Physical Activity Interventions Targeting Older Adults

A Critical Review and Recommendations

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Background: Although many of the chronic conditions plaguing older populations are preventable through appropriate lifestyle interventions such as regular physical activity, persons in this age group represent the most sedentary segment of the adult population. The purpose of the current paper was to provide a critical selected review of the scientific literature focusing on interventions to promote physical activity among older adults.

Methods: Comprehensive computerized searches of the recent English language literature aimed at physical activity intervention in adults aged 50 years and older, supplemented with visual scans of several journal on aging, were undertaken. Articles were considered to be relevant for the current review if they were community-based, employed a randomized design or a quasi-experimental design with an appropriate comparison group, and included information on intervention participation rates, pre- and post-intervention physical activity levels, and/or pre/post changes in relevant physical performance measures.

Results: Twenty-nine studies were identified that fit the stated criteria. Among the strengths of the studies reviewed were reasonable physical activity participation rates and relatively long study durations. Among the weaknesses of the literature reviewed were the relative lack of specific behavioral or program-based strategies aimed at promoting physical activity participation, as well as the dearth of studies aimed at replication, generalizability of interventions to important subgroups, implementation, and cost-effectiveness evaluation.

Conclusions: Recommendations for future scientific endeavors targeting older adults are discussed.

Medical Subject Headings (MeSH): review, physical fitness, exercise, adult aged+, intervention studies, leisure activities (recreation) (Am J Prev Med 1998;15(4):316–333) © 1998 American Journal of Preventive Medicine

People over age 65 constitute one of the fastest-growing population segments among industrialized nations.[1,2] They additionally carry by far the greatest proportion of chronic disease burden, disability, and health care utilization,[3–5] much of it preventable.[3,6] For example, approximately 88% of those over age 65 have at least one chronic health condition,[5] and large numbers of older adults suffer from impaired functioning and well-being.[7] Notably, loss of function can begin to become evident as early as the fifth decade of life,[8] arguing for preventive approaches begun in the middle years, as well as earlier, as a means of promoting health and limiting disability in the later years of life.[3]

Although regular physical activity has been demonstrated to be critical for the promotion of health and function as people age,[9] persons over 50 years of age represent the most sedentary segment of the adult population.[10] This is particularly the case for persons aged 75 and above.[10]

The vast majority of physical activity intervention studies undertaken to date have focused on younger adult populations.[11] The purpose of the current paper is to provide a critical review of the scientific literature focusing on interventions to promote physical activity among older adults. Consonant with the recent World Health Organization guidelines for promoting physical activity and fitness among older persons,[12] as well as recommendations made by other health organizations,[3] we have focused our efforts on summarizing the highest quality studies that have targeted persons aged 50 and older.

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Methods

Comprehensive computerized searches of the recent English language literature aimed at physical activity intervention in the elderly were undertaken independently at two universities (Stanford and Wake Forest). A number of available databases were searched on appropriate key terms and MeSH terms for all previous years through the present, including MEDLINE, PSYC (psychological abstracts), BIOSIS (biological abstracts), ERIC (educational resources information center abstracts), and MAGS (magazine index) databases. In addition, the authors visually checked the previous six volumes of several journals on aging, including *The Gerontologist* and the *Journal of Gerontology*, for relevant articles. Articles were considered to be relevant for the current review if they were community-based (i.e., included reasonable numbers of community-dwelling older adults without diagnosed coronary heart disease, and employed interventions that could be realistically generalized, as opposed to intensive training studies undertaken in a laboratory, medical setting, or similar highly controlled setting); employed a randomized design or a quasi-experimental design with an appropriate comparison group; and included information on intervention participation rates, pre- and post-intervention physical activity levels, and/or pre/post changes in physical performance measures that could be reasonably expected to reflect changes in physical activity. Studies focusing on cardiac patients were excluded in light of their inclusion in another review in this series (see the review focusing on health care settings). Studies of older adults with other, noncardiovascular forms of chronic illness (e.g., arthritis, chronic obstructive pulmonary disease) that met the above criteria were included. Relevant recent work that had been published in abstract form was also included.

Twenty-six randomized trials and three quasi-experimental studies were identified that fit the above criteria. These studies are summarized in Table 1.

These studies were evaluated with respect to eight areas, described below.

Effectiveness

Across the studies evaluated, exercise participation rates were defined typically as the number of exercise sessions attended or reported, divided by the number of sessions prescribed. The exercise participation rates noted in the 19 studies that explicitly reported them ranged from 36%–98% (mean = approximately 75%; median = approximately 80%). In light of the observation that only about 50% of adults without heart disease who begin an exercise program will maintain participation in the program beyond 3 months,[13] this range is relatively high, suggesting the possibility of higher physical activity participation rates in older adult samples relative to the younger samples on whom the majority of the literature has been based, or, alternatively, a positive reporting/publication bias. The somewhat higher exercise participation rates reported also could be due to use of lower-intensity exercise prescriptions in many of the studies reviewed relative to studies focusing on younger individuals. In some studies no description was included regarding how exercise participation rates were specifically tracked or calculated. Although attendance rates are commonly reported, other aspects of the prescription (i.e., exercise intensity, duration) often are not. In addition, some investigators did not employ an intention-to-treat principle in reporting exercise participation rates (i.e., poor compliers or drop-outs were not included in calculating exercise patterns). This can lead to an inflation of the adherence results.

Only 13 (45%) of the studies reviewed explicitly described or mentioned the use of specific behavioral, educational, social, cognitive, or program-based (e.g., exercise type, intensity, format) strategies aimed at promoting physical activity participation. Six studies explicitly manipulated one or more of these strategies as part of the study design with the aim of influencing participation rates.[14–19] The most frequently included methods to promote participation were behavioral strategies based on social learning theory and its derivatives[20] (10 studies), and strategies focused on exercise type (e.g., less vigorous forms of exercise) or format (e.g., self-paced, class- or home-based) (10 studies). Effective interventions included those that employed behavioral or cognitive-behavioral strategies as opposed to health education or instruction alone.[18,21,22] The majority of these studies utilized a combination of behavioral and/or cognitive tools (e.g., goal-setting self-monitoring, feedback, support, relapse-prevention training). From the study descriptions available, however, there is likely a large amount of variance among studies with respect to the specific protocols employed in implementing these strategies. One randomized, controlled trial demonstrated the utility of systematic training in social-cognitive strategies, enhanced through group dynamics, in increasing physical activity frequency 3 months following the formal end of the program.[19] Only two studies were found that systematically tested the effects of specific cognitive or behavioral strategies in influencing exercise participation. One study with chronic obstructive pulmonary disease (COPD) patients found cognitive-behavioral modification approaches to produce greater 3-month physical activity adherence and better adherence during the 3-month maintenance period than either cognitive modification or behavior modification alone.[14] A second study tested the effects of efficacy-based adherence instruction and found it to increase exercise frequency, duration, and distance more effectively than health

Table 1. Physical activity intervention studies in older adults using experimental (n = 26) or quasi-experimental (n = 3) designs

Study	Sample	Design	Setting	Physical activity target	Dependent variable	Intervention	Post-test	Follow-up
Atkins et al. (1984)[14a]	76 COPD pts., mean age = 64.8 ± 7.9 yrs; 63% women	Randomized factorial; no apparent test for gender effect	Home-based	Walking	Walking adher. (logs); exercise tolerance (graded treadmill test); self-reported function; efficacy expectations	I-1: Behav. modification I-2: Cognitive mod. I-3: Cog.-behav. mod. C-1: Attention-control C-2: Assessment only All I *S*s received 5 1-hr. instructional sessions in their homes.	3 mos; (5 dropouts were replaced) Three I programs had increased exercise levels compared to controls; cog.-behav. mod. produced greater walking adherence than other I arms.	6 mos. from baseline; cog.-behav. mod. program continued to report superior walking adherence relative to other arms (based on 2/3 of original sample).
Blumenthal et al. (1989)	101 nondisabled community-dwelling adults (60–83 yrs; mean = 67.0 yrs); well-educated; 50% women; no reported eligibility criteria based on inactivity	Randomized factorial; tested for gender effects	Community, group-based	Aerobic exercise	Cardiorespiratory fitness (peak VO_2)	I: Aerobic exercise (3 supervised sessions/wk) C-1: Yoga + flexibility C-2: Wait-list	4 mos; 96% study retention rate; I significantly improved in peak VO_2 (11.6%) relative to C.	(Emery et al., 1992) 10 more mos. of supervised aerobic exercise; eval. of self-reported activity 1 yr. later; 94% of Ss located reported some form of continued exercise (66% reported regular walking)
Buchner et al. (1997)[33]	105 adults with at least mild deficits in strength and balance (68–85 yrs; mean = 75 yrs); 51% women; well educated	Randomized factorial; *S*s selected from a random sample of HMO enrollees; no apparent test for gender effects	Community, group-based	Aerobic exercise, strength training	Gait and balance tests, physical health status measures, aerobic capacity, self-reported falls, inpatient/outpatient use and costs	I-1: Aerobic exercise (3 supervised sessions/wk for 35 min each using stationary cycles) for 26 wks; I-2: two sets of resistive exerc. on weight machines (3 supervised sessions/wk) for 26 wks; I-3: 20 min of aerobic exer. and 1 set of resistive exerc. for 26 wks; C: Wait-listed 26-wk program followed by self-supervised exercise in all I conditions.	6 mos; 92% study retention rate; I Ss who did not drop out attended 95% of scheduled exerc. session; Sig. increases in isokinetic strength in I-2; within-group increases in aerobic capacity for I-3. No effects on gait, balance, or physical health status; sig. beneficial effect of exerc. on time to first fall and total falls. No sig. group diffs. in ancillary outpatient costs; greater days in hospital for C rel. to I. Minimal injury rates in all I conditions.	9 mos from baseline; adherence to unsupervised exercise reported at 58% exercised 3 or more times/wk, 24% twice/wk, and 5% did not exercise.
Chow et al. (1987)	58 healthy postmenopausal white women (50–62 yrs); no reported eligibility criteria based on inactivity	Randomized factorial	Community, group-based (hospital gymnasium)	Aerobic exercise (higher intensity), strength training (low intensity)	Exercise adherence, calculated VO_2max	I-1: 30 min of group aerobic activities 3×/wk; I-2: same aerobic activities as above + 10 min/session of strength training using wrist and ankle weights. C: Assessment only	1 yr; 83% study retention rate; overall average exercise class attendance for the yr. was 70%; Both I groups had higher fitness levels and greater bone mass than C; no diffs. between I groups.	No follow-up reported
Cunningham et al. (1987)	224 men retirees (55–65 yrs; mean = 62.7 yrs), no reported eligibility criteria based on inactivity	Randomized controlled; stratified on blue- or white-collar job but no apparent test of this subgroup effect	Community, group-based	Aerobic exercise (walking or jogging)	Self-reported activity (Minnesota Leisure Time Activity questionnaire); VO_2max	I: Leader-led group exercise on an outdoor track, 3x/wk (30 min of aerobic ex.) C: Assessment only	1 yr; 96% study retention rate; I successful in increasing high intensity activity and VO_2max relative to C.	No follow-up reported

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Study	Sample	Design	Setting	Physical activity target	Dependent variable	Intervention	Post-test	Follow-up
Emery and Gatz (1990)	48 sedentary older adults (61–86 yrs; mean = 72 yrs) recruited from an inner-city community; ethnically diverse (56% minority); low education levels	Randomized factorial	Community group-based	Brisk walking and rhythmic muscle strengthening exercises	Field tests of physical fitness; psychological and cognitive functioning; group attendance	I: 20–25 min of aerobic ex. (with additional stretching and cool-down), 3x/wk. C-1: Attention-control (social activities) C-2: Wait-listed control	12 wks; 81% study retention rate; group exercise attendance range = 61%–94%; poor attendance in the social control group. Minimal between-group diffs. detected on fitness, psychological, or cognitive measures.	No follow-up reported
Ettinger et al. (1997)[a]	439 community-dwelling adults with knee osteoarthritis; 60+ yrs (mean = 69 yrs); 70% women; range of education; 26% African American	Randomized factorial; post hoc secondary analyses to examine outcomes by race, gender, age, and BMI.	Community, group- and home-based	Aerobic exercise; resistance exercise	Self-reported activity (participation rates), physical function performance measures	I-1: 3-mo. facility-based walking + 15-month home-based walking; 3×/wk, 40 min/session; I-2: Facility+home resistance training as above; home programs for both I conditions included home visits [4] and telephone calls [19] C: Health education	18 mos; 83% study retention rate. Participation rates in both I arms 69%; Both I arms improved on 6-min walk and other perform. tasks relative to C. Improve. generally seen in all subgroups tested.	No follow-up reported
Gillett et al. (1996)[15a]	182 healthy obese, sedentary, nonsmoking women (60–70 yrs; mean = 64.4 yrs)	Randomized factorial	Community, group-based	Low-impact aerobic exercise	Fitness (submax bike test), body composition (skinfolds), self-report physical activity records, attendance roster	I-1: Health + fitness ed. 1×/wk. I-2: Health + fitness ed. + aerobic exercise, 1×/wk of education and 3×/wk for 30 mins/session of supervised low-impact dance exercise; both I groups led by nurses and included behavioral strategies. C: Assessment only	16 wks; 90% study retention rate; both I groups attended approx. 86% of class sessions. Sig. increase in fitness in I-2 rel. to I-1 and C; both I-1 and I-2 reported exercising from 3–4 days/wk; longer ex. duration reported by I-1. No injuries reported.	No follow-up reported
Hamdorf et al. (1992)	80 healthy, sedentary community-dwelling women (60–70 yrs; mean = 64 yrs)	Randomized controlled	Community, group-based	Habitual physical activity patterns; fitness	Self-reported activity (Human Activity Profile; Normative Impairment Index); Fitness (cycle ergometer)	I: 2×/wk of supervised, progressive walking in a group with an enthusiastic and experienced instructor; 45 mins/session C: Wait-listed	26 wks; 82.5% study retention rate; exercise adherence rate of I Ss completing program was 90.6%; Increased habitual activity patterns and fitness relative to C; low injury rate (5%)	(Hamdorf et al. 1993) 12 mos. from baseline (I given community ex. group list at 6 mos); 77.8% of training group reported continued walking participation; increases in reported activity patterns and fitness maintained in I relative to C
Hopkins et al. (1990)	65 sedentary community-dwelling medically cleared women (57–77 yrs; mean = 65.5 yrs);	Randomized controlled	Community classes	Low-impact aerobic dance	6 functional fitness tests (AAHPERD)	I: 20 min. of low-impact progressive aerobic dance, 2×/wk. C: Wait-listed	12 weeks; 81.5% study retention rate; Sig. improvements over C in cardiorespiratory endurance, strength, balance, flexibility, agility, and body fat.	No follow-up reported

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Table 1. Physical activity intervention studies in older adults using experimental (n = 26) or quasi-experimental (n = 3) designs

Study	Sample	Design	Setting	Physical activity target	Dependent variable	Intervention	Post-test	Follow-up
Jette et al. (1996)[26]	102 nondisabled community-dwelling adults (66–87 yrs; mean = 72 yrs); 63% women; well educated; no reported eligibility criteria based on inactivity	Randomized controlled; tested for gender effect	Home-based, mediated (videotape)	Muscle strength using resistive elastic bands	Peak torque in lower and upper extremities	I: One 50-min. training session with PT; 30-min. home videotape, 3× per wk, 12–15 wks. C: Assessment only	12–15 wks; Ss ≤ 72y had sig. increase in knee extension torque rel. to C; no sex effect	No follow-up reported
King et al. (1991)[a]	357 nondisabled, sedentary community-dwelling adults (50–65 yrs; mean = 57 yrs); well educated; 45% women	Randomized factorial; population-based recruitment strategies; test for gender effect	Community group-based, home-based (telephone-supervised)	Leisure aerobic exercise of moderate or higher intensity	Self-reported activity (participation rates), fitness (treadmill performance)	I-1: Higher-intensity, class-based (3×/wk). I-2: Higher-intensity, home-based (3×/wk). I-3: Moderate-intensity, home-based (5×/wk). Cog.-behav. strategies employed for all I. C: Assessment only	1 yr; Exercise participation data available on all Ss; fitness data available on 84% of sample; Participation in 2 home-based arms sig. better than class arm (76% vs. 53%); Treadmill performance sig. improved in all I arms compared to C.	(King et al., 1995)[25] 24 mo from baseline; 1-yr fitness gains maintained for all I arms; Participation highest in higher-intensity home-based arm
King et al. (1997)[a] (abstract)	103 nondisabled, sedentary community-dwelling adults (65–82 yrs; mean = 70.2 yrs); well educated; 65% women	Randomized to 1 of 2 interventions; population-based recruitment strategies; test for gender effect	Community, group + home (telephone-supervised)	Moderate intensity endurance, strength, and flexibility	Participation rates, self-reported activity (PASE, CHAMPS), treadmill exercise testing, performance-based and self-report measures of physical function	I-1: 2 class + 2 home sessions/wk of low-impact aerobics, walking and strengthening (resistive bands) exercise. I-2: class + 2 home sessions/wk of stretching and flexibility exercise. For both I, duration = 40–45 min/session and cognitive-behavioral strategies employed	1 yr; Exercise participation data available on all Ss; Similar exer. participation rates for both I (82% session completion rate); adherence sig. better to home exercise in both programs; I-1 sig. better than I-2 on reported daily energy expenditure, submax HR, upper-body strength, walking impairment; I-2 sig. better than I-1 on rated daily pain	No follow-up reported
Kriska et al. (1986)[a]	229 postmenopausal community-dwelling women who could physically walk (50–65 yrs); no reported eligibility criteria based on inactivity	Randomized controlled	Community, group + home	Walking	Self-reported activity (Paffenbarger survey); LSI activity monitor	I: 2 group sessions/wk + once/wk on own for 8 wks; then group optional. Behavioral strategies employed, including phone calls, logging, newsletters, social events, incentives C: Assessment-only	2 yrs; Mean blocks walked and LSI day activity counts/hr increased sig. relative to control	10-yr. results in preparation
Lord et al. (1995)[47a]	197 healthy, sedentary community dwelling Australian women (60–85 yrs; man = 71.6 yrs)	Randomized controlled; population-based recruitment methods (74% of those eligible took part)	Community classes	Aerobic/balance/ strengthening exercises	Class attendance; perceived and measured physical and psychological function	I: 35-min conditioning period, 2×/wk; emphasis on social interaction and enjoyment; classes were easily accessible C: Assessment only	12 mos; 75% of I completed posttesting and attended 26 or more classes; class attendance rate for those completing study was 73%; I improved in strength and related measures rel. to C	(Williams and Lord, 1995) 18 mos from baseline; 53% of I continued attending exercise classes; continuation associated with better scores on strength, body sway and depression at 12 mos.

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Table 1. Physical activity intervention studies in older adults using experimental (n = 26) or quasi-experimental (n = 3) designs

Study	Sample	Design	Setting	Physical activity target	Dependent variable	Intervention	Post-test	Follow-up
MacKeen et al. (1985)[34]	171 healthy male Penn State employees (40–59 yrs at entry); excluded extremely physically active men, but no other eligibility criteria based on inactivity	Randomized controlled	Community, group-based	Jogging	Physical work capacity; adherence	I: Supervised endurance exercise (primarily jogging); goal of 3×/week, lasting 35–75 min C: Assessment only	By 6 mo, exercise adherence dropped to 50% and then stabilized through 18 mos. (Taylor et al. 1973). At 18 mos, enhancement of physical work capacity compared to C	13 yrs from baseline (aged 53–72 yrs); 28% of I reported some continued jogging; E and C not significantly different with regard to physical activity habits measured via Minnesota Leisure Time Physical Activity interview
McAuley et al. (1994)[18a]	114 healthy, sedentary community-dwelling adults (45–64 yrs; mean = 54.5 yrs); 51% women	Randomized controlled; tests for gender and age effects	Community, group-based	Walking	Exercise behavior (program attendance, daily logs, self-reported exerc. duration and distance covered); self-efficacy for exercise	I: Exercise + adherence intervention (efficacy-based information begun in 3rd week, delivered via six 15-min biweekly meetings prior to exercise). C: exercise + attention-control (health ed.). Both groups received a leader-led walking program 3×/wk for 40 min/session.	20 wks; Study retention rate unclear; I more effective in increasing exercise freq. duration, and distance relative to C; I attended 67% of exercise sessions compared with 55% for C; 62% of I vs. 38% of C attended at least 2 exer. sessions/wk; treatment effects appeared to be most pronounced in last 3 mos of program.	No follow-up reported
McMurdo and Johnstone (1995)[51]	86 adults with limited mobility and dependence in at least 1 ADL (75–96 yrs; mean = 82 yrs); 89% women	Randomized factorial; no apparent test for gender effect	Home-based	Mobility exercise, strength training	Functional performance tasks	I-1: mobility training (stretching, range-of-motion). I-2: strength training (above + resistive elastic bands) Daily 15 min/session for both I arms. C: health education All Ss received 30-min visits by physiotherapist every 3–4 wks.	6 mos; 80% study retention rate; No statistical diffs. between arms; suspected poor compliance, but no info. available. Sample size (power) issues raised.	No follow-up reported
Minor et al. (1989)[52]	120 adults with rheumatoid arthritis (RA) or osteoarthritis (OA) (21–83 yrs; mean = 61 yrs); 82% women	Randomized factorial; stratified by diagnosis and tested for diagnosis effect; no apparent test for diagnosis or gender effects	Community, group-based	Aerobic walking, aerobic aquatics	Exercise tolerance, daily activity level (3-day diary), self-reported health status (AIMS)	I-1: 3×/wk of aerobic walking, 30 min/session (of a 1-hr class); I-2: 3×/wk of aerobic aquatics, 30 min/session (of a 1-hr class); C: 3×/wk of range of motion, 1 hr/session.	12 wks; 80% study retention rate; 78% of I-1, 85% of I-2, and 87% of C completed the class; mean attendance of class completers = 85%; Two I groups had sig. improvement in aerobic capacity, exercise test duration, AIMS scores on physical activity, anxiety, and depression, and 50-ft. walk rel. to C; RA somewhat better net improve. than OA.	6, 12, and 18 mos. from baseline; 69% study retention rate at 6 and 12 mos.; 6 mos.: Changes reasonably maintained over baseline in both I groups; I-1 showed greater improve. in aerobic capacity than I-2 or C. 12 mos.: Changes reasonably maintained over baseline in both I groups; no between-group diffs.; Sig. increase in aerobic capacity in C; 57% of all Ss reported at least 60 mins. of exer/wk. 21 mos: (Minor and Brown, 1993)[53]: 81% study retention rate; mean self-reported exer. = 110 min/wk

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Table 1. Physical activity intervention studies in older adults using experimental (n = 26) or quasi-experimental (n = 3) designs

Study	Sample	Design	Setting	Physical activity target	Dependent variable	Intervention	Post-test	Follow-up
Pollock et al. (1991)[37]	57 healthy, sedentary, community-dwelling adults (70–79 yrs; mean = 72 yrs); 56% women	Randomized factorial	Community, group-based	Walk/jog, resistance training	Participation rates, VO_2max and strength testing; injury rates	I-1: Supervised walk/jog 40 mins/session, 3×/wk. I-2: Supervised 10 variable resistance exercises 40 mins/session, 3×/wk. C: Assessment only	26 wks; 86% study retention rate; 98% attendance rates in I groups; Sig. improvements in VO_2max (I-1) and strength (I-2) rel. to C, but high injury rates with jogging and I-RM testing.	No follow-up reported
Rejeski and Brawley (1997) (abstract)[19a]	60 healthy, sedentary, community-dwelling adults (65–78 yrs; man = 69 yrs); 63% women; 46% of sample had a high school education or less	Randomized factorial; no tests for gender or age effects	Community, center- and home-based	Moderate intensity aerobic exercise, especially walking	Self-reported activity (Stanford 7-day recall), VO_2peak, health-related quality of life	I-1: 12 wks, began with 2 center- and 1 home-based sessions/wk; moved to 1 center- and 4 home-based sessions/wk; home-based exer. monitored via logs, telephone contact. I-2: Focus on maintenance following a structured program in addition to above; use of social-cognitive adher. strategies (buddy system, group activities, self-regulatory strategies). C: Wait-listed	6 mos.; 90% study retention rate; At 6 mos., I-1 and I-2 had sig. higher peak MET capacities and enhanced quality of life rel. to C; no diffs. in these outcomes among two I groups; no diffs. between I groups on mean freq., duration, or vol. of physical activity	9 mos. from baseline; I-2 sig. higher than I-1 in mean freq. of weekly physical activity.
Rikli and Edwards (1991)[40]	31 healthy community-dwelling women who were 1st-time enrollees in exercise classes taught at a local retirement complex and 17 controls enrolled in nonexercise hobby classes (59–81 yrs; mean = 70 yrs)	Quasi-experimental	Classes offered at a local retirement complex	Moderate-intensity low-impact aerobics and walking, general calisthenics	Class attendance records; step-test performance; motor function and cognitive processing speed	I: Instructor-led classes, 20–25 min of aerobic exercise/session, 3×/wk. C: Attention-control (enrolled in nonexercise hobby classes at the same locale)	3 yrs; 71% study retention rate; Approx. 80% average exercise class attendance rates; I sig. improved in step-test perform. in Year 1 rel. to baseline with leveling off (maintenance) in yrs 2 and 3; Sig. improve. in balance, flexibility	No follow-up reported
Rooks et al. (1997)[a]	131 healthy, community-dwelling adults (65–95 yrs; mean = 74 yrs) who participated at least twice a week in community activities at baseline; 66% women	Randomized factorial; tested for gender effect	Community center	Resistance training, walking	Neuromotor performance, participation rates	I-1: Self-paced, class-based resistance training without expensive equipment (stair-climbing with weight belt; hand weights, etc.), 3×/wk, 1 hr/session. I-2: Self-paced, group-based walking, 3×/wk, up to 45 min/session. C: Wait-listed control	10 mos; 81% study retention rate; mean participation rates = 85% in I-1 and 82% in I-2; no injuries occurred; I-1 sig. better than others on muscle strength, reaction time (diff. from C); I-1 and I-2 better than C on stair climbing speed, balance.	No follow-up reported

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Table 1. Physical activity intervention studies in older adults using experimental (n = 26) or quasi-experimental (n = 3) designs

Study	Sample	Design	Setting	Physical activity target	Dependent variable	Intervention	Post-test	Follow-up
Sharpe et al. (1997)[50a]	139 adults from five congregate meal centers in South Carolina; 87% Black, 86% women (60–91 yrs; mean = 75 yrs)	Quasi-experimental (two I sites and 3 comparison sites); no apparent test for gender effect	Classes held at congregate meal centers	Low-intensity exercise, including chair movement, standing dance movement, optional use of hand-weights	Performance-based and self-report measures of physical function	I: Low-intensity exercise 2×/wk; behavioral strategies (goal-setting, feedback, incentives). C: Wait-list	1 yr; 79% study retention rate; mean I participation score = 36%; 72% of I reported doing home exercise; I improved in 10-ft walk rel. to C	No follow-up reported
Stewart et al. (1997)[24a]	91 adults from two HUD-supported senior congregate housing facilities (62–91 yrs; mean =77 yrs); 82% women, mean educ. yrs = 14; Ss with health probs. included	Quasi-experimental (1 I and 1 comparison site); no test for gender effect; pop.-based recruitment methods	Community classes and programs already being offered for seniors	Low- to moderate-intensity endurance and conditioning exercise programs	Participation rates at community classes; reported energy expenditure (CHAMPS); self-report measures of function	I: 1 Face-to-face counseling session with telephone follow-up; behavioral strategies employed to increase participation in exercise classes and programs. C: Wait-list	6 mos; 91% study retention rate; I had sig. greater community program partic. rates than C (54% vs. 34%); Ex. adopters had sig. increases in weekly caloric expenditure and improve. in psychol. outcomes rel. to those who did not.	No follow-up reported
Stewart et al (1997) (abstract)[24a]	173 sedentary adults from 2 Medicare HMOs (65–90 yrs; mean = 74 yrs); 66% women, mean educ. yrs = 15.2; Ss with health probs. included	Randomized controlled; population-based recruit. methods (33% of those eligible enrolled); tests for age and gender effects	Community classes and home	Moderate-intensity endurance and conditioning exercise	Energy expenditure (CHAMPS quest.); participation rates; functional performance tasks	I: 1 Face-to-face counseling session with telephone follow-up and monthly informational classes; goal of 5 sessions/wk; behavioral strategies employed to increase exercise participation. C: Wait-list	12 mos; 95% study retention rate; I had sig. net improvement in reported energy expenditure (405 cal/wk increase) and exercise frequency (3 times/wk) relative to C.	24 mos follow-up planned
Toshima et al. (1990)[22]	129 COPD patients (mean = 62.6 yrs); 27% women	Randomized controlled	Community rehabilitation	Walking (treadmill and free-walking at home)	Exercise endurance (peak, symptom-limited treadmill test); measures of well-being, efficacy	I: Comprehensive rehab. program, with 12, 4-hr sessions; each included 2 ed. group sessions + supervised exercise training (individualized exercise Rx, support). C: Education control (8 hr total). For both I and C, Ss required to make up any sessions missed.	8 wks; 91% study retention rate; Exercise endurance increased relative to C; self-efficacy increased in 1 rel. to C	6 mos. from baseline; 89% study retention rate; exercise endurance increases in I remained rel. to C; self-efficacy increases in I reasonably maintained rel. to C
Wallace et al. (1998)[48]	100 community-dwelling, ambulatory adults (mean = 72 yrs); 73% women; well-educated	Randomized, controlled; recruited via a senior center; S demographics compared with population-based survey respondents	Community senior center classes	Walking/aerobic activity + strength training + flexibility; offered within the context of a multi-factor program for disability prevention	Health-related quality of life (SF-36); class attendance	I: 3 classes/wk, 60 mins. of exercise/class; received risk factor info. in other health areas (diet, smoking, alcohol, etc.); C: Wait-listed	6 mos.; 90% study retention rate; >90% attendance at thrice weekly exercise classes; significant net improve. in nearly all SF-36 subscales in I rel. to C (which declined on this measure).	No follow-up reported

(continued on next page)

Table 1. Physical activity intervention studies in older adults using experimental (n = 26) or quasi-experimental (n = 3) designs

Study	Sample	Design	Setting	Physical activity target	Dependent variable	Intervention	Post-test	Follow-up
Wolf et al. (1996)[72]	200 community-dwelling, ambulatory adults (70 yrs and older; mean = 76 yrs); 81% women	Randomized factorial; no apparent test for gender effect	Community	Tai Chi, balance training	Strength, flexibility, cardiovascular endurance (12-min walk), adherence, falls	I-1: 2×/wk for 45 min/session of group Tai Chi; encouraged to practice daily; I-2: 1×/wk for 45 min/session of computerized balance training; C: 1×/wk for 60 min/session of health education	15 wks; 84% study retention rate; I-2 and C increased walking distance on 12-min. test relative to I-1; 93% of Ss in all groups missed fewer than 2 consecutive sessions and/or were able to make up those missed.	8 mos from baseline; 80% study retention rate; I-1 had reduced risk of multiple falls rel. to other groups.

[a]Explicit inclusion of or testing of behavioral interventions to promote physical activity.

education information.[18] Finally, few studies are available that have compared the addition of behavioral and/or cognitive interventions to more standard approaches in which participants are simply instructed to exercise either through formal center-based programs or various educational mediums. This approach would allow for better determination of the additive effects of such cognitive-behavioral strategies beyond the effects derived from typical exercise program instruction.

In addition to using cognitive-behavioral strategies, programs that also used either a supervised home-based format,[16] or a combination of group- and home-based formats[17,19,21–24] typically reported comparable or better physical activity adherence relative to programs that used a class or group format only. Ongoing telephone supervision of the physical activity program (used in 7 studies) was shown to be an effective alternative to face-to-face on-site instruction, resulting in adherence rates over extended periods of time (i.e., up to 2 years) that were as good as or better than face-to-face instruction.[25] In addition, the few studies that have used fully mediated approaches such as home videotaped physical activity instruction[26] or instruction via telephone-linked computer systems,[27–29] have shown some encouraging, albeit short-term, results.

Maintenance

Although short-term studies (i.e., 6 months or less) have typically comprised the majority of intervention work in the physical activity field as a whole,[30,31] it is notable that a substantial percentage of the studies included in this review (12, or 41%) had intervention durations of 10 months or longer. Eleven of the cited studies have published some form of follow-up information following the end of the major portion of the trial, and at least two others have unpublished follow-up data.[23,32] The published follow-up periods ranged from 3 months[14,19,33] to eleven and a half years.[34] The majority of these studies, with some exceptions,[34] reported physical activity or fitness levels that were greater than baseline levels and, when comparison groups were still available, better than those reported by controls. However, the quality of the measurement employed at the follow-up point was often less rigorous (e.g., global self-reports) than that utilized during the major trial.

In the one published report directly comparing long-term telephone-supervised home-based exercise instruction with class-supervised instruction, the telephone-supervised programs generally showed better physical activity participation rates at the follow-up period occurring 24 months from baseline relative to the class program.[25] During the second year of the intervention, formal telephone support and related intervention strategies had been substantially reduced,

although not eliminated entirely. In this study, the higher-intensity (walk/jog) three-sessions-per-week home-based program evidenced significantly better adherence at 24 months than did the lower-intensity (brisk walk) five-sessions-per-week home-based program, although adherence at the end of the initial 12-month period had been identical for the two programs.[25] This finding suggests that the added inconvenience of attempting to exercise more frequently during the week may override any benefits to adherence accrued from exercising at a less-intensive level—an exercise-related parameter that has typically been reported to be extremely appealing to middle- and older-aged adults.[35] However, the majority of participants in this study (67% of women and 87% of men) worked outside of the household, which could have resulted in greater time constraints relative to retired populations of older adults.[36] The higher- and lower-intensity programs used in this study resulted in reasonably similar (and low) injury rates across the 2-year period, although forms of physical activity that are more strenuous than those tested in that study have been associated with higher injury rates among older populations.[37,38] Similarly, at least one study of older arthritic patients reported that persons engaged in moderate-intensity forms of exercise but for longer durations (e.g., in this study, a mean of 37.5 minutes per session) lost the benefits of physical activity with respect to reductions in knee pain and disability relative to participants exercising for shorter durations.[39]

Potential Public Health Impact of Current Intervention Approaches

A number of the studies reviewed illustrated that structured class- or group-based physical activity formats can result in reasonably high short-term (i.e., 6 months or less) physical activity participation rates. In addition, several studies reported satisfactory longer-term class or group participation rates, extending up to 3 years in at least one case,[40] among some groups of older adults. The data presented by Rejeski and Brawley,[19] who developed a behavioral intervention that explicitly took advantage of the group structure to enhance physical activity levels following termination of the formal group, are particularly encouraging. In that study, the center-based contacts were limited in number and intentionally spaced at greater intervals over time to encourage the development of self-sustaining strategies to promote long-term maintenance.

These innovations notwithstanding, in light of the large percentage of older adults who are underactive, and the data indicating that a substantial proportion of older adults prefer to engage in physical activity outside of a formal class or group,[41–43] additional alternatives to traditional class approaches will be necessary in order to have a major public health impact. Among the mediated approaches that have been tested thus far with older populations, telephone-based strategies for encouraging ongoing physical activity participation, either alone or in combination with group-based formats, have received the largest amount of empirical support. In light of the fact that approximately 94% of U.S. households have a telephone (Pacific Bell, personal communication, 3/97), the public health impact of such approaches is potentially great.

A reasonably large percentage of the studies reviewed (16, or 55%) described physical activity regimens that appeared to meet or exceed the recently updated U.S. public health recommendations for physical activity among the general adult population.[44] However, few studies focusing on more moderate-intensity forms of endurance exercise (e.g., walking) strove to encourage participants to reach the five or more days per week of physical activity that is currently considered to be optimal for achieving significant health-related benefits.[44] The vast majority of these studies were finished or had begun prior to the publication of the current national recommendations. In addition, 12 of the studies focused on forms of nonendurance physical activity (e.g., strength training, flexibility exercises, balance training) that have been increasingly identified as important components of the comprehensive physical activity regimen likely needed to preserve physical function and health with advancing age.[45,46] Few of the reviewed studies, however, attempted to combine two or more of these physical activity components in a systematic way.[17,33,47,48] Given that it currently remains unclear what the optimal physical activity regimen is for preserving health and function with advancing age,[9] efforts to continue to refine the best regimens for older populations need to proceed in parallel with intervention efforts aimed at promoting long-term physical activity participation.

Effects on Subgroups

Of the eight studies that explicitly tested for gender effects, few significant differences in physical activity participation or physical performance outcomes were found between men and women. Notably absent in this literature are well-controlled studies that systematically examine the effects of ethnicity, lower economic status, or age (e.g., "young-old" versus "old-old") on physical activity participation rates. Only three studies in this review either specifically targeted one or more of these important subgroups or systematically tested for their effects.[21,49,50] In addition, the one study reviewed that focused primarily on adults in the older age range (mean age = 82 years), who had limited mobility at baseline, reported the poorest adherence rates at 6-month post-test.[51]

Although persons with significant chronic conditions or disabilities represent the majority of the community-dwelling adult population aged 45 years and up,[5] relatively few rigorous studies were found that focused specifically on such subgroups (excluding cardiac populations, who were not included in this review). The two well-designed trials focused on arthritis sufferers demonstrated that relevant intervention programs can be fashioned to promote long-term physical activity participation sufficient to reduce disability among this prevalent segment of the older adult population.[21,52,53] One of these studies, however, noted that exercise adherence had declined to 50% by 18 months.[21] In addition, some promising, albeit short-term, results have been reported for older COPD patients.[14,22] Among persons with multiple chronic conditions, dropout and nonparticipation may be particularly problematic, as suggested in an uncontrolled investigation of older VA outpatients participating in a 4-month exercise program.[54] Of note, however, 36 (47%) of the original participants were able to complete 2 years of the supervised, multicomponent physical activity program and achieve significant pre-post improvements in cardiovascular function and flexibility.[55] Programs that are fashioned specifically to the needs of such subgroups and that can demonstrate a significant impact on promoting long-term behavior change continue to be indicated.[24,32]

Population-based recruitment methods were noted in six of the articles reviewed. Given, however, the individual level of commitment required to participate in all of the studies evaluated, it is likely that the vast majority of the individuals studied were already in the contemplation, preparation, or early action phases of motivational readiness to make physical activity changes.[56] Few data are currently available on fashioning appropriate interventions for the noncontemplator segment of the older adult population, for whom targeted interventions are particularly warranted. Similarly, little is known about the physical activity preferences and needs of the most sedentary segment of the older adult population, who may have the most to gain in areas of health and functioning from physical activity increases. At least one study in the literature has found that different determinants delineated the subgroup of sedentary, versus intermittently active, older adults who agreed to participate in a randomized trial focusing on physical activity promotion.[57] These two subgroups also responded differentially to the two different forms of recruitment (random-digit-dial telephone survey; community-wide promotion) implemented in the study. Finally, the sedentary subgroup had significantly lower one-year physical activity adherence rates across all three physical activity programs evaluated (i.e., higher-intensity group-based, higher-intensity home-based, lower-intensity home-based) relative to the underactive subgroup.[57]

Replication

With few exceptions, systematic replication of promising intervention strategies has been minimal. Among the few strategies reviewed that have received such replication are the telephone-supervised home-based, or home-plus group-based, physical activity programs. To date there have been at least twelve randomized controlled investigations that have systematically applied such approaches in order to promote physical activity participation in a range of population groups, including middle-aged adults,[58–60] overweight men and women,[61,62] men and women aged 50–65 years,[16,25] middle- and older-aged cardiac patients,[63] community samples of men and women aged 65 and older,[17,24,32] and older adult informal caregivers of relatives with Alzheimer's disease or related dementias.[42] The telephone-supervised approach appears to be effective in older as well as younger age groups, and has been used successfully among older adults to promote physical activity of various intensities,[16] types (e.g., endurance, strength, flexibility, general conditioning[17,24,29]), and formats (e.g., home-based, class-based, home plus class or group combinations[16,17,19,21,24,29]). Adequate physical activity participation has been achieved and maintained via this method for periods of up to 2 years.[25] There is also some evidence from at least one of the studies available that less-educated older adults (i.e., a high school education or less), particularly those with relatively low initial fitness levels, might benefit especially from telephone-supervised home-based approaches through 2 years.[64] Because a number, although not all,[62] of these studies were undertaken in northern California, the generalizability of the supervised home-based approach to other regions of the United States remains to be verified. Currently ongoing multi-site physical activity trials such as the NHLBI-funded Activity Counseling Trial (ACT) will add useful information in this regard.

The use of cognitive-behavioral strategies to increase both initial and longer-term physical activity participation, whether delivered via telephone or in a face-to-face format, also has been found to be a useful intervention tool in a number of the studies reviewed.

Generalizability

As noted earlier, the vast majority of the physical activity intervention studies undertaken with older adults have not included important subgroups, such as lower income individuals, persons of nonwhite ethnicity, and the oldest old. The generalizability of current interventions to these segments of the population is thus

currently unknown, and constitutes an important target for future research in this area.

The above issues notwithstanding, the types of promising intervention approaches that have been reviewed (e.g., use of cognitive-behavioral strategies; implementation of telephone-supervised programs) are potentially generalizable to a broad segment of the older adult population. Most of the telephone-supervised programs utilized a 20- to 40-minute initial face-to-face instructional session in combination with 12 to 15 brief (approximately 10 minutes) staff-initiated telephone contacts during a year's period. There is some evidence suggesting that the frequency of telephone contact could be reduced once the exercise program has been established.[61,65] Possible channels for delivering such programs are currently in place in most communities throughout the United States through the auspices of a variety of community organizations and agencies, including local parks and recreation departments, seniors' centers,[48] community colleges, local health departments, medical clinics, nonprofit health organizations (e.g., the American Heart Association), and organizations focusing on seniors (e.g., the American Association of Retired Persons). However, a mechanism for the training and subsequent oversight of potentially appropriate community groups who could deliver such interventions effectively is currently lacking. An important part of all such interventions in this area is the appropriate ongoing tailoring of a physical activity regimen (e.g., physical activity content, intensity, format) to the needs and preferences of the individual, regardless of the types of behavioral or program-based strategies that are employed to increase subsequent physical activity participation.

Cost-Effectiveness

Attempts to evaluate the cost-effectiveness of intervention approaches in older adults, either relative to no treatment, usual care, or other active interventions, have been minimal. The few published studies that have systematically collected cost data have focused on medical utilization and cost savings related to health outcomes of interest (e.g., costs of inpatient and outpatient services),[33] rather than cost-effectiveness analyses related to the interventions themselves. Such analyses should occur in concert with intervention development and evaluation efforts. At least one recently completed study has such cost-effectiveness analyses currently underway.[24]

Implementation

Few systematic attempts have been made to date by the scientific community to disseminate successful programs to the public. Although there are a plethora of popular books and manuals available focusing on physical activity promotion in older adults, few are based on specific, rigorously controlled research. In addition, relatively few physical activity printed materials and programs aimed at older adults that exist in many communities throughout the United States explicitly include the types of behavioral, cognitive, social, and program-based strategies that have been shown to be effective in promoting physical activity participation rates in older as well as younger adults. A recent example of efforts to do so include dissemination, in book form and through training seminars and similar formats, of the rigorously undertaken research on strength training in older adults conducted by Tufts researchers.[66] The telephone-based approach to promoting ongoing physical activity participation awaits systematic dissemination efforts, although efforts to explore methods of doing so are currently underway in California, through the auspices of the state health department.

Additional Issues

Physical Activity Assessment among Older Adults

Progress in the intervention area continues to be constrained by the dearth of physical activity assessment instruments that are sensitive to the more moderate forms of physical activity typically undertaken and preferred by older adults. Although in recent years several promising physical activity assessment instruments have been developed specifically for older populations,[32,67–70] efforts to evaluate their sensitivity to change with appropriate physical activity intervention have been scarce. Three recently completed studies have indicated that the CHAMPS physical activity questionnaire for older adults developed by Stewart and colleagues[32] is sensitive to change in response to 6-to-12-month physical activity interventions focused on light to moderate-intensity endurance activity.[17,24,32] In one of these investigations, which focused on a 1-year program of moderate-intensity endurance activity in healthy, community-dwelling seniors,[17] estimated energy expenditure as measured via the CHAMPS questionnaire was found to be sensitive to change in the endurance activity program relative to a stretching and flexibility program. In contrast, the Physical Activity Scale for the Elderly (PASE)[68] was not found to be sensitive to change in the same sample.

Defining the Appropriate Physical Activity Stimulus to Target in Interventions for Older Adults

As noted earlier, the optimal physical activity stimulus for gaining appropriate health and functioning benefits among older populations has yet to be adequately defined or agreed upon via scientific consensus. Such a

regimen will likely require a combination of endurance, strength, and flexibility/balance activities.[45,46] The systematic evaluation of physical activity programs that may improve balance, in particular, is an area that has received relatively little systematic attention, although two of the FICSIT (Frailty and Injuries: Cooperative Studies of Intervention Techniques) investigations suggest that physical activities such as tai chi chuan and walking may improve balance and/or reduce risk of falling better than other forms of activity (e.g., use of a cycle ergometer).[71,72] A significant challenge facing this field is the development of intervention strategies to promote ongoing participation in all of these physical activity domains.[48] Although there are likely strategies that will be effective across all such domains (e.g., cognitive-behavioral strategies), the potential for additional intervention approaches that may be specific to each of these physical activity types remains unexplored.

An appropriate physical activity stimulus for older adults must be considered both from subjective and objective points of view. That is, in addition to the operational aspects of the regimen (e.g., exercise type, intensity, frequency) deemed desirable by the scientific community, the individual's perceptions of the program and how it "fits" with personal needs, values, and circumstances require attention.[73]

Applications of Determinants Research in this Area

Relatively few studies undertaken to date to clarify the types of determinants associated with physical activity participation have focused specifically on older populations.[11] Such determinants research may help to identify important contributors as well as barriers to physical activity participation among older adults, thereby potentially leading to more effective interventions. Although the current determinants literature identifies some variables (e.g., educational level, smoking status, overweight, social support, exercise-related self-efficacy, motives to improve physical fitness and appearance) that are associated with physical activity participation among younger and older adult populations alike,[31,39,74–79] other variables appear to be especially influential for older adults. These include transportation problems[75,80,81]; medical concerns, including fear of injury[75,78,79,81]; physician advice to exercise[81,82]; attitudinal barriers, including perceived lack of ability and erroneous beliefs about exercise and physical activity[78,83,84]; and illness and injury.[78,81] In addition, at least one study that employed population-based recruitment strategies to survey 327 women aged 70 to 98 years living in Vancouver, British Columbia, found that self-efficacy for performing fitness-oriented exercise later in life was significantly associated with recollections of childhood physical activity competencies and movement capabilities occurring decades earlier.[74] Such findings underscore physical activity participation in older age as a lifelong process influenced by preceding life experiences and stages of development.

Several studies evaluating the determinants of physical activity adherence among older adults noted that factors influencing physical activity participation may be phase-specific (i.e., dependent on what stage of the program is being evaluated, e.g., initial adoption phase, longer-term maintenance phase).[39,53,85] Results from a study of older arthritic patients also indicate that the determinants of a physical activity regimen may differ, at least for some older adult samples, for various exercise participation parameters (i.e., physical activity attendance as opposed to the actual amount of time spent exercising).[39]

Similar to the older adult intervention literature, few determinants studies have evaluated the importance of different variables in specific subgroups of the older adult population. In one epidemiologic study of 3,223 residents from two communities in South Carolina, reported receipt of physician advice was significantly associated with involvement in leisure-time physical activity among both white and African-American men and women.[82] Among the perceived benefits and barriers to exercise discussed in a recent study of older African-American women[86] were the importance of enjoyment, mental health improvement, and physical enhancement as top benefits of physical activity, and inconvenient locations, safety, social embarrassment, and perceived unpleasantness of physical exertion as the major reported barriers to physical activity. Similar to determinants studies of healthy older adult populations, determinants of exercise maintenance in older arthritic patients have been reported to include initial fitness level, mood disturbance (e.g., anxiety, depressive symptoms), social support, and previous exercise behavior, in addition to changes in pain.[39,53] In one of these studies, ethnicity, gender, and body mass index were not found to be predictive of either exercise frequency or duration over an 18-month period.[39] Specific determinants of potential importance for other major subgroups of older adults (e.g., the oldest-old, the disadvantaged, those with other specific disabilities) remain largely unexplored. Recent applications of signal detection methods to the physical activity field[64] may provide a useful means for identifying clinically meaningful subgroups of older adults, based on initial demographic, behavioral, psychosocial, and physiological variables, for which to better tailor interventions.

Finally, at least one intervention study reviewed noted an increase in physical activity participation, resulting in significant improvement in aerobic power, following the end of the formal study intervention

period among participants randomized originally to an attention-control (range of motion) condition.[52] The authors hypothesized that the exercise content may be less important than a positive exercise experience in motivating at least some subgroups of older adults to maintain exercise or seek out other types of exercise programs.[52] This issue deserves further exploration.

Summary and Recommendations for Future Research and Practice in the Field

The present review underscores a number of gaps in the current physical activity intervention literature for this important population segment that are in critical need of further attention and systematic investigation. These gaps are subsumed in four major recommendations that provide a framework that may guide future efforts in this area. These recommendations have scientific, practice, and policy implications for the field.

Recommendation 1: *Continue to adapt and refine the current national physical activity recommendations to address the specific issues raised when the target is older adults.*

The current national recommendations proposed by the U.S. Centers for Disease Control and Prevention (CDC), the American College of Sports Medicine (ACSM), the American Heart Association, and other national organizations lay the groundwork for an expanded set of physical activity regimens (e.g., those that include more moderate forms of endurance-based physical activity), with enormous applicability to older populations. Yet, additional scientific consensus is needed in other areas related to physical activity prescription for older adults, including an increased focus on additional parameters of the physical activity regimen (e.g., strengthening, flexibility, and balance) as well as expanded physical activity–related outcomes (e.g., health-related quality of life, functional status, depression), which are of particular importance to the day-to-day health and functioning of the older adult. Furthermore, the most effective means for defining what constitutes moderate as opposed to more vigorous intensities of activity in older adults (i.e., using absolute versus relative criteria), as well as the optimal physical activity prescriptions for specific subgroups of older adults (e.g., those with chronic conditions, the frail elderly, those at increased risk of falls) remain unclear. This recommendation might be most readily achieved through convening a panel of scientific experts similar to that convened in developing the current CDC/ACSM recommendations for the American adult population as a whole.

Research Implications: These consensus-building activities would help to define more clearly those areas of physical activity prescription for older adults for which adequate scientific evidence is currently lacking, thereby helping to clarify the most critical research agenda in this area. It will also provide a firm basis on which interventions aimed at promoting a more comprehensive physical activity program (i.e., combining endurance, strengthening, flexibility, and balance-oriented activities) among older adults can continue to be built.

Practice and Policy Implications: Clarification and consolidation of current scientific consensus in this area will help to reduce confusion and enhance efficacy related to physical activity prescription and intervention among health care service providers and exercise specialists working with older adult populations. It will also allow for a more consistent and specific physical activity message to be delivered to the older adult population as a whole.

Recommendation 2: *Systematically evaluate the generalizability of currently supported interventions in more diverse subgroups of older adults. Important subgroups include the frail elderly; those with various chronic conditions and disabilities in areas of physical, psychological, and cognitive function; ethnic minorities; lower socioeconomic status groups; the rural elderly; the oldest-old (aged 85 years and above); and socially isolated and depressed older adults.*

Research Implications: The implementation of pilot work in this area to clarify how current behavioral interventions, such as those utilizing cognitive-behavioral strategies or telephone-based delivery channels, should be adapted to optimize their effectiveness in targeted subgroups is critical. As part of this endeavor, the development of specific intervention strategies that aid effective coping with the chronic illness and injury that often derail attempts among older adults to maintain long-term physical activity participation is strongly indicated. In addition, the field as a whole would benefit from an exploration of the types of demographic, physical, psychosocial, and environmental dimensions and domains that would be most useful for segmenting the older population into meaningful subgroups for intervention.

Practice and Policy Implications: Implementation of the above recommendation will help to clarify how much tailoring will be required to successfully enact physical activity interventions across these different subgroups. This will allow for the delivery of more powerful interventions to those subgroups who may have the most to gain, from a health and quality-of-life perspective, in becoming more regularly active.

Recommendation 3: *Develop evidence-based protocols to aid health care providers and physical activity specialists in appropriately and efficiently assessing older adults in order to triage them to the most appropriate physical activity intervention programs.*

Research, Practice, and Policy Implications: Research focused on developing and testing such empirically-derived protocols is an important step in the develop-

ment of an orchestrated public health approach aimed at tailored intervention delivery and dissemination throughout the older adult population.

Recommendation 4: *Encourage the systematic study of environmental and policy-level approaches to the promotion of physical activity among older adults.*

As noted earlier, it has become increasingly apparent that increases in routine and lifestyle forms of physical activity that can be incorporated naturally throughout a person's day may provide the most effective means for increasing physical activity levels in the population at large. Yet, little information is currently available concerning the types of environmental and lifestyle interventions that could be most potent in facilitating such natural forms of physical activity, particularly among seniors.

Research Implications: The field could benefit greatly from qualitative and determinants research that would allow a better understanding of how and where older adults spend their day and time, as a means of beginning to define relevant situations for which appropriate interventions could be targeted. In addition, research evaluating interventions aimed at different aspects of the physical and social environment, including mass media, as well as policy-level interventions is critically needed.

Practice and Policy Implications: Research in the above areas could help to provide health professionals and physical activity specialists with specific information concerning how such environmental interventions could be combined with educational and behavioral programs to bolster intervention success. In addition, such information could form the basis for promoting advocacy activities aimed at policies conducive to physical activity increases among the elderly. An important goal of environmental and policy-level approaches is to find appropriate ways to make environments more physically challenging for older adults, as a means of facilitating energy expenditure and related processes throughout the day.

Based on the currently available intervention literature, additional recommendations for enhancing the quality and impact of the scientific evidence in this field include:

- comparative studies that rigorously evaluate the efficacy and cost-effectiveness of interventions relative to each other, rather than simply to a control condition. Given that the current national recommendations underscore the utility of increases in physical activity for virtually everyone in a community, comparative studies become particularly important as an aid to tailoring programs to different older adult subgroups. Cost-effectiveness analyses should be included as part of such comparative investigations whenever possible.
- further systematic exploration of fully mediated approaches to physical activity promotion among the older population. Such approaches are essential if current public health goals are to be reached with the older population.
- systematic efforts to disseminate those intervention strategies (e.g., telephone-based intervention) that have shown effectiveness and replicability.
- exploration of the potential utility of intergenerational physical activity programs that facilitate participation among family members (e.g., grandparents and grandchildren) as well as among community subgroups of varying ages (e.g., seniors and preschool or school-aged children).
- applications of a lifespan, developmental perspective to the understanding of physical activity participation in later life, as a means of better understanding how physical activity experience and participation early in life sets the stage for physical activity participation and motivational readiness as one ages.
- continued efforts to systematically apply conceptual or theoretical models to this area as a means of broadening and potentially strengthening intervention development.

References

1. Bureau of the Census. Current population reports: Population projections of the United States by age, sex, race, and Hispanic origin: 1995–2050. Washington, DC: U.S. Department of Commerce, Economics and Statistics Administration, Bureau of the Census; 1996.
2. U.S. Senate Special Committee on Aging. Developments in aging, 1987. Washington, DC: U.S. Government Printing Office; 1988, vol. I.
3. Berg RL, Casells JS, eds. The second fifty years: promoting health and preventing disability. Washington, DC: National Academy Press; 1990.
4. LaPlante MP. Disability in basic life activities across the life span. San Francisco: Institute for Health and Aging; 1989.
5. Hoffman C, Rice D, Sung H. Persons with chronic conditions: their prevalence and costs. J Am Med Assoc 1996;276:1478–9.
6. Lonergan ET, Krevans JR. A national agenda for research on aging. New Engl J Med 1992;324:1825–8.
7. Dawson D, Hendershot G, Fulton J. Aging in the eighties: Functional limitations of individuals age 65 years and over. Washington, DC: National Center for Health Statistics, Advance Data No. 133; June 1987.
8. Huang Y, Macera CA, Blair SN, Brill PA, Kohl HW II, Kronenfeld JJ. Physical fitness, physical activity, and functional limitation in older adults. Med Sci Sports Exerc 1998;30:1430–5.
9. Buchner DM, Wagner EH. Preventing frail health. Clin Geriatr Med 1992;8:1–17.
10. U.S. Department of Health and Human Services. Physical activity and health: a report of the Surgeon General. Atlanta, Georgia: U.S. Department of Health and Human

Services, Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion; 1996.
11. Dishman RK, Sallis JF. Determinants and interventions for physical activity and exercise. In: Bouchard C, Shephard RJ, Stephens T, eds. Physical activity, fitness, and health: International proceedings and consensus statement. Champaign, Ilinois: Human Kinetics Publishers; 1994.
12. World Health Organization. The Heidelberg Guidelines for promoting physical activity among older persons. J Aging Phys Activity 1997;5:1–8.
13. Dishman RK. Motivating older adults to exercise. South Med J 1994;87:S79–S82.
14. Atkins CJ, Kaplan RM, Timms RM, Reinsh S, Lofback K. Behavioral exercise programs in the management of chronic obstructive pulmonary disease. J Consult Clin Psychol 1984;52:591–603.
15. Gillett PA, White AT, Caserta MS. Effect of exercise and/or fitness education on fitness in older, sedentary, obese women. J Aging Phys Activity 1996;4:42–55.
16. King AC, Haskell WL, Taylor CB, Kraemer HC, DeBusk RF. Group-versus home-based exercise training in healthy older men and women: A community-based clinical trial. J Am Med Assoc 1991;266:1535–42.
17. King AC, Oka R, Pruitt L, Phillips W, Haskell WL. Developing optimal exercise regimens for seniors: A clinical trial. Ann Behav Med 1997;19 (Suppl):S56.
18. McAuley E, Courneya KS, Rudolph DL, Lox CL. Enhancing exercise adherence in middle-aged males and females. Prev Med 1994;23:498–506.
19. Rejeski WJ, Brawley LR. Shaping active lifestyles in older adults: a group-facilitated behavior change intervention. Ann Behav Med 1997;19 (Suppl):S106.
20. Bandura A. Social foundations of thought and action: a social cognitive theory. Englewood Cliffs, NJ: Prentice Hall; 1986.
21. Ettinger WH, Burns R, Messier SP, et al. A randomized trial comparing aerobic exercise and resistance exercise with a health education program in older adults with knee osteoarthritis: the Fitness Arthritis and Seniors Trial (FAST). J Am Med Assoc 1997;277:25–31.
22. Toshima MT, Kaplan RM, Ries AL. Experimental evaluation of rehabilitation in chronic obstructive pulmonary disease: short-term effects on exercise endurance and health status. Health Psychol 1990;9:237–52.
23. Kriska AM, Bayles C, Cauley JA, LaPorte RE, Sandler RB, Pambianco G. A randomized exercise trial in older women: increased activity over two years and the factors associated with compliance. Med Sci Sports Exerc 1986; 18:557–62.
24. Stewart AL, Verboncoeur C, McLellan B, et al. Preliminary outcomes of CHAMPS II: a physical activity promotion program for seniors in a medicare HMO setting. In: The Cooper Institute for Aerobics Research and the American College of Sports Medicine, ed. Specialty Conference on Physical Activity Interventions: Cooper Institute for Aerobics Research; 1997:31.
25. King AC, Haskell WL, Young DR, Oka RK, Stefanick ML. Long-term effects of varying intensities and formats of physical activity on participation rates, fitness, and lipoproteins in men and women aged 50 to 65 years. Circulation 1995;91:2596–604.
26. Jette AM, Harris BE, Sleeper L, et al. A home-based exercise program for nondisabled older adults. J Am Geriatr Soc 1996;44:644–9.
27. Cullinane PM, Hyppolite K, Zastawney AL, Friedman RH. Telephone linked communication-activity counseling and tracking for older patients. J Gen Intern Med 1994; 9(Suppl 2):86A.
28. Friedman RH, Stollerman JE, Mahoney DM, Rozenblyum L. The virtual visit: using telecommunications technology to take care of patients. J Am Informatics Assoc 1997;4: 413–25.
29. Jarvis KL, Friedman RH, Heeren T, Cullinane PM. Older women and physical activity: using the telephone to walk. Women's Health Issues 1997;7:24–9.
30. Bouchard C, Shephard RJ, Stephens T, eds. Physical activity and health: international proceedings and consensus statement. Champaign, IL: Human Kinetics Publishers; 1994.
31. King AC, Blair SN, Bild DE, et al. Determinants of physical activity and interventions in adults. Med Sci Sports Exerc 1992;24 (Suppl 6):S221–S236.
32. Stewart AL, Mills KM, Sepsis PG, et al. Evaluation of CHAMPS, a physical activity promotion program for seniors. Ann Behav Med 1997;19:353–361.
33. Buchner DM, Cress ME, de Lateur BJ, et al. The effect of strength and endurance training on gait, balance, fall risk, and health services use in community-living older adults. J Gerontol Med Sci 1997;52A:M218–M224.
34. MacKeen PC, Rosenberg JL, Slater JS, Nicholas WC, Buskirk ER. A 13-year follow-up of a coronary heart disease risk factor screening and exercise program for 40-to 59-year-old men: exercise habit maintenance and physiologic status. J Cardiopul Rehabil 1985;5:510–23.
35. Dishman RK. Determinants of physical activity and exercise for persons 65 years of age and older. In: Spirduso WW, Eckert HM, eds. Physical activity and aging. Champaign, IL: Human Kinetics Publishers; 1989:140–62.
36. Sheldahl LM, Tristani FE, Hastings JE, Wenzler RB, Levandoski SG. Comparison of adaptations and compliance to exercise training between middle-aged and older men. J Am Geriatr Soc 1993;41:795–801.
37. Pollock ML, Carroll JF, Graves JE, et al. Injuries and adherence to walk/jog and resistance training programs in the elderly. Med Sci Sports Exerc 1991;23:1194–200.
38. Seals DR, Hagberg JM, Hurley BF, Ehsani AA, Holloszy JO. Endurance training in older men and women. I. Cardiovascular responses to exercise. J Appl Physiol 1984; 57:1024–9.
39. Rejeski WJ, Brawley LR, Ettinger WH, Morgan T, Thompson C. Compliance to exercise therapy in older participants with knee osteoarthritis: implications for treating disability. Med Sci Sports Exerc 1997;29:977–85.
40. Rikli RE, Edwards DJ. Effects of a three-year exercise program on motor function and cognitive processing speed in older women. Res Q Exerc Sport 1991;62:61–7.
41. King AC, Taylor CB, Haskell WL, DeBusk RF. Identifying strategies for increasing employee physical activity levels: findings from the Stanford/Lockheed exercise survey. Health Educ Q 1990;17:269–85.

42. King AC, Brassington G. Enhancing physical and psychological functioning in older family caregivers: the role of regular physical activity. Ann Behav Med 1997;19:1–11.
43. Mills KM, Stewart AL, Sepsis PG, King AC. Consideration of older adults' preferences for format of physical activity. J Aging Phys Activity 1997;5:50–8.
44. Pate RR, Pratt M, Blair SN, et al. Physical activity and public health: a recommendation from the Centers for Disease Control and Prevention and the American College of Sports Medicine. J Am Med Assoc 1995;273:402–7.
45. Haskell WL, Phillips WT. Exercise training, fitness, health and longevity. In: Lamb DR, Gisolfi CV, Nadel E, eds, vol.8. Perspectives in exercise science and sports medicine: exercise in older adults. Carmel, IN: Cooper, 1995: 11–52.
46. Phillips WT, Haskell WL. "Muscular fitness": easing the burden of disability for elderly adults. J Aging Phys Activity 1995;3:261–89.
47. Lord SR, Ward JA, Williams P, Strudwick M. The effect of a 12-month exercise trial on balance, strength, and falls in older women: a randomized controlled trial. J Am Geriatr Soc 1995;43:1198–1206.
48. Wallace JI, Buchner DM, Grothaus L, et al. Implementation and effectiveness of a community based health promotion program for older adults, under review.
49. Emery CF, Gatz M. Psychological and cognitive effects of an exercise program for community-residing older adults. Gerontologist 1990;30:184–8.
50. Sharpe PA, Jackson KL, White C, et al. Effects of a one-year physical activity intervention for older adults at congregate nutrition sites. Gerontologist 1997;37:208–15.
51. McMurdo MET, Johnstone R. A randomized controlled trial of a home exercise programme for elderly people with poor mobility. Age Ageing 1995;24:425–8.
52. Minor MA, Hewett JE, Webel RR, Anderson SK, Kay DR. Efficacy of physical conditioning exercise in patients with rheumatoid arthritis and osteoarthritis. Arth Rheumat 1989;32:1396–1405.
53. Minor MA, Brown JD. Exercise maintenance of persons with arthritis after participation in a class experience. Health Educ Q 1993;20:83–95.
54. Morey MC, Cowper PA, Feussner JR, et al. Evaluation of a supervised exercise program in a geriatric population. J Am Geriatr Soc 1989;37:348–54.
55. Morey MC, Cowper PA, Feussner JR, et al. Two-year trends in physical performance following supervised exercise among community-dwelling older veterans. J Am Geriatr Soc 1991;39:986–992.
56. Marcus BH, Simkin LR. The transtheoretical model: applications to exercise behavior. Med Sci Sports Exerc 1994;26:1400–4.
57. Young DR, King AC, Oka RK. Determinants of exercise level in the sedentary versus underactive older adult: Implications for physical activity program development. J Aging Phys Activity 1995;3:4–25.
58. Gossard D, Haskell WL, Taylor CB, et al. Effects of low and high intensity home exercise training on functional capacity in healthy middle-aged men. Am J Cardiol 1986;57:446–9.
59. Juneau M, Rogers F, De Santos V, et al. Effectiveness of self-monitored, home-based, moderate-intensity exercise training in middle-aged men and women. Am J Cardiol 1987;60:66–70.
60. King AC, Taylor CB, Haskell WL, DeBusk RF. Strategies for increasing early adherence to and long-term maintenance of home-based exercise training in healthy middle-aged men and women. Am J Cardiol 1988;61:628–32.
61. King AC, Frey-Hewitt B, Dreon D, Wood P. Diet versus exercise in weight maintenance: the effects of minimal intervention strategies on long-term outcomes in men. Arch Intern Med 1989;149:2741–6.
62. Perri MG, Martin AD, Notelovitz M, Leermakers EA, Sears SF. Effects of group-versus home-based exercise in the treatment of obesity. J Consult Clin Psychol 1997;65: 278–85.
63. DeBusk RF, Haskell WL, Miller NH, et al. Medically directed at-home rehabilitation soon after clinically uncomplicated acute myocardial infarction: A new model for patient care. Am J Cardiol 1985;55:251–7.
64. King AC, Kiernan M, Oman RF, Kraemer HC, Hull M, Ahn D. Can we identify who will adhere to long-term physical activity? Application of signal detection methodology as a potential aid to clinical decision-making. Health Psychol 1997;16:380–9.
65. Brassington GS, King AC. Staff contact and exercise maintenance: a randomized study. Proceedings of the Fourth International Congress of Behavioral Medicine. Washington, DC: Society of Behavioral Medicine; 1996:S175.
66. Nelson ME, Wernick S. Strong women stay young. New York: Bantam Books, 1997.
67. Voorrips LE, Ravelli ACJ, Dongelmans PCA, Deurenberg P, Van Staveren WA. A physical activity questionnaire for the elderly. Med Sci Sports Exerc 1991;23:974–9.
68. Washburn RA, Smith KW, Jette AM, Janney CA. The physical activity scale for the elderly (PASE): development and evaluation. J Clin Epidemiol 1993;46:153–62.
69. DiPietro L, Caspersen CJ, Ostfeld AM, Nadel ER. A survey for assessing physical activity among older adults. Med Sci Sports Exerc 1993;25:628–42.
70. Caspersen CJ, Bloemberg BPM, Saris WHM, Merritt RK, Kromhout D. The prevalence of selected physical activities and their relation with coronary heart disease risk factors in elderly men: the Zutphen study, 1985. Am J Epidemiol 1991;133:1078–92.
71. Buchner DM, Cress ME, de Lateur BJ, et al. A comparison of the effects of three types of endurance training on balance and other fall risk factors in older adults. Aging Clin Exp Res 1997;9.
72. Wolf SL, Barnhart HX, Kutner NG, et al. Reducing frailty and falls in older persons: an investigation of tai chi and computerized balance training. J Am Geriatr Soc 1996; 44:489–97.
73. Rejeski WJ. Dose-response issues from a psychosocial perspective. In: Bouchard C, Shephard RJ, Stephens T, eds. Physical activity, fitness, and health: international proceedings and consensus statement. Champaign, IL: Human Kinetics Publishers, 1994:1040–55.
74. Cousins SO. Elderly tomboys? Sources of self-efficacy for physical activity in later life. J Aging Phys Activity 1997;5: 229–43.
75. Elward K, Larson EB. Benefits of exercise for older adults. Clin Geriatr Med1992;8:35–50.

76. Elward KS, Wagner EH, Larson EB. Participation by sedentary persons in an exercise promotion session. Fam Med 1992;24:607–12.
77. Hovell MF, Sallis JF, Hofstetter CR, Spry VM, Faucher P, Caspersen CJ. Identifying correlates of walking for exercise: an epidemiologic prerequisite for physical activity promotion. Prev Med 1989;18:856–66.
78. Stephens RJ, Craig C. The well being of Canadians. Ottawa, ON: Canadian Fitness and Lifestyle Research Institute, 1990.
79. Wolinsy FD, Stump TE, Clark DO. Antecedents and consequences of physical activity an exercise among older adults. Gerontologist 1995;35:451–62.
80. Mills K, Verboncoeur C, McLellan B, et al. Determinants of enrolling in a physical activity program for seniors. Ann Behav Med 1997;19 (Suppl):S103.
81. Shephard RJ. Determinants of exercise in people aged 65 years and older. In: Dishman RK, ed. Advances in exercise adherence. Champaign, IL: Human Kinetics Publishers; 1994:343–60.
82. Macera CA, Croft JB, Brown DR, Ferguson JE, Lane MJ. Predictors of adopting leisure-time physical activity among a biracial community cohort. Am J Epidemiol 1995;142:629–35.
83. Khoury-Murphy M, Murphy MD. Southern (bar) belles: the cultural problematics of implementing a weight training program among older southern women. Play Culture 1992;5:409–419.
84. Mobily KE, Lemke JH, Drube GA, Wallace RB, Leslie DK. Relationship between exercise attitudes and participation among the rural elderly. Adapted Phys Educ Q 1987;4: 38–50.
85. Oka RK, King AC, Young DR. Sources of social support as predictors of exercise adherence in women and men ages 50 to 65 years. Women's Health: Res Gender Behav Policy 1995;1:161–75.
86. Jones M, Nies MA. The relationship of perceived benefits of and barriers to reported exercise in older African American women. Public Health Nurs 1996;13:151–8.