Flex condition reached statistical significance [$p < .036$], while within-group changes observed in the Fit & Firm condition did not). There were no significant gender or Gender × Group interactions for this scale. There were no statistically significant between-group or within-group effects found for the physical functioning scale.

No significant main or interaction effects were found for the Psychological Health Index. Evaluation of within-group changes from baseline to 12 months, undertaken for descriptive purposes only, indicated that the scores on the scales constituting this index remained relatively stable across the study period. The only indications of improvement over time were for the MOS energy/fatigue scale, for which the Fit & Firm group reported significant pre–post improvements (paired-comparison t test = 2.15, $p < .037$, two-tailed); and the MOS emotional well-being scale, for which the Stretch & Flex group reported significant pre–post improvements (paired-comparison t test = 2.18, $p < .034$, two-tailed).

Evaluating the Time Course of Change: 6-Month Results

The interim assessment at 6 months occurred at a different time of the year for each participant than the baseline and one-year assessments, and garnered somewhat lower participation rates than the 12-month assessment. However, evaluating outcomes at this interim timepoint can nonetheless be instructive with respect to understanding the time course over which changes in outcomes of interest were made. For those outcomes for which significant between-group differences were noted at 12 months, ANCOVAs were conducted to evaluate whether such differences were apparent at the 6-month assessment. Significant 6-month main effects for group (with greater improvement in Fit & Firm relative to Stretch & Flex) were found for submaximal heart rate only ($F[4,76] = 6.90$, $p < .005$, one-tailed test). No other significant group or Gender × Group effects were noted at 6 months.

Exercise-Related Injuries

Exercise-related injuries reported at the assessments and noted on the exercise logs and during the regular telephone contacts were found to be minimal (reported by less than 10% of subjects) for both exercise programs. The most frequent physical activity-related symptoms (constituting approximately three fourths of those reported) were muscle soreness and pain around the joints, and these were quickly resolved with an adjustment of the exercise program and instructions for self-care. No participant in either exercise condition suffered an injury or symptom that was severe enough that they had to end participation in the study.

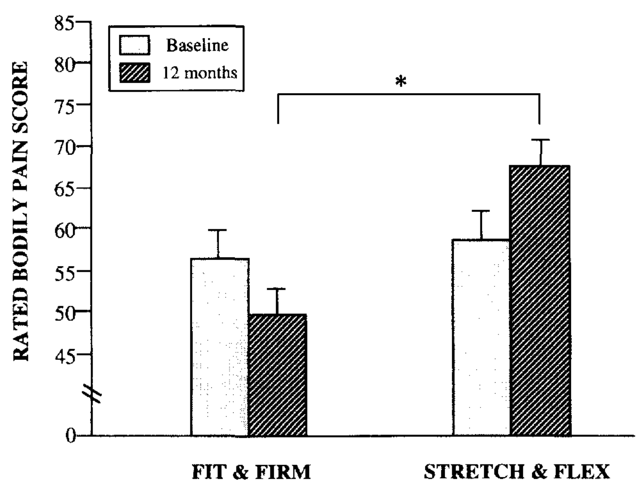

Figure 1. Means and standard errors for rated bodily pain scores at baseline (shaded bars) and 12 months (hatched bars) by condition assignment; note that an increase signifies improvement. *Stretch & Flex condition significantly different from Fit & Firm condition at $p < .0007$ (two-tailed test).

Discussion

The results of this study extend previous findings supporting the efficacy of physical activity regimens focusing on endurance and strengthening exercises in enhancing both measured and self-rated physical performance and functioning (7,8,11). Men and women assigned to the Fit & Firm program showed improved upper-body strength as measured by a functional task (i.e., the lift and reach task) as well as significant improvements in their heart rate response to a submaximal work load relative to the Stretch & Flex program participants. Improvements in submaximal performance may provide a better reflection of physical activity participation in older adults than maximal treadmill measures, which have been noted to be only modestly related to physical activity levels among older populations (52). Significant improvements in perceptions of endurance and strength as measured by the Colorado Walking Impairment Scale and the Self-Efficacy for Physical Performance Scale were also obtained in Fit & Firm relative to Stretch & Flex participants. In contrast, the men assigned to the Stretch & Flex program showed significant improvements in flexibility relative to the Fit & Firm men, the latter group of whom tended to show a decrease in flexibility across the one-year period. This result underscores the importance of building in a specific regimen of flexibility exercises as a regular part of exercise programs aimed at older adults (11). This issue may be particularly important for older men, who may have reduced flexibility relative to female peers.

Both women and men assigned to the Stretch & Flex program also reported a significant improvement in their overall bodily pain levels across the 12-month period relative to participants assigned to the Fit & Firm program. This finding is notable in light of the dearth of information currently available on the effects of stretching and flexibility training, relative to other forms of exercise, on such perceived functioning and well-being outcomes (10,16), as well as the importance of bodily pain levels to overall quality of life (34).

In contrast, no between-group differences and few within-group changes were found for those scales constituting the psychological functioning portion of the perceived functioning and well-being domain. This may be due to a ceiling effect in the relatively high-functioning sample being studied, or to a lack of sensitivity to change with respect to the MOS scales and related perceived functioning and well-being instruments under study. Of relevance to these issues, a recently completed investigation of the effects of a moderate-intensity physical activity intervention in a more infirm sample of elders indicated significant improvements across a 6-month period on several psychological well-being indicators (e.g., self-esteem, psychological well-being) using similar measures (40).

Apart from the submaximal heart rate changes, none of the significant 12-month improvements discussed above were discernible at the 6-month assessment. This suggests that older adults undertaking similar forms of physical activity will likely need to participate regularly throughout a year before such benefits may become noticeable.

A combination of formats (class-based and home-based) was used to optimize the safety and effectiveness of both community-based physical activity programs. Classes were used to enhance accurate and safe exercise performance, particularly with respect to the strengthening and flexibility exercises. The home-based portion was included to facilitate long-term exercise adherence (43). The combination of these two formats resulted in excellent overall exercise adherence across the 12-month period for both physical activity programs with a minimal number of injuries. In addition, similar to a study undertaken with adults between the ages of 50 and 65 years, the home-based format resulted in significantly greater exercise adherence than the class-based format for both physical activity programs (43). This suggests that the telephone-supervised home-based format may provide a more convenient means for promoting regular exercise participation even in postretirement populations.

The use of single measurement instruments for several of the domains, in combination with omnibus testing and factor analytic strategies for those domains represented by more than one instrument or scale, was applied to curb potential proliferation of Type I error. This approach was deemed preferable to other approaches to this issue (e.g., the Bonferroni correction) in light of the extremely conservative nature of the latter approach, and the fact that so few data are currently available in many of the functioning domains of interest for the two types of physical activity regimens and the older population being targeted (10). Future studies in this area are indicated to evaluate the reproducibility of the current results in similar populations.

Similar to a previous physical activity study undertaken in the target community, population-based recruitment techniques (i.e., a random-digit-dial telephone survey) were used to enumerate a broad portion of the older adult segment of the community who were deemed eligible for study participation (17). The analyses comparing study enrollees with eligible persons who refused study participation indicated that enrollees may have had a generally greater level of health awareness and more motivation to pursue outside activities (as evidenced by a greater percentage reporting involvement in work and volunteer activities) than those who did not enroll. Continued efforts to evaluate strategies to enhance enrollment of the latter subgroup remain indicated. In addition, the target community was well-educated and largely white. Further research is needed to determine the best ways of adapting both the exercise programs and recruitment strategies to communities differing on such variables.

We conclude that community-based physical activity regimens focusing on moderate-intensity endurance and strengthening exercises or flexibility exercises can be delivered through a combination of formats that result in improvements in important functional and quality of life outcomes. The challenge remains to develop strategies to foster long-term adherence to a *combination* of both exercise programs. Supervised home-based exercise provides an attractive means for augmenting class-based instruction and enhancing participation rates in older adults.

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Address correspondence to Dr. Abby C. King, Stanford University School of Medicine, 730 Welch Rd., Suite B, Palo Alto, CA 94304-1583. E-mail: king@scrdp.stanford.edu

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