**Table G6.A2. Summary Table of Studies Investigating Whether Regular Physical Activity Improves or Maintains Functional Ability and Role Ability With Aging In Older Adults Who Have Mild, Moderate, or Severe Functional or Role Limitations**

| Article, Study Aims, Sample, Number in Study, Duration | Intervention | Functional Outcomes | Other Effects | Comments |
|---|---|---|---|---|
| Cress et al., 1999 (1)<br>• To evaluate exercise in independent older adults for significant and meaningful improvements in physical function not detected by commonly used measures of physical function.<br>• Men and women aged 70+ years, relatively good health, live in a retirement community or an apartment<br>• n=56 (beginning sample)<br>• n=49 (analytic sample)<br>• 6 months | • Intervention group: Aerobic, strength training (3/week, 60 minutes). Exercise intensity was graded by a specialized coach according to the progression of each subject and based on the Borg scale. 60-minute resistance exercises that consisted of a period of warming up, 3 levels of step-ups on a stair and arm pull-ups using exercise bands plus respiratory muscle training. Subjects also took part in 15-minute walking periods before and after resistance training.<br>• Control group: Did not exercise | • No significant differences were found between groups for changes in the usual walking speed, or the 6 minutes walk. However, the CS-PFP score improved significantly in the exercise group (14%, effect size 0.80).<br>• Functional reach distance changed significantly ($P$=0.028) with the intervention effect size = 0.62. | • No significant differences found between groups for changes in time on balance beam, step reaction time, SIP, or SF-36 scales.<br>• Compared to the control group, the exercise group showed significant increases in maximal oxygen consumption (11%) and muscle strength (33%). | Mixed functional limitation at start |
| King et al., 2000 (2)<br>• To evaluate the effects of two different community-based physical activity regimens on measured and perceived physical functioning and other health-related quality of life outcomes in older adults<br>• Men and women aged 65+ years, not exercising >2/week in previous 6 months, free from CV disease and musculoskeletal problems that would prevent participation in PA<br>• n=103 (baseline)<br>• n=103 (analytic)<br>• 12 months | • Intervention group: Aerobic + strength (4/week, average 50 minutes), 2 days at class and 2 days at home. A combination of aerobic, strength, and muscle-toning exercises conducted in a circuit-type format. Both upper and lower body exercises. Participants were encouraged to reach a target heart rate of 60-75% of heart rate reserve.<br>• Control group: Stretching (4/week, 40 minutes), 2 days in class and 2 days at home, which included a total body stretching routine.<br>• All subjects received individualized instruction before beginning their exercise program and regular telephone counseling throughout the intervention. | • 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 ($P$ <0.015, one-tailed test).<br>• Intervention participants showed significantly greater 12-month improvements in the lift and reach task compared to controls [flexibility] (F[4,95]=3.93, $P$ <0.025, one-tailed test).<br>• There was a significant main effect for group with respect to self-efficacy related to strength. Intervention group reported greater improvement in their confidence for lifting increasingly heavy objects relative to controls (flexibility) (F[4,99]=3.66, $P$ <0.03, one-tailed test).<br>• Intervention group reported a greater improvement in their ability to walk than the control group [flexibility] according to the Colorado Walking Impairment subscale (F[4,99] = 9.60, $P$ <0.002, one-tailed test). | • Intervention group showed greater improvements in submax heart rate than controls.<br>• No significant between group differences for $VO_{2max.}$<br>• Men in the control group [flexibility] showed a greater increase in the sit and reach than men in the intervention group; women assigned to the intervention group showed a pattern of somewhat greater increases, but not statistically significant.<br>• Intervention group reported greater improvement in their confidence for lifting increasingly heavy objects relative to control [flexibility] group.<br>• Intervention group reported greater improvement in their self-efficacy for walking relative to control [flexibility] group.<br>• Both groups showed better adherence to home- versus class-based portions of their exercise prescriptions, t-test = 5.2, $P$ <0.0001<br>• Controls [flexibility] showed greater improvements in daily pain levels relative to intervention group. | Mixed functional limitation at start |

**Table G6.A2. Summary Table of Studies Investigating Whether Regular Physical Activity Improves or Maintains Functional Ability and Role Ability With Aging In Older Adults Who Have Mild, Moderate, or Severe Functional or Role Limitations (continued)**

| Article, Study Aims, Sample, Number in Study, Duration | Intervention | Functional Outcomes | Other Effects | Comments |
|---|---|---|---|---|
| Rubenstein et al., 2000 (3)<br>• To measure effects of an exercise intervention on muscle strength, gait, balance, and endurance among elderly men with risk factors for falls<br>• Men aged 70+years, ≥1 of the following: lower extremity weakness, impaired gait, impaired balance, or >1 fall in previous 6 months<br>• n=59 (beginning sample)<br>• n=59 (analytic sample)<br>• 3 months | • Intervention group: Strength, balance, mobility, endurance (3/week, 90 minutes). Strength: subjects progressed from 1 to 3 sets of 12 repetitions over the first 4 weeks. Rate of progression was modified for subjects with physical limitations. Balance training was performed 2/week, increasing in difficulty over the 12 weeks. Endurance training also increased in intensity over the 12 weeks. Classes led by exercise physiology grad student.<br>• Control: Continued usual activities | • Exercise showed no significant effect on balance or self-reported physical functioning.<br>• Exercisers had a 10% ($P$ <0.05) increase in distance walked in 6 minutes, and improved ($P$ <0.05) scores on an observational gait scale. | • Exercise showed no significant effect on hip or ankle strength, or number of falls.<br>• Isokinetic endurance increased 21% for right knee flexion and 26% for extension. | – |
| Bunout et al., 2001 (4)<br>• To assess the impact of an 18-month nutritional supplementation and resistance training program on health functioning of elders.<br>• Men and women 70+ years, assigned to one of 3 outpatient clinics, 2 that were providing nutritional supplements and 1 that was not<br>• n=149 (beginning sample)<br>• n=98 (analytic sample)<br>• 18 months | • Intervention group: Strength, balance, respiratory muscle training, walking (2/week, 90 minutes). Endurance intensity was 75-80% of estimated 1RM.<br>• 10-minute warm-up, 40 minutes divided equally between aerobic and strength. The kayak and single-stair stepper were used for aerobic activity. Strength training included both upper and lower body exercises.<br>• Control group: Not supplemented, not trained | Walking capacity (12-minute walk) remained constant in trained subjects whereas it declined significantly in non-trained groups, regardless of supplementation ($P$ <0.01). | Right quadriceps strength ($P$ <0.01), right biceps strength ($P$ <0.01), and maximal inspiratory pressure ($P$=0.03) improved more in trained than in non-trained subjects. No effect of nutritional supplementation was observed. | Mixed functional limitation at start |

**Table G6.A2. Summary Table of Studies Investigating Whether Regular Physical Activity Improves or Maintains Functional Ability and Role Ability With Aging In Older Adults Who Have Mild, Moderate, or Severe Functional or Role Limitations (continued)**

| Article, Study Aims, Sample, Number in Study, Duration | Intervention | Functional Outcomes | Other Effects | Comments |
|---|---|---|---|---|
| Binder et al., 2002 (5)<br>• To determine the effects of intensive exercise training on measures of physical frailty in older community-dwelling men and women<br>• Men and women aged 78+ years, at least 2 of the following: score between 18 and 32 on the modified PPT, report of difficulty or need of assistance with up to 2 IADLs or 1 ADL, or achievement of a $VO_{2\ peak}$ between 10 and 18 mL/kg/minute<br>• n=119 (beginning sample)<br>• n=115 (analytic sample)<br>• 9 months | • Intervention group: Strength, balance, endurance (3/week, progressive time). Program introduced in phases. Participants required to complete 36 sessions of each phase before progressing to next phase. Phase 1 group format, included 22 exercises focused on flexibility, balance, coordination, speed of reaction, and to a modest extent, strength. The participants continued to perform a shortened version of the Phase 1 exercises during Phase 2, which added progressive resistance training. Phase 3 endurance training introduced using treadmills, stationary bicycles, Aerodyne bicycles, or rowing machines. Initially, participants exercised for 15 minutes. The duration was increased progressively to 20 minutes. The training regimen was then supplemented with interval training interspersed with 2 to 3 minutes of rest. Shortened programs of Phase 1 and Phase 2 exercises were continued during Phase 3.<br>• Control group: Performed a low-intensity exercise program (2-3/week, of unknown duration), primarily flexibility, not expected to improve primary outcome measures. | • Modified PPT:<br>Intervention vs. Controls<br>Improvement 95% CI = 1.0 to 5.2 points<br>• FSQ:<br>Intervention vs. Controls<br>Improvement 95% CI = 1.6 to 4.9 points<br>• OARS ADL scales:<br>No significant changes<br>• Responses on the Change in Health subscale of the self-reported health status and quality of life (SF-36) improved more in the intervention group than in the control. | • $VO_{2\ peak}$:<br>Intervention vs. Controls<br>Improvement 95% CI = 0.9 to 3.6 mL/kg/min<br>• Intervention group had significant improvements in maximum voluntary knee extensor and knee flexor torque and one-leg stance time, and the Berg Balance Test; these were significantly greater than the changes for controls. | – |

**Table G6.A2. Summary Table of Studies Investigating Whether Regular Physical Activity Improves or Maintains Functional Ability and Role Ability With Aging In Older Adults Who Have Mild, Moderate, or Severe Functional or Role Limitations (continued)**

| Article, Study Aims, Sample, Number in Study, Duration | Intervention | Functional Outcomes | Other Effects | Comments |
|---|---|---|---|---|
| King et al., 2002 (6)<br>• To determine the effects center-based exercise on physical performance in older persons at risk for decline in physical functioning<br>• Men and women aged 70+ years, SPPB score of 9 or lower and independence in at least 5 or 6 ADLs<br>• n=155 (beginning sample)<br>• n=155 (analytic sample)<br>• 18 months | • Intervention group: Strength, endurance, balance, flexibility (3/week, 75 minutes)<br>• Exercise at a center 3 times weekly, for months 1 to 6; once weekly, for months 7 to 12 with home exercise 2 sessions/week; and at home only, for months 13 to 18<br>• Control group: Instructed in home endurance exercise | • MacArthur battery scores improved in intervention compared with home control at 3, 6, and 12 months (repeated measures analysis of variance: group X time, $P$ <0.05) but not 18 months. PPT-8 and 6-minute walk test did not improve.<br>• Improvements were not sustained with transition to home exercise for months 13 to 18.<br>• Better baseline physical function, intervention group assignment, younger age, self-perceived health were independent predictors of long-term MacArthur battery score improvement. | • At 6-month testing, the average intervention group ABC score increased. Although the 2 groups did not differ at 6, 12, and 18 months, differences seen between baseline and 6-month ABC scores in the intervention group persisted.<br>• SF-36 improved in both groups from baseline to 6 months and remained higher than baseline at 12 months. No group by time effect.<br>• The mental health subscale score did not change over time or with the intervention. | – |
| Miszko et al., 2003 (7)<br>• To determine whether power training is more efficacious than strength training for improving whole-body physical function in older adults and to examine the relationship between changes in anaerobic power and muscle strength and changes in physical function<br>• Men and women aged 65-90 years, leg extensor power <140W for women, <210W for men<br>• n=50 (beginning sample)<br>• n=39 (analytic sample)<br>• 4 months | • Intervention group 1: Strength training, (3/week, N/R time), 3 upper and 3 lower body exercises performed for 3 sets of 6-8 repetitions. 5 minutes dynamic warm-up at the beginning of each session and muscle-specific stretches were performed after each set. Intensity progressed from 50% to 70% of 1RM by week 8, then, remained at 80% 1RM for weeks 9-16 (4-second concentric, slow and controlled eccentric).<br>• Intervention group 2: Power training, (3/week, N/R time), first 8 weeks same as strength program; however, this group did jump squats instead of squats. After 8 weeks, the program altered to 3 sets of 6-8 reps at 40% 1RM as fast as possible (1 second concentric, 2 seconds eccentric)<br>• Control group: Maintained usual activity — no strength training. Met for educational presentation 3 times during the 16 weeks. | • CS-PFP total score was significantly greater for the Power Training group compared to the Strength Training ($P$=0.033) and Control groups ($P$=0.016). | • Maximal strength was significantly greater for the strength training group than for the control group ($P$=0.015).<br>• There was no significant difference between groups for peak anaerobic power.<br>• Strength group had significantly more relative mean power than the control group. | – |

**Table G6.A2. Summary Table of Studies Investigating Whether Regular Physical Activity Improves or Maintains Functional Ability and Role Ability With Aging In Older Adults Who Have Mild, Moderate, or Severe Functional or Role Limitations (continued)**

| Article, Study Aims, Sample, Number in Study, Duration | Intervention | Functional Outcomes | Other Effects | Comments |
|---|---|---|---|---|
| Jensen et al., 2004 (8)<br>• To determine whether exercise as part of a fall-prevention program would have positive effects, both short- and long-term, on gait, balance, and strength in older people with a high risk of falling and with varying levels of cognition, residing in residential care facilities.<br>• Men and women aged 65+ years, screened as being at high risk of falling<br>• n=402 (beginning sample)<br>• n=187 (analytic sample)<br>• 2.75 months, 9-month follow-up | • Intervention group: Pattern, duration, and frequency not reported. An individualized exercise program was designed for each resident based on baseline assessment. Resident-specific programs included balance exercises, resistance training focused on the lower extremities, and safe movement behavior training.<br>• Control group: Usual care | At 11 weeks:<br>• Positive intervention effects were found on independent ambulation (FAC, *P*=0.026), maximum gait speed (*P*=0.002), and step height (>10 cm, *P* <0.001), but not significantly on the Berg Balance Scale.<br>At 9 months:<br>• Independent ambulation and maximum gait speed were maintained in the intervention group, but deteriorated in the control group (*P*=0.001).<br>• 3 intervention and 15 control residents had lost the ability to walk (*P*=0.001).<br>• No association was found between improved mobility and reduced risk of falling. | – | – |
| Nelson et al., 2004 (9)<br>• To determine whether a home-based exercise program would improve functional performance in elderly people.<br>• Men and women aged 70+ years, not currently exercising >1 day/week, have at least 2 functional limitations, score 10 or less on SPPB<br>• n=72 (beginning sample)<br>• n=70 (analytic sample)<br>• 6 months | • Intervention group: Aerobic, strength, and balance (3/week, varied time per day). Target exertion rate of 7-7-8 on the 10-point Borg scale with the exception of the balance exercises. Participants received 2 home visits during month 1, followed by 1 home visit each month thereafter. 2 sets of 8 repetitions + balance + 120 minutes of PA per week.<br>• Attention control group: 6 months of nutrition education, 2 home visits with a dietician in first month of study, then 1 visit per month thereafter. | PPT:<br>Exercisers: ↑ 6.1 ± 13.4%<br>Controls: ↓ by 2.8 ±13.6%<br>(*P*=0.02)<br>SPPB:<br>Exercisers: ↑ 26.2 ± 37.5%<br>Controls: ↓ 1.2 ± 22.1%<br>(*P*=0.001)<br>• There was a trend for exercise group to improve in maximal gait speed (*P*=0.08)<br>• 6-minute walk test did not change | • No differences between groups for SF-36 or Geriatric Depression Scale.<br>• Intervention group improved compared to the control in tandem walk scores and one-legged stand (*P*=0.0002-0.007).<br>• No association was found between improved mobility and reduced risk of falling.<br>• No significant group by time interaction on any measure of strength. | – |

**Table G6.A2. Summary Table of Studies Investigating Whether Regular Physical Activity Improves or Maintains Functional Ability and Role Ability With Aging In Older Adults Who Have Mild, Moderate, or Severe Functional or Role Limitations**

| Article, Study Aims, Sample, Number in Study, Duration | Intervention | Functional Outcomes | Other Effects | Comments |
|---|---|---|---|---|
| Means et al., 2005 (10)<br>• To assess the short-term effect of an exercise-based rehabilitation intervention on balance, mobility, falls, and injuries<br>• Men and women aged 65+ years, ability to walk at least 30 feet with or without an assistive device and without physical assistance from others<br>• n=338 (beginning sample)<br>• n=205 (analytic sample)<br>• 1.5, 6 months follow-up | • Intervention group: Active stretching, postural control, endurance walking, and repetitive muscle coordination exercises (3/week, 90 minutes). Progressive, guided by an RPE rating (13 — somewhat hard — on the scale).<br>• Sessions were supervised by a physical therapist. Program started at low-level intensity, and frequency, repetitions, and resistance of the exercises were adjusted individually. Program included warm-up and cool-down.<br>• Control group: Attended a series of seminars on various, non-health-related topics of general interest to senior citizens. | • The exercise group's functional obstacle course quality improved 2.3% post-intervention and 1.57% at follow-up compared with 0.3% for the control group for each time period (*P*=0.001).<br>• Functional obstacle course completion time improved 7.69% at post-intervention and 8.35% at follow-up for the exercise group compared with 4.0% and 3.4% for the control group.<br>• Of the baseline fallers in the intervention group, 87% (compared with 34.5% for the controls) reported no falls in the subsequent 6 months. | • The intervention group improved in muscle strength and declined but remained above baseline level 6 months later, whereas the control group remained relatively constant across all periods of the study.<br>• Significant group-by-time findings for range of motion. | Mixed functional limitation at start |
| LIFE-P Study Investigators, 2006 (11)<br>• To assess the effect of a comprehensive physical activity intervention on the SPPB and other physical performance measures.<br>• Men and women 70-89<br>• Sedentary, ambulatory, SPPB score ≤9<br>• n=424 (beginning sample)<br>• n=424 (analytic sample)<br>• Average 14 months | • Intervention group: Aerobic (primary focus), strength training, balance, flexibility (frequency varied, 40-60 minutes/strength, balance, flexibility session). Walking goal of at least 150 minutes/week throughout study. Program was divided into three phases: adoption (weeks 1-8), transition (weeks 9-24), maintenance (week 25 to end of trial). Adoption: 3 center-based sessions 40-60 minutes; Transition: 2 center-based sessions and >3 home-based sessions; Maintenance: home-based exercise with optional 1-2/week center-based sessions. 5-minute warm-up, 45 minutes of 8-10 resistance exercises for upper and lower body, 5-minute cool-down. Each participant went through an individualized session before intervention started to optimize safety and participation. They received behavioral counseling for first 10 weeks.<br>• Active control group: Attended health education sessions. | • Baseline SPPB score 7.5 (on a scale of 0-12, with 12 corresponding to the highest performance)<br>• At 6 and 12 months, the PA vs. control group adjusted SPPB (± standard error) scores were 8.7 ± 0.1 vs. 8.0 ± 0.1, and 8.5 ±0.1 vs. 7.9 ± 0.2, respectively (*P* <0.001).<br>• There was a trend toward PA group having a lower incidence of major mobility disability, defined as incapacity to complete a 400-meter walk (hazard ratio = 0.71, 95% CI = 0.44-1.20). (Not significant) | – | • Average frequency of PA at 6 months was 6.4/week; at 12 months, 5.1/week<br>• Average walking minutes/ week = 138 |

**Table G6.A2. Summary Table of Studies Investigating Whether Regular Physical Activity Improves or Maintains Functional Ability and Role Ability With Aging In Older Adults Who Have Mild, Moderate, or Severe Functional or Role Limitations (continued)**

| Article, Study Aims, Sample, Number in Study, Duration | Intervention | Functional Outcomes | Other Effects | Comments |
|---|---|---|---|---|
| Luukinen et al., 2006 (12)<br>• To assess the effectiveness of an intervention planned and implemented by regional geriatric care teams in order to prevent disability in an elderly population<br>• Men and women aged 85+ years, recurrent falling, feelings of loneliness, poor self-rated health, depression, low cognitive status, impaired vision, hearing, and/or balance, slow walking speed, impaired ability to stand up from a chair.<br>• n=486 (beginning sample)<br>• n=358 (analytic sample)<br>• 17 months | • Intervention: One or more of the following: home, walking, group, self-care exercises (varied x week, varied minutes/session). Intervention conducted by geriatric home health care workers.<br>• Home: 5-15 reps/session, 3 sessions/day<br>• Walking: Not described<br>• Group: PA in small groups<br>• Self-care: Varies — planned by OT<br>• Control: Were asked to visit their physician without a written intervention form | • Mobility score improved more in interven-tion subjects than in controls (*P*=0.013).<br>• No difference in ADL score between intervention and controls (*P*=0.462).<br>• At the end of the intervention, severe mobility restrictions and frequency of admissions into long-term institutional care existed similarly in intervention and controls.<br>• Severe mobility restrictions: Interventions: (48, 34%) Controls: (46, 31%) (*P*=0.650)<br>• Long-term care admission: Interventions: (15, 7%) Controls: (13, 6%) (*P*=0.669)<br>• Impaired balance existed in fewer intervention subjects (64, 45%) than controls (89, 59%) (*P*=0.015). | – | – |

↑, increases; ↓, decreases; ABC, activities-specific balance confidence; ADL, activities of daily living; C, control; CI, confidence interval; CS-PFP, Continuous Scale Physical Functional Performance test; CV, cardiovascular; FAC, Functional Ambulation Categories Scale; FSQ, functional status questionnaire; IADL, instrumental activities of daily living; mL/kg/min, milliliters per kilogram per minute; N/R, not reported; OARS, Older American Resources and Services; OT, occupational therapist; PA, physical activity; PPT, Physical Performance Test; 1RM, one-repetition maximum; RPE, rate of perceived exertion; SF-36, short form health survey with 36 questions; SIP, Sickness Impact Profile; SPPB, Short Physical Performance Battery; ST, strength training

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