Evidence Portfolio – Aging Subcommittee, Question 2

What is the relationship between physical activity and physical function among the general aging population?

a. Is there a dose-response relationship? If yes, what is the shape of the relationship?
b. Does the relationship vary by age, sex, race/ethnicity, socio-economic status, or weight status?
c. What type(s) of physical activity are effective for improving or maintaining physical function?
d. What impairment(s) modify the relationship between physical activity and physical function among the general aging population?

Sources of Evidence: Existing Systematic Reviews, Meta-Analyses, and Pooled Analysis

Conclusion Statements and Grades

Strong evidence demonstrates that physical activity improves physical function and reduces risk of age-related loss of physical function in the general aging population. **PAGAC Grade: Strong.**

Strong evidence demonstrates an inverse dose-response relationship between volume of aerobic physical activity and risk of physical functional limitations in the general aging population. **PAGAC Grade: Strong.**

Limited evidence suggests an inverse dose-response relationship of volume of muscle-strengthening and frequency of balance training with risk of physical functional limitations in the general aging population. **PAGAC Grade: Limited.**

Limited evidence suggests that the relationship between physical activity and physical function does not vary by age, sex, or weight status in the general population of older adults. **PAGAC Grade: Limited.**

Insufficient evidence is available to determine whether the relationship between physical activity and physical function varies by race/ethnicity and socioeconomic status in the general population of older adults. **PAGAC Grade: Not assignable.**

Strong evidence demonstrates that aerobic, muscle-strengthening, and multicomponent physical activity improves physical function in the general aging population. **PAGAC Grade: Strong**.

Moderate evidence indicates that balance training improves physical function in the general aging population. **PAGAC Grade: Moderate**.

Limited evidence suggests that tai chi exercise, dance training, active video gaming, and dual-task training improve physical function in the general aging population. **PAGAC Grade: Limited**.

Insufficient evidence is available to determine the effects of flexibility activity, yoga, and qigong exercise on physical function in the general aging population. **PAGAC Grade: Not assignable**.

Limited evidence suggests that the effect of physical activity on physical function is relatively stronger in older adults with limitations in physical function compared to relatively healthy older adults. **PAGAC Grade: Limited.**

Insufficient evidence is available to determine whether visual impairments or cognitive impairments modify the relationship between physical activity and physical function among the general aging population. **PAGAC Grade: Not assignable**.

Description of the Evidence

An initial search for systematic reviews, meta-analyses, pooled analyses, and reports identified sufficient literature to answer both Aging Subcommittee Question 2 (physical function among the general aging population) and Aging Subcommittee Question 3 (physical function in older individuals with selected chronic conditions) as determined by the Aging Subcommittee. Additional searches for original research were not needed.

Existing Systematic Reviews, Meta-Analyses, and Pooled Analysis

Overview

A total of 38 existing reviews that assessed the relationship between physical activity and physical function among the general aging population were included. Of those, 20 were meta-analyses,[1-20] 17 systematic reviews,[21-37] and 1 was a pooled analysis.[38] The reviews were published between 2007 and 2017.

The meta-analyses included a range of 4 to 121 studies and covered the following timeframes: 1960 to 2015[1]; inception to 2015[2, 17, 20]; 1990 to 2006 and 2013[3, 19]; inception to 2013[4]; 1974 to 2014[5]; 1984 to 2014[6]; inception to 2011[7]; 1973 to 2007[8]; 1985 to 2015[9]; 1998 to 2008[10]; 1948 to 2007 and 2008[11, 12]; 1995 to 2003[13]; inception to 2014[14]; 1997 to April 2013[15]; inception to 2012[16]; inception to 2010.[18]

The systematic reviews included a range of 3 to 100 studies and covered the following timeframes: from 1966 to 2006[21]; 2000 to 2015[22]; inception to 2016[23]; 1990 to 2008[24]; 2000 to 2012 and 2013[25, 35]; inception to 2012 and 2014[26, 27]; 2015 to 2016[29]; inception to 2006 and 2008[30, 31]; inception to 2010[32]; 1993 to 2007[33]; inception to 2011 and 2013[34, 37]; 1998 to 2016.[36] One systematic review did not report the timeframe searched.[28]

Exposures

The included reviews examined a wide range of physical activity and exercise modalities. Some reviews assessed multiple modalities of exercise, including aerobic, resistance, balance, coordination, and/or flexibility.[3, 7, 13, 19, 21, 22, 24, 37] Some reviews focused on specific types of physical activity or exercise, including aerobic and/or resistance training,[1, 8, 29] aerobic training only,[23] progressive resistance training,[11, 12, 30] outdoor walking,[4] virtual reality training or active video games,[2, 15, 17] balance training,[9] tai chi,[10] tai chi and qigong,[33] power training,[18] yoga,[20] dance,[28] and flexibility training.[34]

Outcomes

All the included reviews examined physical function outcomes using physical or functional performance tests and/or self-report. Physical performance outcomes included measures of ability to: maintain

balance (e.g. stand on one leg), walk (e.g. walking speed), stand from a chair (e.g. timed chair stand), and do combined activities (e.g. Timed Up and Go). Self-report measures of physical function included the SF-36 physical function subscale and ADL (Activities of Daily Living) scales.

Populations Analyzed

The table below lists the populations analyzed in each article.

Table 1. Populations Analyzed by All Sources of Evidence

	Sex	Age	Chronic Conditions	Other
Baker, 2007		Adults ≥60		
Bouaziz, 2016		Adults ≥65		
Bouaziz, 2017		Adults ≥70		
Chase, 2012		Older adults (>80)		
Chase, 2017		Adults ≥65		Frailty
Donath, 2016		Adults ≥60 (mean age 76)		
Fernandez-Arguelles, 2015		Adults >60		
Fritz, 2015		Adults >18		Central neurologic disorder
Gobbo, 2014		Adults ≥60		
Gu, 2008		Adults >65		
Hanson, 2015		Older adults		
Hill, 2015		≥60		
Hortobágyi, 2015		Adults ≥65		
Howe, 2011	Male, Female	Adults 60–75, >75		Frailty
Kelley, 2009		Adults >50		
Keogh, 2009		Adults >60		
Lesinski, 2015		Adults ≥65		
Leung, 2011		Adults ≥60		
Liberman, 2017		Adults ≥65		
Liu, 2009		Adults ≥50		
Liu, 2011		Older adults		

	Sex	Age	Chronic Conditions	Other
Lopopolo, 2006		Adults 60–89		
Morey, 2008		Adults 65–94		
Orr, 2008		Adults ≥50		
Paterson, 2010		Adults 65–85		
Pichierri, 2011		Older adults		
Plummer, 2015		Adults ≥60		
Rodrigues, 2014		Older adults		
Rogers, 2009		Adults >55		
Stathokostas, 2012		Older adults		
Tak, 2013		Adults >75, ≤75		
Taylor, 2016		Adults ≥65 (mean 75.6)		
Tschopp, 2011		Older adults		
Vagetti, 2014		Adults ≥60		
Van Abbema, 2015		Adults ≥60		
van der Vorst, 2016		Adults ≥75		
Youkhana, 2016		Adults ≥60 (mean range 63–84)		
Zanotto, 2014		Adults >59	Stroke	Parkinson's disease, dementia, frail elderly

Supporting Evidence

Existing Systematic Reviews, Meta-Analyses, and Pooled Analysis

Table 2. Existing Systematic Reviews, Meta-Analyses, and Pooled Analysis Individual Evidence Summary Tables

<table>
<tr><td colspan="2">Systematic Review
Citation: Baker MK, Atlantis E, Fiatarone Singh MA. Multi-modal exercise programs for older adults. Age Ageing. 2007;36(4):375-381.</td></tr>
<tr><td>Purpose: To systematically review all health outcomes to concurrent strength, aerobic, and balance training in older adults to assess the current level of evidence regarding the feasibility and efficacy of current guidelines.</td><td rowspan="5">Abstract: BACKGROUND: Various modalities of exercise have been demonstrated to improve physical function and quality of life in older adults. Current guidelines stress the importance of multi-modal exercise for this cohort, including strengthening exercises, cardiovascular, flexibility and balance training. There is a lack of evidence, however, that simultaneously prescribed doses and intensities of strength, aerobic, and balance training in older adults are both feasible and capable of eliciting changes in physical function and quality of life. METHODS: A comprehensive, systematic database search for manuscripts was performed. Two reviewers independently assessed studies for potential inclusion. Physical and functional performance outcomes were extracted. The relative effect sizes (ES) were calculated with 95% confidence intervals. RESULTS: Fifteen studies were included totalling 2,149 subjects; the mean cohort age ranging from 67 +/- 8 to 84 +/- 3 years. A low mean relative ES for strength was seen across the reviewed studies. Only six of the eleven studies that included balance measurements found a significant improvement in balance compared to controls. Aerobic fitness was seldom measured or reported. Five out of the six studies investigating fall rates showed a significant reduction. Functional and quality of life measures generally did not improve with exercise. CONCLUSION: Multi-modal exercise has a positive effect on falls prevention. The limited data available suggests that multi-modal exercise has a small effect on physical, functional and quality of life outcomes. Future research should include robustly designed trials that involve multi-modal exercise at individually prescribed intensities based on doses found to be effective in single-modality studies.</td></tr>
<tr><td>Timeframe: 1966–December 2006</td></tr>
<tr><td>Total # of Studies: 15 (4 only addressing quality of life outcome)</td></tr>
<tr><td>Exposure Definition: Multi-modal exercise intervention with at least 3 concurrently conducted modalities of strength/progressive resistance training, aerobic/cardiovascular endurance (e.g., walking, cycling) training, and balance/stability training. Intervention may or may not have included flexibility exercises. Interventions were home-based or supervised center-based programs ranging from 3 to 12 months, and the most common frequency was 3 times per week.
Measures Steps: No
Measures Bouts: No
Examines HIIT: No</td></tr>
<tr><td>Outcomes Addressed: Balance outcomes: single-leg stance time, Berg Balance scale, units of sway, POMI balance scale. Functional outcomes: incidence of falling, habitual gait velocity, maximal gait velocity. Quality of life: SF-36 quality-of-life, Geriatric Depression Scale score for depressive symptoms.
Examine Cardiorespiratory Fitness as Outcome: Yes</td></tr>
<tr><td>Populations Analyzed: Age ≥60</td><td>Author-Stated Funding Source: Not reported.</td></tr>
</table>

<table>
<tr><td colspan="2">Systematic Review
Citation: Bouaziz W, Lang PO, Schmitt E, Kaltenbach G, Geny B, Vogel T. Health benefits of multicomponent training programmes in seniors: a systematic review. Int J Clin Pract. 2016;70(7):520-536. doi:10.1111/ijcp.12822.</td></tr>
<tr><td>Purpose: To evaluate the evidence of the health benefits of multicomponent training, including endurance training, muscle strengthening, balance exercises, stretching and/or coordination training in older adults.</td><td rowspan="4">Abstract: BACKGROUND: The ageing process is intrinsically associated with decline in physical endurance, muscle strength and gait ability and balance, which all contribute to functional disability. Regular physical training, and more particularly multicomponent training (MCT), has demonstrated many health benefits. OBJECTIVE: To evaluate the evidence of the health benefits of MCT including endurance training, muscle strengthening, balance exercises, and/or stretching (i.e. flexibility training) and/or coordination training in adults aged 65 years or over. METHODS: A comprehensive, systematic database search for manuscripts was performed in CINAHL Plus, Embase, Medline, PubMed Central, ScienceDirect, Scopus, Sport Discus and Web of Science using key words. For potential inclusion, two reviewers independently assessed all intervention studies published in English language from 1 January 2000 to 30 April 2015. RESULTS: Of 2525 articles initially identified, 27 studies were finally included in this systematic review. They were all divided into five categories according to their main outcome measurements (cardio-respiratory fitness, metabolic outcomes, functional and cognitive functions and quality of life, QoL). These studies reported that MCT has a significant beneficial effect on cardio-respiratory fitness and on metabolic outcomes. Substantial improvement in functional and cognitive performance was also measured and a slighter but positive effect on QoL. CONCLUSION: Overall, this review demonstrates a positive effect of MCT with functional benefits and positive health outcomes for seniors. Based on this evidence, clinicians should encourage all adults aged 65 or over to engage in MCT programmes to favour healthy ageing and keeping older members of our society autonomous and independent.</td></tr>
<tr><td>Timeframe: 2000–April 2015</td></tr>
<tr><td>Total # of Studies: 27 (5 addressing QoL)</td></tr>
<tr><td>Exposure Definition: Multi-modal or multicomponent training composed of endurance/aerobic (e.g., walking, cycling, or rowing), strength/resistance training (progressive in nature), and balance/stability (e.g., specific balance exercises, tai chi).
Measures Steps: No
Measures Bouts: No
Examines HIIT: No</td></tr>
<tr><td>Outcomes Addressed: Functional status (muscle strength), functional fitness (balance, gait ability, flexibility, exercise capacity), quality of life.
Examine Cardiorespiratory Fitness as Outcome: Yes</td></tr>
<tr><td>Populations Analyzed: Age ≥65</td><td>Author-Stated Funding Source: Not reported.</td></tr>
</table>

<table>
<tr><td colspan="2">Systematic Review
Citation: Bouaziz W, Vogel T, Schmitt E, Kaltenbach G, Geny B, Lang PO. Health benefits of aerobic training programs in adults aged 70 and over: a systematic review. Arch Gerontol Geriatr. 2017;69:110-127. doi:10.1016/j.archger.2016.10.012.</td></tr>
<tr><td>Purpose: To examine the cardiovascular, metabolic, functional, cognitive, and quality of life outcomes resulting from aerobic training program in adults aged 70 years and over in order to assess the current level of evidence regarding its benefit on five major health-related conditions.</td><td rowspan="5">Abstract: Aging is intrinsically associated with a progressive decline in muscle strength and mass, and aerobic capacity. This contributes to reduced mobility and impaired quality of life (QoL) among seniors. Regular physical activity, and more particularly aerobic training (AT), has demonstrated benefits on adults' health. The aim of this review was to assess the current level of evidence regarding the health benefits of AT in the population aged 70 years and over. A comprehensive, systematic database search for manuscripts was performed. Two reviewers independently assessed interventional studies for potential inclusion. Cardiovascular, metabolic, functional, cognitive, and QoL outcomes were targeted. Fifty-three studies were included totalling 2051 seniors aged 70 years and over. Studies selected were divided into 5 categories according to their main outcomes: cardiovascular function (34 studies), metabolic outcomes (26 studies), functional fitness (19 studies), cognitive functions (8 studies), and QoL (3 studies). With a good level of evidence but a wide heterogeneity between study designs, a significant and beneficial effect of AT was measured on the 5 outcomes. For QoL results showed a significant but slighter improvement. This systematic review highlights the benefits of AT on seniors' health outcome such as cardiovascular, functional, metabolic, cognitive, and QoL outcomes although the optimal program remains unclear. When more studies regarding this specific population are needed to determine the most favourable exercise program, clinicians should nevertheless encourage older adults over 70 to participate in AT programs to favour active and healthy ageing.</td></tr>
<tr><td>Timeframe: Inception–January 2016</td></tr>
<tr><td>Total # of Studies: 53 (3 only addressing quality of life outcome)</td></tr>
<tr><td>Exposure Definition: Aerobic training: mainly using treadmill running/walking, cycling, and rowing. Most interventions were 3 days a week or 2–6 sessions, ranging from a 9- to 96-week period, and with varying levels of intensity.
Measures Steps: No
Measures Bouts: No
Examines HIIT: No</td></tr>
<tr><td>Outcomes Addressed: Cardiovascular function (i.e., cardio-respiratory fitness and blood pressure), metabolic outcomes (i.e., glucose metabolism, blood lipid profile, and body composition), functional status (i.e., muscle strength, physical performance, and risk of falling), cognitive performance, and quality of life.
Examine Cardiorespiratory Fitness as Outcome: No</td></tr>
<tr><td>Populations Analyzed: Age ≥70</td><td>Author-Stated Funding Source: Not reported.</td></tr>
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<table>
<tr><td colspan="2">Systematic Review
Citation: Chase CA, Mann K, Wasek S, Arbesman M. Systematic review of the effect of home modification and fall prevention programs on falls and the performance of community-dwelling older adults. Am J Occup Ther. 2012;66(3):284-291. doi:10.5014/ajot.2012.005017.</td></tr>
<tr><td>Purpose: To review the most recent evidence for various fall prevention and home modification strategies.</td><td rowspan="4">Abstract: This systematic review explored the impact of fall prevention programs and home modifications on falls and the performance of community-dwelling older adults. It was conducted as part of the American Occupational Therapy Association’s Evidence-Based Practice Project. Thirty-three articles were analyzed and synthesized. The strongest results were found for multifactorial programs that included home evaluations and home modifications, physical activity or exercise, education, vision and medication checks, or assistive technology to prevent falls. Positive outcomes included a decreased rate of functional decline, a decrease in fear of falling, and an increase in physical factors such as balance and strength. The strength of the evidence for physical activity and home modification programs provided individually was moderate. Implications for practice, education, and research are also discussed.</td></tr>
<tr><td>Timeframe: 1990–November 2008</td></tr>
<tr><td>Total # of Studies: 33 (17 physical activity interventions)</td></tr>
<tr><td>Exposure Definition: Group and individual sessions that incorporated balance retraining, walking, general exercise in sitting and standing, lower-extremity strengthening, use of a workstation format, or tai chi.
Measures Steps: No
Measures Bouts: No
Examines HIIT: No</td></tr>
<tr><td>Outcomes Addressed: Activities of daily living, balance (functional reach and balance scores), sit-to-stand time, functional motor ability, functional step.
Examine Cardiorespiratory Fitness as Outcome: No</td></tr>
<tr><td>Populations Analyzed: Older adults (>80)</td><td>Author-Stated Funding Source: Not reported.</td></tr>
</table>

<table>
<tr><td colspan="2">Meta-Analysis
Citation: Chase JD, Phillips LJ, Brown M. Physical activity intervention effects on physical function among community-dwelling older adults: a systematic review and meta-analysis. J Aging Phys Act. 2017;25(1):149-170. doi:10.1123/japa.2016-0040.</td></tr>
<tr><td>Purpose: To determine the effects of PA interventions on performance-based, composite measures of physical function among older adults.</td><td rowspan="4">Abstract: The purpose of this systematic review and meta-analysis was to determine the effects of supervised resistance and/or aerobic training physical activity interventions on performance-based measures of physical functioning among community-dwelling older adults, and to identify factors impacting intervention effectiveness. Diverse search strategies were used to identify eligible studies. Standardized mean difference effect sizes (d, ES) were synthesized using a random effects model. Moderator analyses were conducted using subgroup analyses and meta-regression. Twenty-eight studies were included. Moderator analyses were limited by inconsistent reporting of sample and intervention characteristics. The overall mean ES was 0.45 (k = 38, p </= .01), representing a clinically meaningful reduction of 0.92 s in the Timed Up and Go for treatment versus control. More minutes per week (p < .01) and longer intervention session duration (p < .01) were associated with larger effects. Interventions were especially effective among frail participants (d = 1.09). Future research should clearly describe sample and intervention characteristics and incorporate frail populations.</td></tr>
<tr><td>Timeframe: 1960–2015</td></tr>
<tr><td>Total # of Studies: 28</td></tr>
<tr><td>Exposure Definition: Supervised PA intervention: involved resistance (high intensity and progressive training) and/or aerobic training (generally low to moderate intensity). Interventions were conducted over a median of 112 days.
Measures Steps: No
Measures Bouts: No
Examines HIIT: No</td></tr>
<tr><td>Outcomes Addressed: Physical function: short physical performance battery, functional fitness test, physical performance test, continuous scale physical functional performance, timed up and go test.
Examine Cardiorespiratory Fitness as Outcome: No</td></tr>
<tr><td>Populations Analyzed: Adults ≥65, Frail</td><td>Author-Stated Funding Source: Mizzou Alumni Association Richard Wallace Faculty Incentive Grant and University of Missouri Research Council Grant; National Institute of Nursing Research of the National Institutes of Health.</td></tr>
</table>

Meta-Analysis

Citation: Donath L, Rossler R, Faude O. Effects of virtual reality training (exergaming) compared to alternative exercise training and passive control on standing balance and functional mobility in healthy community-dwelling seniors: a meta-analytical review. *Sports Med.* 2016;46(9):1293-1309. doi:10.1007/s40279-016-0485-1.

Purpose: To examine and classify the effects of virtual reality training on fall-risk relevant balance performance and functional mobility compared to alternative balance training programs and an inactive control condition in healthy seniors.

Timeframe: Inception–June 2015

Total # of Studies: 18

Exposure Definition: Interventions with virtual reality training as the target strategy. Most were supervised trainings, 30–60 minutes/session, 2–3 times/week for 3–20 weeks. Subgroups: comparison of alternative based exercise training (ball exercise training, tai chi, and balance training) or passive control condition.
Measures Steps: No
Measures Bouts: No
Examines HIIT: No

Outcomes Addressed: Standardized mean differences of functional mobility outcomes (Timed Up and Go, Berg Balance Scale), and balance performances (functional reach, single leg stance, and double leg stance variations).
Examine Cardiorespiratory Fitness as Outcome: No

Abstract: BACKGROUND: Balance training is considered an important means to decrease fall rates in seniors. Whether virtual reality training (VRT) might serve as an appropriate treatment strategy to improve neuromuscular fall risk parameters in comparison to alternative balance training programs (AT) is as yet unclear. OBJECTIVE: To examine and classify the effects of VRT on fall-risk relevant balance performance and functional mobility compared to AT and an inactive control condition (CON) in healthy seniors. DATA SOURCES: The literature search was conducted in five databases (CINAHL, EMBASE, ISI Web of Knowledge, PubMed, SPORTDiscus). The following search terms were used with Boolean conjunction: (exergam* OR exer-gam* OR videogam* OR video-gam* OR video-based OR computer-based OR Wii OR Nintendo OR X-box OR Kinect OR play-station OR playstation OR virtua* realit* OR dance dance revolution) AND (sport* OR train* OR exercis* OR intervent* OR balanc* OR strength OR coordina* OR motor control OR postur* OR power OR physical* OR activit* OR health* OR fall* risk OR prevent*) AND (old* OR elder* OR senior*). STUDY SELECTION: Randomized and non-randomized controlled trials applying VRT as interventions focusing on improving standing balance performance (single and double leg stance with closed and open eyes, functional reach test) and functional mobility (Berg balance scale, Timed-up and go test, Tinetti test) in healthy community-dwelling seniors of at least 60 years of age were screened for eligibility. DATA EXTRACTION: Eligibility and study quality (PEDro scale) were independently assessed by two researchers. Standardized mean differences (SMDs) served as main outcomes for the comparisons of VRT versus CON and VRT versus AT on balance performance and functional mobility indices. Statistical analyses were conducted using a random effects inverse-variance model. RESULTS: Eighteen trials (mean PEDro score: 6 +/- 2) with 619 healthy community dwellers were included. The mean age of participants was 76 +/- 5 years. Meaningful effects in favor of VRT compared to CON were found for balance performance [p < 0.001, SMD: 0.77 (95 % CI 0.45-1.09)] and functional mobility [p = 0.004, SMD: 0.56 (95 % CI 0.25-0.78)]. Small overall effects in favor of AT compared to VRT were found for standing balance performance [p = 0.31, SMD: -0.35 (95 % CI -1.03 to 0.32)] and functional mobility [p = 0.05, SMD: -0.44 (95 % CI: -0.87 to 0.00)]. Sensitivity analyses between "weaker" (n = 9, PEDro </=5) and "stronger" (n = 9, PEDro >/=6) studies indicated that weaker studies showed larger effects in favor of VRT compared to CON regarding balance performance (p < 0.001). CONCLUSIONS: Although slightly less effective than AT, VRT-based balance training is an acceptable method

	for improving balance performance as well as functional mobility outcomes in healthy community dwellers. VRT might serve as an attractive complementary training approach for the elderly. However, more high-quality research is needed in order to derive valid VRT recommendations compared to both AT and CON.
Populations Analyzed: Age ≥60 (mean age 76)	**Author-Stated Funding Source:** No funding source used.

Systematic Review **Citation:** Fernandez-Arguelles EL, Rodriguez-Mansilla J, Antunez LE, Garrido-Ardila EM, Munoz RP. Effects of dancing on the risk of falling related factors of healthy older adults: a systematic review. *Arch Gerontol Geriatr.* 2015;60(1):1-8. doi:10.1016/j.archger.2014.10.003.	
Purpose: To know the therapeutic effects of dancing as a physical exercise modality on balance, flexibility, gait, and muscle strength in older adults.	**Abstract:** INTRODUCTION: Deficits of balance or postural control in persons of advanced age are one of the factors that influence the risk of falling. The most appropriate treatment approaches and their benefits are still unknown. OBJECTIVE: The aim of this article is to systematically review the scientific literature to identify the therapeutic effects of dancing as a physical exercise modality on balance, flexibility, gait, muscle strength and physical performance in older adults. METHODS: A systematic search of Pubmed, Cochrane Library Plus, PEDro, Science Direct, Dialnet and Academic Search Complete using the search terms "dance", "older", "dance therapy", "elderly", "balance", "gait" and "motor skills". The eligibility criteria were: studies written in English and Spanish, published from January 2000 to January 2013, studies which analyzed the effects of dance (ballroom dance and/or dance based exercise) in older adults over 60 years of age with no disabling disease and included the following variables of study: balance, gait, risk of falls, strength, functionality, flexibility and quality of life. RESULTS: 123 articles were found in the literature. A final selection of seven articles was used for the present manuscript. Although the selected studies showed positive effects on the risk of falling related to factors (balance, gait and dynamic mobility, strength and physical performance), there were some aspects of the studies such as the methodological quality, the small sample size, the lack of homogeneity in relation to the variables and the measurement tools, and the existing diversity regarding the study design and the type of dance, that do not enable us to confirm that dance has significant benefits on these factors based on the scientific evidence.
Timeframe: 2000–January 2013	
Total # of Studies: 7	
Exposure Definition: Interventions of dance (ballroom dance and/or dance-based exercise). Interventions varied from 8 weeks to 12 months long, with all sessions lasting for at least 60 minutes and performed at least once per week. **Measures Steps:** No **Measures Bouts:** No **Examines HIIT:** No	
Outcomes Addressed: Balance (functional reach, single leg stand), gait, strength, and flexibility. **Examine Cardiorespiratory Fitness as Outcome:** No	
Populations Analyzed: Age >60	**Author-Stated Funding Source:** Not reported.

<table>
<tr><td colspan="2">Systematic Review
Citation: Fritz NE, Cheek FM, Nichols-Larsen DS. Motor-cognitive dual-task training in persons with neurologic disorders: a systematic review. J Neurol Phys Ther. 2015;39(3):142-153. doi:10.1097/NPT.0000000000000090.</td></tr>
<tr><td>Purpose: To examine the literature to determine the effectiveness of dual-task training on mobility and cognition compared to usual care in individuals with neurological disorders.</td><td rowspan="4">Abstract: BACKGROUND AND PURPOSE: Deficits in motor-cognitive dual tasks (eg, walking while talking) are common in individuals with neurologic conditions. This review was conducted to determine the effectiveness of motor-cognitive dual-task training (DTT) compared with usual care on mobility and cognition in individuals with neurologic disorders. METHODS: Databases searched were Biosis, CINAHL, ERIC, PsychInfo, EBSCO Psychological & Behavioral, PubMed, Scopus, and Web of Knowledge. Eligibility criteria were studies of adults with neurologic disorders that included DTT, and outcomes of gait or balance were included. Fourteen studies met inclusion criteria. Participants were subjects with brain injury, Parkinson disease (PD), and Alzheimer disease (AD). Intervention protocols included cued walking, cognitive tasks paired with gait, balance, and strength training and virtual reality or gaming. Quality of the included trials was evaluated with a standardized rating scale of clinical relevance. RESULTS: Results show that DTT improves single-task gait velocity and stride length in subjects with PD and AD, dual-task gait velocity and stride length in subjects with PD, AD, and brain injury, and may improve balance and cognition in those with PD and AD. The inclusion criteria of the studies reviewed limited the diagnostic groups included. DISCUSSION AND CONCLUSIONS: While the range of training protocols and outcome assessments in available studies limited comparison of the results across studies motor-cognitive dual-task deficits in individuals with neurologic disorders appears to be amenable to training. Improvement of dual-task ability in individuals with neurologic disorders holds potential for improving gait, balance, and cognition.Video Abstract available for additional insights from the authors (Supplemental Digital Content, http://links.lww.com/JNPT/A104).</td></tr>
<tr><td>Timeframe: Inception–January 2014</td></tr>
<tr><td>Total # of Studies: 14</td></tr>
<tr><td>Exposure Definition: Motor-cognitive dual-task training with varied protocols, including single-sessions of cueing; multi-session training including various cognitive tasks paired with gait or balance/strength tasks, virtual reality, or gaming; and dual task training used alongside additional therapies (balance or aerobic exercise). Interventions varied from a single session to 16 weeks and varied in session duration and intensity.
Measures Steps: No
Measures Bouts: No
Examines HIIT: No</td></tr>
<tr><td>Outcomes Addressed: Mobility: single task gait (3D motion capture, 2D kinematics, and the GAITRite electronic walkway) and/or static and dynamic balance (center of pressure assessments and Berg Balance Scale).
Examine Cardiorespiratory Fitness as Outcome: No</td></tr>
<tr><td>Populations Analyzed: Adults >18, Central neurologic disorder</td><td>Author-Stated Funding Source: National Center for Advancing Translational Sciences.</td></tr>
</table>

<table>
<tr><td colspan="2">Systematic Review
Citation: Gobbo S, Bergamin M, Sieverdes JC, Ermolao A, Zaccaria M. Effects of exercise on dual-task ability and balance in older adults: a systematic review. Arch Gerontol Geriatr. 2014;58(2):177-187. doi:10.1016/j.archger.2013.10.001.</td></tr>
<tr><td>Purpose: To critically review the body of literature and understand the benefits of exercise on static and dynamic balance during dual-task performance in healthy older adults.</td><td rowspan="4">Abstract: The interest in research on exercise and physical activity effects on dual-task performance has grown rapidly in the last decade due to the aging global population. Most of the available literature is focused on exercise benefits for the risk of falls, attention, and gait-speed; however, there is a lack of evidence reporting the exercise effects on balance in healthy older adults during dual-task performance. The objective of this study was to critically review the existing evidence of a potential relationship between exercise and improvement of static and dynamic balance during dual-task in healthy older adults and secondary outcomes in other physical and cognitive indices. A systematic search using online databases was used to source articles. Inclusion criteria included articles classified as randomized controlled trials (RCT), controlled trials (CT) and uncontrolled trials (UT). Moreover, the studies had to include an exercise or physical activity protocol in the intervention. Eight studies met the eligibility criteria and included 6 RCTs, 1 CT, and 1 UT. Several limitations were identified, mainly focused on the lack of a common and standardized method to evaluate the balance during the dual-task performance. Additionally, exercise protocols were extensively different, and generally lacked reporting measures. Preliminary findings show that the current body of evidence does not support that exercises used in these interventions entail clear and noteworthy benefits on static or dynamic balance improvements during dual-task performance. Innovative measures and exercise programs may need to be developed before efficacious screening and treatment strategies can be used in clinical settings.</td></tr>
<tr><td>Timeframe: Inception–October 2012</td></tr>
<tr><td>Total # of Studies: 8</td></tr>
<tr><td>Exposure Definition: Exercise programs included concurrent cognitive tasks, biofeedback techniques, and tai chi/qigong intervention. The durations of the exercise interventions ranged from 8 to 24 weeks and included sessions that spanned 1–3 times per week.
Measures Steps: No
Measures Bouts: No
Examines HIIT: No</td></tr>
<tr><td>Outcomes Addressed: Static balance (e.g., postural sway) and dynamic balance (e.g., 10-meter gait speed, Timed Up and Go tests, walking cost, walking step, and walking cadence in cognitive and manual task conditions). Flexibility: functional reach test. Aerobic capacity: 6-minute walking test, stepping test. Lower limb strength: chair stand test, five chair stand test. Reaction times.
Examine Cardiorespiratory Fitness as Outcome: No</td></tr>
<tr><td>Populations Analyzed: Adults ≥60</td><td>Author-Stated Funding Source: No funding source used.</td></tr>
</table>

<table>
<tr><td colspan="2">Meta-Analysis
Citation: Gu MO, Conn VS. Meta-analysis of the effects of exercise interventions on functional status in older adults. Res Nurs Health. 2008;31(6):594-603. doi:10.1002/nur.20290.</td></tr>
<tr><td>Purpose: To synthesize results of primary studies of exercise interventions delivered to samples representative of the general population of older adults.</td><td rowspan="4">Abstract: A meta-analysis was conducted to quantify the impact of exercise interventions on the functional status of older adults. Searches of Medline and CINAHL databases revealed 19 randomized controlled trials reporting 30 interventions (n = 2,201). Fixed- and random-effects models were used to estimate overall mean effect sizes (ESs) for functional and physical performance outcomes and activities of daily living (ADL). Modest but statistically significant ESs were found for functional performance and physical performance but not for ADL. Exercise improved functional and physical performance but the improvement may be insufficient to have an impact on ADL. Further studies are needed to determine exercise's effects on ADL and to identify moderators associated with functional status outcomes in older adults.</td></tr>
<tr><td>Timeframe: 1990–2006</td></tr>
<tr><td>Total # of Studies: 19</td></tr>
<tr><td>Exposure Definition: Interventions included a strength or resistance component; aerobic, balance, flexibility, or functional exercise; or combination. Interventions involving multiple behaviors such as diet plus exercise were not included.
Measures Steps: No
Measures Bouts: No
Examines HIIT: No</td></tr>
<tr><td>Outcomes Addressed: Physical performance: chair-rise, stair climbing, walk speed-fast pace, walk endurance. Functional performance: functional reach, floor-rise, timed up-and-go, and stair down. Activities of daily living.
Examine Cardiorespiratory Fitness as Outcome: No</td></tr>
<tr><td>Populations Analyzed: Adults >65</td><td>Author-Stated Funding Source: 2006 GSNU professor sabbatical year program.</td></tr>
</table>

<table>
<tr><td colspan="2">Meta-Analysis
Citation: Hanson S, Jones A. Is there evidence that walking groups have health benefits? A systematic review and meta-analysis. Br J Sports Med. 2015;49(11):710-715. doi:10.1136/bjsports-2014-094157.</td></tr>
<tr><td>Purpose: To understand whether there is evidence that outdoor walking groups have wider health benefits as an intervention among adults.</td><td rowspan="4">Abstract: OBJECTIVE: To assess the health benefits of outdoor walking groups. DESIGN: Systematic review and meta-analysis of walking group interventions examining differences in commonly used physiological, psychological and well-being outcomes between baseline and intervention end. DATA SOURCES: Seven electronic databases, clinical trial registers, grey literature and reference lists in English language up to November 2013. ELIGIBILITY CRITERIA: Adults, group walking outdoors with outcomes directly attributable to the walking intervention. RESULTS: Forty-two studies were identified involving 1843 participants. There is evidence that walking groups have wide-ranging health benefits. Meta-analysis showed statistically significant reductions in mean difference for systolic blood pressure -3.72 mm Hg (-5.28 to -2.17) and diastolic blood pressure -3.14 mm Hg (-4.15 to -2.13); resting heart rate -2.88 bpm (-4.13 to -1.64); body fat -1.31% (-2.10 to -0.52), body mass index -0.71 kg/m(2) (-1.19 to -0.23), total cholesterol -0.11 mmol/L (-0.22 to -0.01) and statistically significant mean increases in VO(2max) of 2.66 mL/kg/min (1.67-3.65), the SF-36 (physical functioning) score 6.02 (0.51 to 11.53) and a 6 min walk time of 79.6 m (53.37-105.84). A standardised mean difference showed a reduction in depression scores with an effect size of -0.67 (-0.97 to -0.38). The evidence was less clear for other outcomes such as waist circumference fasting glucose, SF-36 (mental health) and serum lipids such as high-density lipids. There were no notable adverse side effects reported in any of the studies. CONCLUSIONS: Walking groups are effective and safe with good adherence and wide-ranging health benefits. They could be a promising intervention as an adjunct to other healthcare or as a proactive health-promoting activity.</td></tr>
<tr><td>Timeframe: Inception–November 2013</td></tr>
<tr><td>Total # of Studies: 42 (15 older adults, 3 physical function)</td></tr>
<tr><td>Exposure Definition: Outdoor walking intervention and group-based intervention. Interventions were varied in volume and intensity, ranging from 168 to 8,580 minutes of walking over a period of 3 weeks to 1 year, with intensity ranging from self-selected and low to brisk walking and high-intensity intervals.
Measures Steps: No
Measures Bouts: No
Examines HIIT: No</td></tr>
<tr><td>Outcomes Addressed: Physical function: SF-36 quality of life physical functioning score (points), 6-minute walk test.
Examine Cardiorespiratory Fitness as Outcome: Yes</td></tr>
<tr><td>Populations Analyzed: Older adults</td><td>Author-Stated Funding Source: The Centre for Diet and Activity Research, a United Kingdom Clinical Research Collaboration Public Health Research Centre of Excellence. The British Heart Foundation, Economic and Social Research Council, Medical Research Council, National Institute for Health Research and the Wellcome Trust.</td></tr>
</table>

<table>
<tr><td colspan="2">Meta-Analysis
Citation: Hill KD, Hunter SW, Batchelor FA, Cavalheri V, Burton E. Individualized home-based exercise programs for older people to reduce falls and improve physical performance: a systematic review and meta-analysis. Maturitas. 2015;82(1):72-84. doi:10.1016/j.maturitas.2015.04.005.</td></tr>
<tr><td>Purpose: To determine the effectiveness of individualized home-based exercise programs for older people in the community setting in reducing falls, as well as improving secondary outcomes of physical performance, including physical activity, balance, mobility, and strength.</td><td rowspan="5">Abstract: There is considerable diversity in the types of exercise programs investigated to reduce falls in older people. The purpose of this paper was to review the effectiveness of individualized (tailored) home-based exercise programs in reducing falls and improving physical performance among older people living in the community. A systematic review and meta-analysis was conducted of randomized or quasi-randomized trials that utilized an individualized home-based exercise program with at least one falls outcome measure reported. Single intervention exercise studies, and multifactorial interventions where results for an exercise intervention were reported independently were included. Two researchers independently rated the quality of each included study. Of 16,871 papers identified from six databases, 12 met all inclusion criteria (11 randomized trials and a pragmatic trial). Study quality overall was high. Sample sizes ranged from 40 to 981, participants had an average age 80.1 years, and although the majority of studies targeted the general older population, several studies included clinical groups as their target (Parkinson’s disease, Alzheimer’s disease, and hip fracture). The meta-analysis results for the five studies reporting number of fallers found no significant effect of the intervention (RR [95% CI]=0.93 [0.72-1.21]), although when a sensitivity analysis was performed with one study of participants recently discharged from hospital removed, this result was significant (RR [95% CI] = 0.84 [0.72-0.99]). The meta-analysis also found that intervention led to significant improvements in physical activity, balance, mobility and muscle strength. There were no significant differences for measures of injurious falls or fractures.</td></tr>
<tr><td>Timeframe: 1974–December 2014</td></tr>
<tr><td>Total # of Studies: 12</td></tr>
<tr><td>Exposure Definition: Home-based exercise programs personalized or individualized to the older person’s capabilities. Duration of interventions ranged from 6 weeks to 2 years, with exercises generally performed 3–5 days/week. Most studies utilized the Otago Exercise program that includes strength and balance exercises (30 minutes each, 3 times/week), and a walking program (30 minutes 2 times/week). Strength training was mostly lower body, balance was static and dynamic, and stair climbing and range of motion exercises were used.
Measures Steps: No
Measures Bouts: No
Examines HIIT: No</td></tr>
<tr><td>Outcomes Addressed: Physical function: balance (functional reach test and step up test) and mobility (sit-to-stand test and Timed Up and Go).
Examine Cardiorespiratory Fitness as Outcome: No</td></tr>
<tr><td>Populations Analyzed: Age ≥60</td><td>Author-Stated Funding Source: No funding source used.</td></tr>
</table>

Meta-Analysis

Citation: Hortobágyi T, Lesinski M, Gäbler M, VanSwearingen JM, Malatesta D, Granacher U. Effects of three types of exercise interventions on healthy old adults' gait speed: a systematic review and meta-analysis. *Sports Med.* 2015;45(12):1627-1643. doi:10.1007/s40279-015-0371-2.

Purpose: To determine the effects of strength, power, coordination, and multimodal exercise training on the habitual and fast gait speed of healthy old adults.

Timeframe: 1984–December 2014

Total # of Studies: 42

Exposure Definition: The resistance training programs lasted 14.6 weeks (±6.6, range 6–26), consisted of 39 sessions (±20, range 30–60), and were delivered at a low to high exercise intensity, quantified as 50–80% of the 1 repetition maximum of various leg exercises. Multimodal training was also used and lasted for 17.7 weeks (±10.2, range 8–47) and consisted of 41.4 sessions (±22.7, range 16–94). The intensity of these programs was characterized as "moderate," "hard," "very hard," to "volitional fatigue" or "using body weight." Coordination training lasted 11.5 weeks (±4.3, range 6–18) and consisted of 31 sessions (±14, range 16–54).
Measures Steps: No
Measures Bouts: No
Examines HIIT: No

Outcomes Addressed: Changes in gait speed: short and straight distance, long distance, and Timed Up and Go Test.
Examine Cardiorespiratory Fitness as Outcome: No

Populations Analyzed: Adults ≥ 65

Abstract: BACKGROUND: Habitual walking speed predicts many clinical conditions later in life, but it declines with age. However, which particular exercise intervention can minimize the age-related gait speed loss is unclear. PURPOSE: Our objective was to determine the effects of strength, power, coordination, and multimodal exercise training on healthy old adults' habitual and fast gait speed. METHODS: We performed a computerized systematic literature search in PubMed and Web of Knowledge from January 1984 up to December 2014. Search terms included 'Resistance training', 'power training', 'coordination training', 'multimodal training', and 'gait speed (outcome term). Inclusion criteria were articles available in full text, publication period over past 30 years, human species, journal articles, clinical trials, randomized controlled trials, English as publication language, and subject age >/=65 years. The methodological quality of all eligible intervention studies was assessed using the Physiotherapy Evidence Database (PEDro) scale. We computed weighted average standardized mean differences of the intervention-induced adaptations in gait speed using a random-effects model and tested for overall and individual intervention effects relative to no-exercise controls. RESULTS: A total of 42 studies (mean PEDro score of 5.0 +/- 1.2) were included in the analyses (2495 healthy old adults; age 74.2 years [64.4-82.7]; body mass 69.9 +/- 4.9 kg, height 1.64 +/- 0.05 m, body mass index 26.4 +/- 1.9 kg/m2, and gait speed 1.22 +/- 0.18 m/s). The search identified only one power training study, therefore the subsequent analyses focused only on the effects of resistance, coordination, and multimodal training on gait speed. The three types of intervention improved gait speed in the three experimental groups combined (n = 1297) by 0.10 m/s (+/-0.12) or 8.4% (+/- 9.7), with a large effect size (ES) of 0.84. Resistance (24 studies; n = 613; 0.11 m/s; 9.3%; ES: 0.84), coordination (eight studies, n = 198; 0.09 m/s; 7.6%; ES: 0.76), and multimodal training (19 studies; n = 486; 0.09 m/s; 8.4%, ES: 0.86) increased gait speed statistically and similarly. CONCLUSIONS: Commonly used exercise interventions can functionally and clinically increase habitual and fast gait speed and help slow the loss of gait speed or delay its onset.

Author-Stated Funding Source: German Research Foundation, University Medical Center Groningen.

Aging Subcommittee: Q2. What is the relationship between physical activity and physical function among the general aging population?

Meta-Analysis

Citation: Howe TE, Rochester L, Neil F, Skelton DA, Ballinger C. Exercise for improving balance in older people. *Cochrane Database Syst Rev.* 2011;(11):Cd004963. doi:10.1002/14651858.CD004963.pub3.

Purpose: To examine the effects of exercise interventions on balance in older people.

Timeframe: Inception–January 2011

Total # of Studies: 75

Exposure Definition: Gait, balance, coordination, and functional tasks. Strengthening exercises (including resistance or power training). 3D (including tai chi, qi gong, dance, yoga). General PA (walking, cycling). Computerised balance training using visual feedback. Vibration platform used as intervention. Multiple intervention types (combinations of the above).
Measures Steps: No
Measures Bouts: No
Examines HIIT: No

Outcomes Addressed: Timed Up and Go Test, standing on one leg for as long as possible with eyes open, standing on one leg with eyes closed, walking speed, Berg Balance Scale, adverse events associated with the exercise intervention, direct measures of balance

Abstract: BACKGROUND: In older adults, diminished balance is associated with reduced physical functioning and an increased risk of falling. This is an update of a Cochrane review first published in 2007. OBJECTIVES: To examine the effects of exercise interventions on balance in older people, aged 60 and over, living in the community or in institutional care. SEARCH METHODS: We searched the Cochrane Bone, Joint and Muscle Trauma Group Specialised Register, CENTRAL (The Cochrane Library 2011, Issue 1), MEDLINE and EMBASE (to February 2011). SELECTION CRITERIA: Randomised controlled studies testing the effects of exercise interventions on balance in older people. The primary outcomes of the review were clinical measures of balance. DATA COLLECTION AND ANALYSIS: Pairs of review authors independently assessed risk of bias and extracted data from studies. Data were pooled where appropriate. MAIN RESULTS: This update included 94 studies (62 new) with 9,917 participants. Most participants were women living in their own home.Most trials were judged at unclear risk of selection bias, generally reflecting inadequate reporting of the randomisation methods, but at high risk of performance bias relating to lack of participant blinding, which is largely unavoidable for these trials. Most studies only reported outcome up to the end of the exercise programme.There were eight categories of exercise programmes. These are listed below together with primary measures of balance for which there was some evidence of a statistically significant effect at the end of the exercise programme. Some trials tested more than one type of exercise. Crucially, the evidence for each outcome was generally from only a few of the trials for each exercise category. 1. Gait, balance, co-ordination and functional tasks (19 studies of which 10 provided primary outcome data): Timed Up & Go test (mean difference (MD) -0.82 s; 95% CI -1.56 to -0.08 s, 114 participants, 4 studies); walking speed (standardised mean difference (SMD) 0.43; 95% CI 0.11 to 0.75, 156 participants, 4 studies), and the Berg Balance Scale (MD 3.48 points; 95% CI 2.01 to 4.95 points, 145 participants, 4 studies).2. Strengthening exercise (including resistance or power training) (21 studies of which 11 provided primary outcome data): Timed Up & Go Test (MD -4.30 s; 95% CI -7.60 to -1.00 s, 71 participants, 3 studies); standing on one leg for as long as possible with eyes closed (MD 1.64 s; 95% CI 0.97 to 2.31 s, 120 participants, 3 studies); and walking speed (SMD 0.25; 95% CI 0.05 to 0.46, 375 participants, 8 studies).3. 3D (3 dimensional) exercise (including Tai Chi, qi gong, dance, yoga) (15 studies of which seven provided primary outcome data): Timed Up & Go Test (MD -1.30 s; 95% CI -2.40 to -0.20 s, 44 participants, 1 study); standing on one leg for as long as possible with eyes open (MD 9.60 s; 95% CI 6.64 to 12.56 s, 47 participants, 1 study), and with eyes closed (MD 2.21 s; 95% CI 0.69 to 3.73 s, 48 participants, 1 study); and the Berg Balance Scale (MD 1.06 points; 95% CI 0.37 to 1.76 points, 150 participants, 2 studies).4. General physical activity (walking) (seven studies of which five provided primary outcome data). 5. General

(center of pressure behavior or position, sway, anterior posterior or medio lateral stability, limits of stability), indirect measures of balance (Functional Reach Test), level of adherence or compliance with the exercise intervention. **Examine Cardiorespiratory Fitness as Outcome:** No	physical activity (cycling) (one study which provided data for walking speed). 6. Computerised balance training using visual feedback (two studies, neither of which provided primary outcome data). 7. Vibration platform used as intervention (three studies of which one provided primary outcome data).8. Multiple exercise types (combinations of the above) (43 studies of which 29 provided data for one or more primary outcomes): Timed Up & Go Test (MD -1.63 s; 95% CI -2.28 to -0.98 s, 635 participants, 12 studies); standing on one leg for as long as possible with eyes open (MD 5.03 s; 95% CI 1.19 to 8.87 s, 545 participants, 9 studies), and with eyes closed ((MD 1.60 s; 95% CI -0.01 to 3.20 s, 176 participants, 2 studies); walking speed (SMD 0.04; 95% CI -0.10 to 0.17, 818 participants, 15 studies); and the Berg Balance Scale ((MD 1.84 points; 95% CI 0.71 to 2.97 points, 80 participants, 2 studies).Few adverse events were reported but most studies did not monitor or report adverse events.In general, the more effective programmes ran three times a week for three months and involved dynamic exercise in standing. AUTHORS' CONCLUSIONS: There is weak evidence that some types of exercise (gait, balance, co-ordination and functional tasks; strengthening exercise; 3D exercise and multiple exercise types) are moderately effective, immediately post intervention, in improving clinical balance outcomes in older people. Such interventions are probably safe. There is either no or insufficient evidence to draw any conclusions for general physical activity (walking or cycling) and exercise involving computerised balance programmes or vibration plates. Further high methodological quality research using core outcome measures and adequate surveillance is required.
Populations Analyzed: Male, Female, Adults 60–75 and >75, Frailty	**Author-Stated Funding Source:** Glasgow Caledonian University, UK; University of Northumbria, UK; University of Newcastle, UK; University of Southampton, UK; Scottish Funding Council, UK; Scottish Executive Health Department, UK; National Health Service Education for Scotland, UK; Chief Scientist Office, UK; National Institute of Health Research, UK; Cochrane Incentive Award.

<table>
<tr><td colspan="2">Meta-Analysis
Citation: Kelley GA, Kelley KS, Hootman JM, Jones DL. Exercise and health-related quality of life in older community-dwelling adults: a meta-analysis of randomized controlled trials. J Appl Gerontol. 2009;28(3):369-394.</td></tr>
<tr><td>Purpose: To use the meta-analytic approach to examine the effects of PA across all components of health-related quality of life among older adults.</td><td rowspan="4">Abstract: The authors used the meta-analytic approach to examine the effects of physical activity on health-related quality of life (HRQOL) in older community-dwelling adults. A random-effects model was used for all primary analyses. Of the 257 studies screened, 11 randomized controlled trials representing 13 groups and 617 men and women (324 physical activity, 293 control), all older than 50, were included. Overall, a significant (small to moderate) standardized effect size improvement was found for physical function as a result of physical activity (Hedges's g = 0.41, 95% confidence interval [CI] = 0.19, 0.64, p < .001). This was equivalent to a common language effect size of 62% and an odds ratio of 2.14 (95% CI = 1.42, 3.24). No significant differences were found for the other nine HRQOL outcomes. Although additional research is needed, results suggest that physical activity improves self-reported physical function, a component of HRQOL, in older community-dwelling adults.</td></tr>
<tr><td>Timeframe: 1973–August 2007</td></tr>
<tr><td>Total # of Studies: 11</td></tr>
<tr><td>Exposure Definition: Aerobic and/or strength training interventions. Length of training across all interventions ranged from 8 to 26 weeks. Most common aerobic training modalities were walking and stationary cycling.
Measures Steps: No
Measures Bouts: No
Examines HIIT: No</td></tr>
<tr><td>Outcomes Addressed: Health-related quality of life for one or more of the 10 components of the Medical Outcomes Study 36-Item Short Form Health Survey. Physical function component.
Examine Cardiorespiratory Fitness as Outcome: No</td></tr>
<tr><td>Populations Analyzed: Age >50</td><td>Author-Stated Funding Source: Centers for Disease Control and Prevention through the Association of American Medical Colleges.</td></tr>
</table>

<table>
<tr><td colspan="2">Systematic Review
Citation: Keogh JW, Kilding A, Pidgeon P, Ashley L, Gillis D. Physical benefits of dancing for healthy older adults: a review. J Aging Phys Act. 2009;17(4):479-500.</td></tr>
<tr><td>Purpose: To describe the physical benefits of dancing for healthy older adults.</td><td rowspan="4">Abstract: Dancing is a mode of physical activity that may allow older adults to improve their physical function, health, and well-being. However, no reviews on the physical benefits of dancing for healthy older adults have been published in the scientific literature. Using relevant databases and keywords, 15 training and 3 cross-sectional studies that met the inclusion criteria were reviewed. Grade B-level evidence indicated that older adults can significantly improve their aerobic power, lower body muscle endurance, strength and flexibility, balance, agility, and gait through dancing. Grade C evidence suggested that dancing might improve older adults' lower body bone-mineral content and muscle power, as well as reduce the prevalence of falls and cardiovascular health risks. Further research is, however, needed to determine the efficacy of different forms of dance, the relative effectiveness of these forms of dance compared with other exercise modes, and how best to engage older adults in dance participation.</td></tr>
<tr><td>Timeframe: Not reported</td></tr>
<tr><td>Total # of Studies: 18</td></tr>
<tr><td>Exposure Definition: Various types of dance (traditional Korean, Turkish folkloristic, ballroom, tango, line, and aerobic dance) with 30–90 minute sessions, 1–5 times/week for 8 weeks to 12 months.
Measures Steps: No
Measures Bouts: No
Examines HIIT: No</td></tr>
<tr><td>Outcomes Addressed: Aerobic power (6-minute walk), muscle endurance and strength (grip strength, sit-to-stand), static and dynamic balance (one-foot stance), flexibility (sit-and-reach), changes in body composition (bone mineral density), gait performance, prevalence of falls, and cardiovascular risk factors.
Examine Cardiorespiratory Fitness as Outcome: No</td></tr>
<tr><td>Populations Analyzed: Age >60</td><td>Author-Stated Funding Source: Sport and Recreation New Zealand.</td></tr>
</table>

Meta-Analysis

Citation: Lesinski M, Hortobágyi T, Muehlbauer T, Gollhofer A, Granacher U. Effects of balance training on balance performance in healthy older adults: a systematic review and meta-analysis. *Sports Med.* 2015;45(12):1721-1738. doi:10.1007/s40279-015-0375-y.

Purpose: To quantify balance training intervention effects on balance outcomes and to additionally characterize dose-response relationships of balance training modalities among older adults.

Timeframe: 1985–January 2015

Total # of Studies: 23

Exposure Definition: Balance training protocols comprised static/dynamic steady-state, proactive, and reactive balance exercises on stable/unstable surfaces, and balance systems with eyes opened or closed. Many contained exercises related to activities of daily living, such as obstacle walking.

Measures Steps: No

Measures Bouts: No

Examines HIIT: No

Outcomes Addressed: Balance outcome: static steady-state balance (e.g., center of pressure (CoP) displacements during single-leg stance), dynamic steady-state balance (10m gait speed test), proactive balance (Functional

Abstract: BACKGROUND: The effects of balance training (BT) in older adults on proxies of postural control and mobility are well documented in the literature. However, evidence-based dose-response relationships in BT modalities (i.e., training period, training frequency, training volume) have not yet been established in healthy older adults. OBJECTIVES: The objectives of this systematic literature review and meta-analysis are to quantify BT intervention effects and to additionally characterize dose-response relationships of BT modalities (e.g., training period, training frequency) through the analysis of randomized controlled trials (RCTs) that could maximize improvements in balance performance in healthy community-dwelling older adults. DATA SOURCES: A computerized systematic literature search was performed in the electronic databases PubMed and Web of Science from January 1985 up to January 2015 to capture all articles related to BT in healthy old community-dwelling adults. STUDY ELIGIBILITY CRITERIA: A systematic approach was used to evaluate the 345 articles identified for initial review. Only RCTs were included if they investigated BT in healthy community-dwelling adults aged >/=65 years and tested at least one behavioral balance performance outcome (e.g., center of pressure displacements during single-leg stance). In total, 23 studies met the inclusionary criteria for review. STUDY APPRAISAL AND SYNTHESIS METHODS: Weighted mean standardized mean differences between subjects (SMDbs) of the intervention-induced adaptations in balance performance were calculated using a random-effects model and tested for an overall intervention effect relative to passive controls. The included studies were coded for the following criteria: training modalities (i.e., training period, training frequency, training volume) and balance outcomes [static/dynamic steady-state (i.e., maintaining a steady position during standing and walking), proactive balance (i.e., anticipation of a predicted perturbation), reactive balance (i.e., compensation of an unpredicted perturbation) as well as balance test batteries (i.e., combined testing of different balance components as for example the Berg Balance Scale)]. Heterogeneity between studies was assessed using I2 and Chi2-statistics. The methodological quality of each study was tested by means of the Physiotherapy Evidence Database (PEDro) Scale. RESULTS: Weighted mean SMDbs showed that BT is an effective means to improve static steady-state (mean SMDbs = 0.51), dynamic steady-state (mean SMDbs = 0.44), proactive (mean SMDbs = 1.73), and reactive balance (mean SMDbs = 1.01) as well as the performance in balance test batteries (mean SMDbs = 1.52) in healthy older adults. Our analyses regarding dose-response relationships in BT revealed that a training period of 11-12 weeks (mean SMDbs= 1.26), a frequency of three training sessions per week (mean SMDbs= 1.20), a total number of 36-40 training sessions (mean SMDbs = 1.39), a duration of a single training session of 31-45 min (mean SMDbs = 1.19), and a total

Reach Test or Timed Up and Go), reactive balance (CoP displacements after an unexpected perturbation, and balance test batteries (Berg Balance Scale). **Examine Cardiorespiratory Fitness as Outcome:** No	duration of 91-120 min of BT per week (mean SMDbs = 1.93) of the applied training modalities is most effective in improving overall balance performance. However, it has to be noted that effect sizes for the respective training modalities were computed independently (i.e., modality specific). Because of the small number of studies that reported detailed information on training volume (i.e., number of exercises per training session, number of sets and/or repetitions per exercise, duration of single-balance exercises) dose-response relationships were not computed for these parameters. LIMITATIONS: The present findings have to be interpreted with caution because we indirectly compared dose-response relationships across studies using SMDbs and not in a single controlled study as it is difficult to separate the impact of a single training modality (e.g., training frequency) from that of the others. Moreover, the quality of the included studies was rather limited with a mean PEDro score of 5 and the heterogeneity between studies was considerable (i.e., I2 = 76-92 %). CONCLUSIONS: Our detailed analyses revealed that BT is an effective means to improve proxies of static/dynamic steady-state, proactive, and reactive balance as well as performance in balance test batteries in healthy older adults. Furthermore, we were able to establish effective BT modalities to improve balance performance in healthy older adults. Thus, practitioners and therapists are advised to consult the identified dose-response relationships of this systematic literature review and meta-analysis. However, further research of high methodologic quality is needed to determine (1) dose-response relationships of BT in terms of detailed information on training volume (e.g., number of exercises per training session) and (2) a feasible and effective method to regulate training intensity in BT.
Populations Analyzed: Adults ≥65	**Author-Stated Funding Source:** German Research Foundation.

<table>
<tr><td colspan="2">Meta-Analysis
Citation: Leung DP, Chan CK, Tsang HW, Tsang WW, Jones AY. Tai chi as an intervention to improve balance and reduce falls in older adults: a systematic and meta-analytical review. Altern Ther Health Med. 2011;17(1):40-48.</td></tr>
<tr><td>Purpose: To update and review the evidence of tai chi for balance improvement and fall reduction.</td><td rowspan="4">Abstract: OBJECTIVE: The evidence of tai chi for balance improvement and fall reduction in older adults was updated and reviewed. METHOD: A systematic review was carried out by two independent reviewers among nine electronic databases to identify randomized controlled trials (RCTs) that examined the effects of tai chi on balance improvement and fall reduction in older adults using such key words as tai chi, falls, balance, and randomized trial. RESULTS: The results based on 13 RCTs indicated that tai chi was effective in improving balance of older adults but may not necessarily be superior to other interventions. Results also showed that in the absence of other interventions, tai chi reduced falls in the nonfrail elderly. CONCLUSION: Tai chi is recommended as an alternative treatment for improving balance so as to reduce falls. Future research with improved research designs such as more consistent outcome measures on balance and fall reduction and longer postintervention follow-up should be conducted to unravel the efficacy of different types of tai chi.</td></tr>
<tr><td>Timeframe: 1998–January 2008</td></tr>
<tr><td>Total # of Studies: 13</td></tr>
<tr><td>Exposure Definition: Randomized control trials of tai chi. Programs varied from 10 to 52 weeks, with frequencies from once to every 2 weeks to daily sessions. Most sessions last from 20 to 90 minutes.
Measures Steps: No
Measures Bouts: No
Examines HIIT: No</td></tr>
<tr><td>Outcomes Addressed: Weighted mean difference for balance score (Berg Balance Test, Timed Up and Go, Functional Reach) and odds ratio for fall count.
Examine Cardiorespiratory Fitness as Outcome: No</td></tr>
<tr><td>Populations Analyzed: Age ≥60</td><td>Author-Stated Funding Source: Not reported.</td></tr>
</table>

<table>
<tr><td colspan="2">Systematic Review
Citation: Liberman K, Forti LN, Beyer I, Bautmans I. The effects of exercise on muscle strength, body composition, physical functioning and the inflammatory profile of older adults: a systematic review. Curr Opin Clin Nutr Metab Care. 2017;20(1):30-53.</td></tr>
<tr><td>Purpose: To provide an overview of the most recent literature regarding the effects of physical exercise on muscle strength, body composition, physical functioning, and the inflammatory profile in older adults.</td><td rowspan="5">Abstract: PURPOSE OF REVIEW: This systematic review reports the most recent literature regarding the effects of physical exercise on muscle strength, body composition, physical functioning and inflammation in older adults. All articles were assessed for methodological quality and where possible effect size was calculated. RECENT FINDINGS: Thirty-four articles were included - four involving frail, 24 healthy and five older adults with a specific disease. One reported on both frail and nonfrail patients. Several types of exercise were used: resistance training, aerobic training, combined resistance training and aerobic training and others. In frail older persons, moderate-to-large beneficial exercise effects were noted on inflammation, muscle strength and physical functioning. In healthy older persons, effects of resistance training (most frequently investigated) on inflammation or muscle strength can be influenced by the exercise modalities (intensity and rest interval between sets). Muscle strength seemed the most frequently used outcome measure, with moderate-to-large effects obtained regardless the exercise intervention studied. Similar effects were found in patients with specific diseases. SUMMARY: Exercise has moderate-to-large effects on muscle strength, body composition, physical functioning and inflammation in older adults. Future studies should focus on the influence of specific exercise modalities and target the frail population more.</td></tr>
<tr><td>Timeframe: 2015–May 2016</td></tr>
<tr><td>Total # of Studies: 34</td></tr>
<tr><td>Exposure Definition: Resistance training ranging from moderate (50–60% 1RM [1 repetition maximum]) to high (70–80% 1RM) intensity. Aerobic training, including mainly cycling and walking. A combination of resistance training and aerobic training was also used. Other types of exercises included whole body vibration, exercise with horses, Pilates, and Huber training.
Measures Steps: No
Measures Bouts: No
Examines HIIT: No</td></tr>
<tr><td>Outcomes Addressed: Physical function: no units or measurements described.
Examine Cardiorespiratory Fitness as Outcome: No</td></tr>
<tr><td>Populations Analyzed: Adults ≥65</td><td>Author-Stated Funding Source: No funding source used.</td></tr>
</table>

<table>
<tr><td colspan="2">Meta-Analysis
Citation: Liu CJ, Latham N. Can progressive resistance strength training reduce physical disability in older adults? A meta-analysis study. Disabil Rehabil. 2011;33(2):87-97. doi:10.3109/09638288.2010.487145.</td></tr>
<tr><td>Purpose: To evaluate the effect of progressive resistance training on physical disability outcomes in the older population via meta-analysis.</td><td rowspan="4">Abstract: PURPOSE: The decline of muscle strength is associated with physical disability in late adulthood. Progressive resistance strength training has been demonstrated to be an effective intervention to increase muscle strength, however, its effect on reducing physical disability in older adults is unclear. The purpose of this study is to examine the effect of progressive resistance strength training on physical disability via meta-analysis. METHOD: Two reviewers independently searched for qualified trials, assessed trial quality and extracted data. Trial inclusion criteria are: (1) Randomised controlled trials, (2) Mean age of participant sample is >/= 60 years, (3) Progressive resistance strength training as the primary intervention and (4) the trial included outcome measures of physical disability (i.e. physical function domain of the Short-Form 36). RESULTS: Thirty-three trials were analysed. Although the effect size is small, the intervention groups showed reduced physical disability when compared to the control groups (SMD = 0.14, 95% CI = 0.05 to 0.22). CONCLUSIONS: Progressive resistance strength training appears to be an effective intervention to reduce physical disability in older adults. To maximise the effect, we suggest therapists use responsive outcome measures and multi-component intervention approach.</td></tr>
<tr><td>Timeframe: 1948–May 2007</td></tr>
<tr><td>Total # of Studies: 33</td></tr>
<tr><td>Exposure Definition: Progressive resistance training programs using elastic bands or tubing, cuff weights, free weights, isokinetic machines, or other exercise equipment. Program duration varied from 6 to 78 weeks. The most common exercise frequency was 3 times a week. High exercise intensity was defined as 65% or more of a 1 repetition maximum.
Measures Steps: No
Measures Bouts: No
Examines HIIT: No</td></tr>
<tr><td>Outcomes Addressed: Physical performance (i.e., Short Physical Performance Battery), self-reported measures of activities of dail living (i.e., the Barthel Index), and the physical function domain of health-related quality of life.
Examine Cardiorespiratory Fitness as Outcome: No</td></tr>
<tr><td>Populations Analyzed: Older adults</td><td>Author-Stated Funding Source: National Institute on Disability and Rehabilitation Research.</td></tr>
</table>

Meta-Analysis

Citation: Liu CJ, Latham NK. Progressive resistance strength training for improving physical function in older adults. *Cochrane Database Syst Rev.* 2009;(3):Cd002759. doi:10.1002/14651858.CD002759.pub2.

Purpose: To determine the effects of progressive resistance strength training (PRT) on physical function in older adults through comparing PRT with no exercise or another type of care or exercise (e.g., aerobic training).

Timeframe: 1948–May 2008

Total # of Studies: 121

Exposure Definition: Progressive resistance training done 2 to 3 times a week. Type of resistance used included elastic bands or tubing (e.g., therabands), cuff weights, free weights, isokinetic machines, or other weight machines.
Measures Steps: No
Measures Bouts: No
Examines HIIT: No

Outcomes Addressed: Physical disability: primary assessment of physical disability included the evaluation of self-reported measures of activities of daily living (ADL, e.g., the Barthel Index) and the physical domains of health-related quality of life (HRQOL, e.g., the physical function domain of the SF-36). Aerobic capacity was also assessed (e.g., 6-minute walk test, VO2 max: maximal oxygen uptake during exercise).
Examine Cardiorespiratory Fitness as Outcome: Yes

Abstract: BACKGROUND: Muscle weakness in old age is associated with physical function decline. Progressive resistance strength training (PRT) exercises are designed to increase strength. OBJECTIVES: To assess the effects of PRT on older people and identify adverse events. SEARCH STRATEGY: We searched the Cochrane Bone, Joint and Muscle Trauma Group Specialized Register (to March 2007), the Cochrane Central Register of Controlled Trials (The Cochrane Library 2007, Issue 2), MEDLINE (1966 to May 01, 2008), EMBASE (1980 to February 06 2007), CINAHL (1982 to July 01 2007) and two other electronic databases. We also searched reference lists of articles, reviewed conference abstracts and contacted authors. SELECTION CRITERIA: Randomised controlled trials reporting physical outcomes of PRT for older people were included. DATA COLLECTION AND ANALYSIS: Two review authors independently selected trials, assessed trial quality and extracted data. Data were pooled where appropriate. MAIN RESULTS: One hundred and twenty one trials with 6700 participants were included. In most trials, PRT was performed two to three times per week and at a high intensity. PRT resulted in a small but significant improvement in physical ability (33 trials, 2172 participants; SMD 0.14, 95% CI 0.05 to 0.22). Functional limitation measures also showed improvements: e.g. there was a modest improvement in gait speed (24 trials, 1179 participants, MD 0.08 m/s, 95% CI 0.04 to 0.12); and a moderate to large effect for getting out of a chair (11 trials, 384 participants, SMD -0.94, 95% CI -1.49 to -0.38). PRT had a large positive effect on muscle strength (73 trials, 3059 participants, SMD 0.84, 95% CI 0.67 to 1.00). Participants with osteoarthritis reported a reduction in pain following PRT(6 trials, 503 participants, SMD -0.30, 95% CI -0.48 to -0.13). There was no evidence from 10 other trials (587 participants) that PRT had an effect on bodily pain. Adverse events were poorly recorded but adverse events related to musculoskeletal complaints, such as joint pain and muscle soreness, were reported in many of the studies that prospectively defined and monitored these events. Serious adverse events were rare, and no serious events were reported to be directly related to the exercise programme. AUTHORS' CONCLUSIONS: This review provides evidence that PRT is an effective intervention for improving physical functioning in older people, including improving strength and the performance of some simple and complex activities. However, some caution is needed with transferring these exercises for use with clinical populations because adverse events are not adequately reported.

Populations Analyzed: Adults ≥50	**Author-Stated Funding Source:** National Institute on Disability and Rehabilitation Research, Boston University and Switzer Research Fellowship and National Institute on Aging, Pepper Center Trainee Award from Boston Pepper Center funded by the National Institute on Aging.

<table>
<tr><td colspan="2">Meta-Analysis
Citation: Lopopolo RB, Greco M, Sullivan D, Craik RL, Mangione KK. Effect of therapeutic exercise on gait speed in community-dwelling elderly people: a meta-analysis. Phys Ther. 2006;86(4):520-540.</td></tr>
<tr><td>Purpose: To conduct a systematic review of the published literature from 1995 to 2003 on the effect of therapeutic exercise on gait speed in community-dwelling elderly people.</td><td rowspan="4">Abstract: BACKGROUND AND PURPOSE: Inconsistent research findings make it unclear whether therapeutic exercise improves gait speed in community-dwelling elderly people. Using meta-analytical procedures, we examined the effect of therapeutic exercise on changing gait speed in community-dwelling older adults and the effect of type, intensity, and dose of therapeutic exercise on gait speed. METHOD: Studies were retrieved using a comprehensive database search. Two independent reviewers determined study eligibility based on inclusion criteria, rated study quality, and extracted information on study methods, design, intervention, and results. Data were combined to obtain an overall effect size, its 95% confidence interval, and a measure of significance. In addition, analyses to characterize the clinical relevance of the findings were performed. RESULTS: One hundred seventeen studies were evaluated, with 24 studies (n=1,302 subjects) meeting the inclusion criteria for habitual gait speed and 18 studies (n=752 subjects) meeting the inclusion criteria for fast gait speed. Therapeutic exercise--or, more specifically, strength training and combination training (aerobic plus other exercise)--had significant effects (r=.145, P=.017; r=.176, P=.002, respectively) on habitual gait speed. High-intensity (effort expended by subjects) exercise and high-dosage (frequency and duration of exercise sessions) intervention also had a significant effect (r=.184, P=.001; r=.190, P=.001, respectively) on gait speed, whereas there was no effect for moderate- and low-intensity exercise or for low-dosage exercise. No exercise intervention affected fast gait speed in this analysis. DISCUSSION AND CONCLUSION: The results provide support for the belief that therapeutic exercise can improve gait speed in community-dwelling elderly people and that intensity and dosage are important contributing factors. The relatively weak correlation found between therapeutic exercise and gait speed merits further study.</td></tr>
<tr><td>Timeframe: 1995–2003</td></tr>
<tr><td>Total # of Studies: 33</td></tr>
<tr><td>Exposure Definition:
Interventions included aerobic training, stretching or flexibility exercise, balance and relaxation training, and tai chi. Strength training programs performed at 60%–80% of the 1-repetition maximum level or combination training programs performed at 70%–85% of heart rate reserve, at 80% of age-predicted heart rate maximum and high-dosage exercise (180 minutes of exercise per week; 60 minutes of treatment, 3 times a week).
Measures Steps: No
Measures Bouts: No
Examines HIIT: No</td></tr>
<tr><td>Outcomes Addressed: Gait speed was converted to meters per second for all studies.
Examine Cardiorespiratory Fitness as Outcome: No</td></tr>
<tr><td>Populations Analyzed: Adults 60–89</td><td>Author-Stated Funding Source: Not reported.</td></tr>
</table>

<table>
<tr><td colspan="2">Pooled Analysis
Citation: Morey MC, Sloane R, Pieper CF, et al. Effect of physical activity guidelines on physical function in older adults. J Am Geriatr Soc. 2008;56(10):1873-1878. doi:10.1111/j.1532-5415.2008.01937.x.</td></tr>
<tr><td>Purpose: To determine whether elderly people who meet national guidelines have higher physical function scores than those who do not and the effect on functional trajectory when PA levels change from above to below this threshold, or vice versa.</td><td rowspan="4">Abstract: OBJECTIVES: To determine whether elderly people who meet national guidelines have higher physical function (PF) scores than those who do not and the effect on functional trajectory when physical activity (PA) levels change from above to below this threshold, or vice versa. DESIGN: Pooled data. SETTING: Two 6-month randomized controlled trials aimed at increasing PA in adults. PARTICIPANTS: Adults aged 65 to 94 (N=357). INTERVENTION: PA counseling over the telephone and through mailed materials. MEASUREMENTS: Self-reported PA dichotomized at 150 minutes/week and PF using the Medical Outcomes Study 36-item Short Form Questionnaire PF subscale. RESULTS: At baseline, individuals reporting 150 minutes or more of moderate PA/week had mean PF scores that were 20.3 points higher than those who did not (P<.001). Change in PA minutes from above threshold to below threshold or from below threshold to above threshold from baseline to 6 months resulted in an average change in PF of -11.18 (P<.001) and +5.10 (P=.05), respectively. CONCLUSION: These findings suggest that PA is an important predictor of functional status. Older sedentary adults can improve PF by meeting recommended PA levels. Conversely, dropping below recommended PA levels has a deleterious effect on PF. Given the importance of PF in maintenance of independence and quality of life in older adults, adherence to recommended PA guidelines should be endorsed.</td></tr>
<tr><td>Total # of Studies: 2</td></tr>
<tr><td>Exposure Definition: PA counseling over the phone and through mailed materials. Self-reported PA dichotomized at 150 minutes/week.
Measures Steps: No
Measures Bouts: No
Examines HIIT: No</td></tr>
<tr><td>Outcomes Addressed: Physical function measured by the Medical Outcomes Study 36-item Short Form Questionnaire physical function subscale.
Examine Cardiorespiratory Fitness as Outcome: No</td></tr>
<tr><td>Populations Analyzed: Age 65–94</td><td>Author-Stated Funding Source: Department of Veterans Affairs Rehabilitation Research and Development and National Institutes of Health.</td></tr>
</table>

Systematic Review

Citation: Orr R, Raymond J, Fiatarone Singh M. Efficacy of progressive resistance training on balance performance in older adults: a systematic review of randomized controlled trials. *Sports Med.* 2008;38(4):317-343.

Purpose: To present the first systematic synthesis of evidence from randomized controlled trials in order to determine the efficacy of progressive resistance training as a singular intervention on balance performance in older adults.

Timeframe: Inception–October 2006

Total # of Studies: 29

Exposure Definition:
Progressive resistance training: Training intensity was classified as high, medium, and low (≥70% 1 repetition maximum [RM], 41–69% 1RM, and ≤40% 1RM). The study duration averaged 22.7 weeks. The mean training session duration was 58.8 minutes (range 35–90 minutes) and the frequency of training was 2–3 days/week. Two to three sets per session were prescribed in included studies.
Measures Steps: No
Measures Bouts: No
Examines HIIT: No

Outcomes Addressed: Static, dynamic, and functional balance performance and postural challenge assessment (computerized dynamic posturography). Balance outcomes were measured differently, and a standardized difference was used as the review's outcome. Mobility, functional capacity, physical health, and cognitive function were also measured.

Abstract: The serious health, social and economic consequences of falls are well documented. Lower extremity muscle weakness and power as well as balance impairment are major independent intrinsic contributors to falls and amenable to intervention. Progressive resistance training (PRT) is widely accepted as an appropriate modality for treating sarcopenia and has been reported to improve balance. However, other studies affirm no significant effect of PRT on balance. To date, there is no clear, definitive statement or synthesis of studies that has examined the effect of PRT on balance. Therefore, our objective was to systematically review the literature to probe the merit of PRT as a single intervention on balance performance in older adults. We conducted a comprehensive search of major electronic databases to October 2006, with citation searches and bibliographic searches of journal articles and literature/systematic reviews. Two independent reviewers screened for eligibility and assessed the quality of the studies using the Physiotherapy Evidence Database scale for validity assessment. Randomized controlled trials of PRT only, with any balance outcome in participants with a mean age of ≥60 years (individual minimum age >50 years) were included. Trials that contained more than one intervention, providing the PRT and control groups matched the inclusion criteria, were also included. Because of the heterogeneity of interventions and balance outcomes, a meta-analysis was not performed. However, corrected effect sizes with confidence intervals were determined for each study outcome. Twenty-nine studies were compatible with the inclusion/exclusion criteria and were eligible for review. Participants (n = 2174) included healthy, community-dwelling, mobility-limited, frail cohorts and those with chronic comorbidities. Balance outcomes conducted were extensive and were broadly categorized by the authors as: static, dynamic, functional and computerized dynamic posturography. Some studies used more than one balance outcome. The number of balance tests in all totalled 68. Fourteen studies (15 tests representing 22% of all balance tests) reported improvements, significantly greater than controls, in balance performance following PRT. Improvements were not linked to a particular type of balance performance. The inconsistent effect of PRT on balance may be explained by heterogeneity of cohort and balance tests, variability in methodology of the balance test and sample size, inadequate dose of PRT and/or compliance to training, or lack of statistical power. Standardization of balance testing methodology and better reporting of procedures may ensure greater comparability of

Examine Cardiorespiratory Fitness as Outcome: No	results in future studies. It is also possible that PRT alone is not a robust intervention for balance control. This is the first systematic synthesis of the literature to examine the effectiveness of PRT alone on balance performance in older adults. The limited evidence presented in currently published data has not consistently shown that the use of PRT in isolation improves balance in this population. However, further research should explore optimal resistance training regimens that: focus on the muscles most pertinent to balance control, best target neuromuscular adaptations that protect against postural challenges and elucidate mechanism(s) by which PRT may affect balance control.
Populations Analyzed: Adults ≥50	**Author-Stated Funding Source:** No funding source used.

Systematic Review

Citation: Paterson DH, Warburton DE. Physical activity and functional limitations in older adults: a systematic review related to Canada's Physical Activity Guidelines. *Int J Behav Nutr Phys Act.* 2010;7:38. doi:10.1186/1479-5868-7-38.

Purpose: To examine the role of physical activity in the maintenance of functional independence in the elderly.

Timeframe: Inception–March 2008

Total # of Studies: 100 (66 functional independence, 34 cognitive function)

Exposure Definition: Self-reported PA was quantified by volume (as a total energy expenditure, or as a frequency and duration of activities) and other studies also attempted to account for the relative intensity of the activities (light, moderate, vigorous) and types of activity (walking, exercising, sports play, recreation, household chores).
Measures Steps: No
Measures Bouts: No
Examines HIIT: No

Outcomes Addressed: Functional outcomes included assessments of functional status decline, impairment of functional limitations, or disability, including self-report questionnaire assessments or measured physical performance tests.
Examine Cardiorespiratory Fitness as Outcome: No

Populations Analyzed: Adults 65–85

Abstract: BACKGROUND: The purpose was to conduct systematic reviews of the relationship between physical activity of healthy community-dwelling older (>65 years) adults and outcomes of functional limitations, disability, or loss of independence. METHODS: Prospective cohort studies with an outcome related to functional independence or to cognitive function were searched, as well as exercise training interventions that reported a functional outcome. Electronic database search strategies were used to identify citations which were screened (title and abstract) for inclusion. Included articles were reviewed to complete standardized data extraction tables, and assess study quality. An established system of assessing the level and grade of evidence for recommendations was employed. RESULTS: Sixty-six studies met inclusion criteria for the relationship between physical activity and functional independence, and 34 were included with a cognitive function outcome. Greater physical activity of an aerobic nature (categorized by a variety of methods) was associated with higher functional status (expressed by a host of outcome measures) in older age. For functional independence, moderate (and high) levels of physical activity appeared effective in conferring a reduced risk (odds ratio ~0.5) of functional limitations or disability. Limitation in higher level performance outcomes was reduced (odds ratio ~0.5) with vigorous (or high) activity with an apparent dose-response of moderate through to high activity. Exercise training interventions (including aerobic and resistance) of older adults showed improvement in physiological and functional measures, and suggestion of longer-term reduction in incidence of mobility disability. A relatively high level of physical activity was related to better cognitive function and reduced risk of developing dementia; however, there were mixed results of the effects of exercise interventions on cognitive function indices. CONCLUSIONS: There is a consistency of findings across studies and a range of outcome measures related to functional independence; regular aerobic activity and short-term exercise programmes confer a reduced risk of functional limitations and disability in older age. Although a precise characterization of a minimal or effective physical activity dose to maintain functional independence is difficult, it appears moderate to higher levels of activity are effective and there may be a threshold of at least moderate activity for significant outcomes.

Author-Stated Funding Source: Public Health Agency of Canada.

Aging Subcommittee: Q2. What is the relationship between physical activity and physical function among the general aging population?

Systematic Review

Citation: Pichierri G, Wolf P, Murer K, de Bruin ED. Cognitive and cognitive-motor interventions affecting physical functioning: a systematic review. *BMC Geriatr.* 2011;11:29. doi:10.1186/1471-2318-11-29.

Purpose: To examine the literature regarding the use of cognitive and cognitive-motor interventions to improve physical functioning in older adults and in adults with neurological impairments.

Timeframe: Inception–July 2010

Total # of Studies: 28 (subset included PA)

Exposure Definition: Cognitive and cognitive-motor interventions included cognitive rehabilitation or a combination of cognitive rehabilitation and physical exercise, respectively. Separated into dual-task interventions, computerized interventions, and cognitive rehabilitation interventions.
Measures Steps: No
Measures Bouts: No
Examines HIIT: No

Outcomes Addressed: Balance: e.g., Berg Balance Scale, Activities-specific Balance Confidence Scale, Functional Balance and Mobility test, Balance Index, one-leg stance tests. Gait: e.g., Timed Up and Go Test, Dynamic Gait Index, or step recording with pedometers. Functional mobility: e.g., manual ability measurements, functional reach tests, Physical Performance Test, Rivermead Motor Assessment, Nottingham 10 Point ADL Scale, the Box and Block Test, Fugl-Meyer Assessment of Upper Limb Motor Function.

Abstract: BACKGROUND: Several types of cognitive or combined cognitive-motor intervention types that might influence physical functions have been proposed in the past: training of dual-tasking abilities, and improving cognitive function through behavioral interventions or the use of computer games. The objective of this systematic review was to examine the literature regarding the use of cognitive and cognitive-motor interventions to improve physical functioning in older adults or people with neurological impairments that are similar to cognitive impairments seen in aging. The aim was to identify potentially promising methods that might be used in future intervention type studies for older adults. METHODS: A systematic search was conducted for the Medline/Premedline, PsycINFO, CINAHL and EMBASE databases. The search was focused on older adults over the age of 65. To increase the number of articles for review, we also included those discussing adult patients with neurological impairments due to trauma, as these cognitive impairments are similar to those seen in the aging population. The search was restricted to English, German and French language literature without any limitation of publication date or restriction by study design. Cognitive or cognitive-motor interventions were defined as dual-tasking, virtual reality exercise, cognitive exercise, or a combination of these. RESULTS: 28 articles met our inclusion criteria. Three articles used an isolated cognitive rehabilitation intervention, seven articles used a dual-task intervention and 19 applied a computerized intervention. There is evidence to suggest that cognitive or motor-cognitive methods positively affects physical functioning, such as postural control, walking abilities and general functions of the upper and lower extremities, respectively. The majority of the included studies resulted in improvements of the assessed functional outcome measures. CONCLUSIONS: The current evidence on the effectiveness of cognitive or motor-cognitive interventions to improve physical functioning in older adults or people with neurological impairments is limited. The heterogeneity of the studies published so far does not allow defining the training methodology with the greatest effectiveness. This review nevertheless provides important foundational information in order to encourage further development of novel cognitive or cognitive-motor interventions, preferably with a randomized control design. Future research that aims to examine the relation between improvements in cognitive skills and the translation to better performance on selected physical tasks should explicitly take the relation between the cognitive and physical skills into account.

Examine Cardiorespiratory Fitness as Outcome: No	
Populations Analyzed: Older adults	**Author-Stated Funding Source:** Not reported.

Meta-Analysis

Citation: Plummer P, Zukowski LA, Giuliani CA, Hall AM, Zurakowski D. Effects of physical exercise interventions on gait-related dual-task interference in older adults: a systematic review and meta-analysis. *Gerontology*. 2015;62(1):94-117. doi:10.1159/000371577.

Purpose: To compare any physical exercise intervention to a control group on dual task interference during walking in older adults.

Timeframe: Inception–September 2014

Total # of Studies: 14

Exposure Definition: Interventions that involved a dual-task component, either by performing cognitive activities, or other motor activities during exercises, or group training, ranging from 20 to 90 minutes 1 to 3 times per week for 4 to 25 weeks. Control groups consisted primarily of an active exercise control or an inactive treatment group.
Measures Steps: No
Measures Bouts: No
Examines HIIT: No

Outcomes Addressed: Single-task gait speed, dual task gait speed, and dual-tasks cost on gait speed (%).
Examine Cardiorespiratory Fitness as Outcome: No

Populations Analyzed: Adults ≥60

Abstract: Dual-task interference during walking can substantially limit mobility and increase the risk of falls among community-dwelling older adults. Previous systematic reviews examining intervention effects on dual-task gait and mobility have not assessed relative dual-task costs (DTC) or investigated whether there are differences in treatment-related changes based on the type of dual task or the type of control group. The purpose of this systematic review was to examine the effects of physical exercise interventions on dual-task performance during walking in older adults. A meta-analysis of randomized controlled trials (RCTs) compared treatment effects between physical exercise intervention and control groups on single- and dual-task gait speed and relative DTC on gait speed. A systematic search of the literature was conducted using the electronic databases PubMed, CINAHL, EMBASE, Web of Science, and PsycINFO searched up to September 19, 2014. Randomized, nonrandomized, and uncontrolled studies published in English and involving older adults were selected. Studies had to include a physical exercise intervention protocol and measure gait parameters during continuous, unobstructed walking in single- and dual-task conditions before and after the intervention. Of 614 abstracts, 21 studies met the inclusion criteria and were included in the systematic review. Fourteen RCTs were included in the meta-analysis. The mean difference between the intervention and control groups significantly favored the intervention for single-task gait speed (mean difference: 0.06 m/s, 95% CI: 0.03, 0.10, $p < 0.001$), dual-task gait speed (mean difference: 0.11 m/s, 95% CI 0.07, 0.15, $p < 0.001$), and DTC on gait speed (mean difference: 5.23%, 95% CI 1.40, 9.05, $p = 0.007$). Evidence from subgroup comparisons showed no difference in treatment-related changes between cognitive-motor and motor-motor dual tasks, or when interventions were compared to active or inactive controls. In summary, physical exercise interventions can improve dual-task walking in older adults primarily by increasing the speed at which individuals walk in dual-task conditions. Currently, evidence concerning whether physical exercise interventions reduce DTC or alter the self-selected dual-task strategy during unobstructed walking is greatly lacking, mainly due to the failure of studies to measure and report reciprocal dual-task effects on the non-gait task.

Author-Stated Funding Source: Not reported.

<table>
<tr><td colspan="2">Meta-Analysis
Citation: Rodrigues EV, Valderramas S, Rossetin LL, Raquel A, Gomes S. Effects of video game training on the musculoskeletal function of older adults. Top Geriatr Rehabil. 2014;30(4):238-245. doi:10.1097/TGR.0000000000000040.</td></tr>
<tr><td>Purpose: To evaluate the effects of video game exercise training on the musculoskeletal function of older adults.</td><td rowspan="4">Abstract: This systematic review and meta-analysis aimed to evaluate the effects of video game exercise training (VGET) on the musculoskeletal function of older adults. The review was carried out in the PubMed, LILACS, WEB OF SCIENCE, WEB OF KNOWLEDGE, PEDro, and Cochrane CENTRAL. Sixteen controlled clinical trials were included, and the risks of bias were measured using the JADAD scale. There was no evidence that VGET might be effective on functional mobility (standardized mean difference [SMD] = 0.23, 95% confidence interval [CI]: -0.13 to 0.59) or on balanced self-efficacy (SMD = 0.15, 95% CI: -0.29 to 0.60). Future randomized controlled trials with greater methodological rigor, focusing on the parameters used to prescribe the exercises, are necessary.</td></tr>
<tr><td>Timeframe: 1997–April 2013</td></tr>
<tr><td>Total # of Studies: 16 in qualitative review (4 only in meta-analysis)</td></tr>
<tr><td>Exposure Definition: Various populations (community dwelling elderly, geriatric rehabilitation, outpatients) and various types of video game exercise training (Nintendo Wii Fit, Dance Video Game Training, Play Station) with 25–60 minute session, 1–7 times/week for 3 to 20 weeks.
Measures Steps: No
Measures Bouts: No
Examines HIIT: No</td></tr>
<tr><td>Outcomes Addressed: Standardized mean difference of functional balance (including Berg Balance Scale, activities-specific balance confidence), hand grip strength (hand dynamometer), and functional mobility (Timed Up and Go), center of pressure (Force Plate), muscular power (chair stand), functional exercise capacity (6-minute walk test), flexibility (sit and reach test), and spatial temporal gait parameters (treadmill).
Examine Cardiorespiratory Fitness as Outcome: No</td></tr>
<tr><td>Populations Analyzed: Older adults</td><td>Author-Stated Funding Source: Conselho Nacional de Desenvolvimento Cientifico e Technologico.</td></tr>
</table>

<table>
<tr><td colspan="2">Systematic Review
Citation: Rogers CE, Larkey LK, Keller C. A review of clinical trials of tai chi and qigong in older adults. West J Nurs Res. 2009;31(2):245-279. doi:10.1177/0193945908327529.</td></tr>
<tr><td>Purpose: To synthesize intervention studies targeting tai chi and qigong, and identify the physical and psychological health outcomes shown to be associated with tai chi and qigong in community dwelling adults over 55.</td><td rowspan="4">Abstract: Initiation and maintenance of physical activity (PA) in older adults is of increasing concern as the benefits of PA have been shown to improve physical functioning, mood, weight, and cardiovascular risk factors. Meditative movement forms of PA, such as tai chi and qigong (TC & QG), are holistic in nature and have increased in popularity over the past few decades. Several randomized controlled trials have evaluated TC & QG interventions from multiple perspectives, specifically targeting older adults. The purpose of this report is to synthesize intervention studies targeting TC & QG and identify the physical and psychological health outcomes shown to be associated with TC & QG in community dwelling adults older than 55. Based on specific inclusion criteria, 36 research reports with a total of 3,799 participants were included in this review. Five categories of study outcomes were identified, including falls and balance, physical function, cardiovascular disease, and psychological and additional disease-specific responses. Significant improvement in clusters of similar outcomes indicated interventions utilizing TC & QG may help older adults improve physical function and reduce blood pressure, fall risk, and depression and anxiety. Missing from the reviewed reports is a discussion of how spiritual exploration with meditative forms of PA, an important component of these movement activities, may contribute to successful aging.</td></tr>
<tr><td>Timeframe: 1993–2007</td></tr>
<tr><td>Total # of Studies: 36</td></tr>
<tr><td>Exposure Definition: Randomized control trials of tai chi or qigong (tai chi chih; taijiquan; easy tai chi; yang; sun-style, and a variety of hybrids). Most interventions were 3 months to 6 months long and meeting 2 to 3 times a week for 60 minutes.
Measures Steps: No
Measures Bouts: No
Examines HIIT: No</td></tr>
<tr><td>Outcomes Addressed: Balance and falls, physical function (functional fitness, functional performance as observational, and functional performance as self report), cardiovascular health (blood pressure, body mass index, and VO2 Max), and disease outcomes (arthritis, Parkinson’s disease and immune system strength).
Examine Cardiorespiratory Fitness as Outcome: No</td></tr>
<tr><td>Populations Analyzed: Age >55</td><td>Author-Stated Funding Source: National Institute of Nursing Research and a John A. Hartford Building Academic Geriatric Nursing Capacity Scholarship.</td></tr>
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<table>
<tr><td colspan="2">Systematic Review
Citation: Stathokostas L, Little RM, Vandervoort AA, Paterson DH. Flexibility training and functional ability in older adults: a systematic review. J Aging Res. 2012;2012:306818. doi:10.1155/2012/306818.</td></tr>
<tr><td>Purpose: To investigate the functional outcomes of flexibility specific training in older adults.</td><td rowspan="4">Abstract: Background. As indicated in a recent systematic review relating to Canada's Physical Activity Guidelines for Older Adults, exercise interventions in older adults can maintain or improve functional abilities. Less is known about the role of flexibility in the maintenance or improvement of functional abilities, and there currently does not exist a synthesis of the literature supporting a consensus on flexibility training prescription. Purpose. To systematically review the effects of flexibility-specific training interventions on measures of functional outcomes in healthy older adults over the age of 65 years. Methods. Five electronic databases were searched for intervention studies involving concepts related to aging, flexibility, functional outcomes, and training interventions. After evaluating the articles for relevance, 22 studies were considered. Results. The results suggested that while flexibility-specific interventions may have effects on range of motion (ROM) outcomes, there is conflicting information regarding both the relationship between flexibility interventions and functional outcomes or daily functioning. Conclusions. Due to the wide range of intervention protocols, body parts studied, and functional measurements, conclusive recommendations regarding flexibility training for older adults or the validity of flexibility training interventions as supplements to other forms of exercise, or as significant positive influences on functional ability, require further investigation.</td></tr>
<tr><td>Timeframe: Inception–January 2011</td></tr>
<tr><td>Total # of Studies: 22</td></tr>
<tr><td>Exposure Definition: Intervention that used flexibility training alone, along with strength or aerobic exercise. Training methods varied from simple static stretches to different proprioceptive neuromuscular facilitation (PNF) techniques, passive static stretching, active-assisted stretching, contract-relax PNF, contract-relax-agonist contract PNF, and hold-relax-agonist contract PNF. Length of intervention ranged from 4 weeks to 1 year. Frequency ranged from 2 to 14 times per week. Sessions ranged from 30 seconds to 85 minutes.
Measures Steps: No
Measures Bouts: No
Examines HIIT: No</td></tr>
<tr><td>Outcomes Addressed: Flexibility measurements: change in range of motion usually assessed by goniometry. Physical ability tests assessed using gait and walking speed, sit and reach, Timed Up and Go, sit-to-stand test, Romberg test, Berg Balance scale, questionnaires, peg board, red-light-green-light, Lequesne's index of disability, the physical performance test, and the gallon jug shelf test.
Examine Cardiorespiratory Fitness as Outcome: No</td></tr>
<tr><td>Populations Analyzed: Older adults</td><td>Author-Stated Funding Source: Not reported.</td></tr>
</table>

<table>
<tr><td colspan="2">Meta-Analysis
Citation: Tak E, Kuiper R, Chorus A, Hopman-Rock M. Prevention of onset and progression of basic ADL disability by physical activity in community dwelling older adults: a meta-analysis. Ageing Res Rev. 2013;12(1):329-338. doi:10.1016/j.arr.2012.10.001.</td></tr>
<tr><td>Purpose: To report a systematic review and meta-analysis of longitudinal studies analyzing the association between PA and both incidence and progression of disability in activities of daily living among older adults.</td><td rowspan="5">Abstract: PURPOSE: Physical activity (PA) is an important behavior when it comes to preventing or slowing down disablement caused by aging and chronic diseases. It remains unclear whether PA can directly prevent or reduce disability in activities of daily living (ADL). This article presents a meta-analysis of the association between PA and the incidence and progression of basic ADL disability (BADL). METHODS: Electronic literature search and cross-referencing of prospective longitudinal studies of PA and BADL in community dwelling older adults (50+) with baseline and follow-up measurements, multivariate analysis and reporting a point estimate for the association. RESULTS: Compared with a low PA, a medium/high PA level reduced the risk of incident BADL disability by 0.51 (95% CI: 0.38, 0.68; p<001), based on nine longitudinal studies involving 17,000 participants followed up for 3-10 years. This result was independent of age, length of follow-up, study quality, and differences in demographics, health status, functional limitations, and lifestyle. The risk of progression of BADL disability in older adults with a medium/high PA level compared with those with a low PA level was 0.55 (95% CI: 0.42, 0.71; p<001), based on four studies involving 8500 participants. DISCUSSION: This is the first meta-analysis to show that being physically active prevents and slows down the disablement process in aging or diseased populations, positioning PA as the most effective preventive strategy in preventing and reducing disability, independence and health care cost in aging societies.</td></tr>
<tr><td>Timeframe: Inception–January 2012</td></tr>
<tr><td>Total # of Studies: 13</td></tr>
<tr><td>Exposure Definition: Reported levels of PA: reduced to three levels (non/low, medium, high/vigorous).
Measures Steps: No
Measures Bouts: No
Examines HIIT: No</td></tr>
<tr><td>Outcomes Addressed: Onset of basic activities of daily living (ADL) and increase in disability (progression, either defined as a change score between measurements or increase on the respective ADL scale score). Basic ADLs included activities related to personal care and hygiene, such as dressing/grooming, arising, eating, bathing, and using the toilet.
Examine Cardiorespiratory Fitness as Outcome: No</td></tr>
<tr><td>Populations Analyzed: Adults >75, ≤75</td><td>Author-Stated Funding Source: Not reported.</td></tr>
</table>

<table>
<tr><td colspan="2">Meta-Analysis
Citation: Taylor LM, Kerse N, Frakking T, Maddison R. Active video games for improving physical performance measures in older people: a meta-analysis. J Geriatr Phys Ther. March 2016.</td></tr>
<tr><td>Purpose: To provide an updated analysis of randomized control trials that have used active video games to improve physical function in older people.</td><td rowspan="5">Abstract: BACKGROUND AND PURPOSE: Participation in regular physical activity is associated with better physical function in older people (>65 years); however, older people are the least active of all age groups. Exercise-based active video games (AVGs) offer an alternative to traditional exercise programs aimed at maintaining or enhancing physical performance measures in older people. This review systematically evaluated whether AVGs could improve measures of physical performance in older people. Secondary measures of safety, game appeal, and usability were also considered. METHODS: Electronic databases were searched for randomized controlled trials published up to April 2015. Included were trials with 2 or more arms that evaluated the effect of AVGs on outcome measures of physical performance in older people. RESULTS: Eighteen randomized controlled trials (n = 765) were included. Most trials limited inclusion to healthy community-dwelling older people. With the exception of 1 trial, all AVG programs were supervised. Using meta-analyses, AVGs were found to be more effective than conventional exercise (mean difference [MD], 4.33; 95% confidence intervals [CIs], 2.93-5.73) or no intervention (MD, 0.73; 95% CI, 0.17-1.29) for improving Berg Balance scores in community-dwelling older people. Active video games were also more effective than control for improving 30-second sit-to-stand scores (MD, 3.99; 95% CI, 1.92-6.05). No significant differences in Timed Up and Go scores were found when AVGs were compared with no intervention or with conventional exercise. CONCLUSIONS: Active video games can improve measures of mobility and balance in older people when used either on their own or as part of an exercise program. It is not yet clear whether AVGs are equally suitable for older people with significant cognitive impairments or balance or mobility limitations. Given the positive findings to date, consideration could be given to further development of age-appropriate AVGs for use by older people with balance or mobility limitations.This is an open-access article distributed under the terms of the Creative Commons Attribution-Non Commercial-No Derivatives License 4.0 (CCBY-NC-ND), where it is permissible to download and share the work provided it is properly cited. The work cannot be changed in any way or used commercially.</td></tr>
<tr><td>Timeframe: Inception–April 2015</td></tr>
<tr><td>Total # of Studies: 18 in qualitative review (10 only in meta-analysis)</td></tr>
<tr><td>Exposure Definition: Exercise-based active video games (AVGs), in community dwelling; most programs were usually for 3 to 20 weeks and 2 to 3 times weekly, with 40-minute sessions. In hospital settings, the intervention lasted as long as the patient’s stay (about 7 days). Subgroups: usual care compared to AVGs, conventional exercise compared to AVGs.
Measures Steps: No
Measures Bouts: No
Examines HIIT: No</td></tr>
<tr><td>Outcomes Addressed: Mean Difference of mobility measures (Timed Up and Go), and balance measures (Berg Balance Scale scores and 30-second chair stand scores).
Examine Cardiorespiratory Fitness as Outcome: No</td></tr>
<tr><td>Populations Analyzed: Age ≥65 (mean age 75.6)</td><td>Author-Stated Funding Source: Not reported.</td></tr>
</table>

Meta-Analysis

Citation: Tschopp M, Sattelmayer MK, Hilfiker R. Is power training or conventional resistance training better for function in elderly persons? A meta-analysis. *Age and Ageing*. 2011;40(5):549-556. doi:10.1093/ageing/afr005.

Purpose: To determine the effects of power training with high movement velocity compared with conventional resistance training with low movement velocity for older community-dwelling people.

Timeframe: Inception–April 2010

Total # of Studies: 11

Exposure Definition: Training sessions with 2–3 sets of 8–12 repetitions, thrice per week over a period of 8 to 16 weeks, with a maximum of 24 weeks. Training intensities in the power groups were: 40–60% of 1 repetition maximum (RM), 70% of 1 RM, 45–75% of 1 RM, and 40% of 2 RM.
Measures Steps: No
Measures Bouts: No
Examines HIIT: No

Outcomes Addressed: Functional outcomes including chair rise tests, box stepping, short physical performance battery or continuous scale physical functional performance scores. Balance and gait were also measured.
Examine Cardiorespiratory Fitness as Outcome: No

Abstract: OBJECTIVE: To determine the effects of power training with high movement velocity compared with conventional resistance training with low movement velocity for older community-dwelling people. DESIGN: Systematic review of randomised controlled trials. DATA SOURCES: The Cochrane Central Register of Controlled TRIALS, PubMed (Medline), EMBASE, CINAHL, PEDro and Scholar-Google. Trials: All randomised or quasi-randomised trials investigating power training with high movement velocity versus conventional resistance training with low movement velocity in elderly persons over the age of 60 years. The primary outcomes were measures of functional outcomes; secondary outcomes were balance, gait, strength, power, muscle volume and adverse effects. Results: Eleven trials were identified involving 377 subjects. The pooled effect size for the follow-up values of the functional outcomes was 0.32 in favour of the power training (95% CI 0.06 to 0.57) and 0.38 (95% CI -0.51 to 1.28) for the change value. The pooled effect from three studies for self-reported function was 0.16 in favour of power training (95% CI -0.17 to 0.49). CONCLUSION: Power training is feasible for elderly persons and has a small advantage over strength training for functional outcomes. No firm conclusion can be made for safety.

Populations Analyzed: Older adults

Author-Stated Funding Source: Not reported.

<table>
<tr><td colspan="2">Systematic Review
Citation: Vagetti GC, Barbosa Filho VC, Moreira NB, Oliveira Vd, Mazzardo O, Campos Wd. Association between physical activity and quality of life in the elderly: a systematic review, 2000-2012. Rev Bras Psiquiatr. 2014;36(1):76-88.</td></tr>
<tr><td>Purpose: To systematically review information regarding the association of PA with specific domains of quality of life in the elderly and to identify the study designs and measurement instruments most commonly used for the assessment of PA and quality of life in the elderly.</td><td rowspan="4">Abstract: OBJECTIVE: To review information regarding the association of physical activity (PA) with quality of life (QoL) in the elderly and to identify the study designs and measurement instruments most commonly used in its assessment, in the period 2000-2012. METHODS: Relevant articles were identified by a search of four electronic databases and cross-reference lists and by contact with the authors of the included manuscripts. Original studies on the association between PA and QoL in individuals aged 60 years or older were examined. The quality of studies as well as the direction and the consistency of the association between PA and QoL were evaluated. RESULTS: A total of 10,019 articles were identified as potentially relevant, but only 42 (0.42%) met the inclusion criteria and were retrieved and examined. Most studies demonstrated a positive association between PA and QoL in the elderly. PA had a consistent association with the following QoL domains: functional capacity; general QoL; autonomy; past, present and future activities; death and dying; intimacy; mental health; vitality; and psychological. CONCLUSION: PA was positively and consistently associated with some QoL domains among older individuals, supporting the notion that promoting PA in the elderly may have an impact beyond physical health. However, the associations between PA and other QoL domains were moderate to inconsistent and require further investigation.</td></tr>
<tr><td>Timeframe: 2000–November 2012</td></tr>
<tr><td>Total # of Studies: 42</td></tr>
<tr><td>Exposure Definition: PA was measured in a variety of ways in the included studies, either by self-report or objectively. Duration of PA exposure ranged from 3 to 12 months, session duration ranged from 30 to 90 minutes, and the weekly frequency ranged from 1 to 5 sessions per week.
Measures Steps: No
Measures Bouts: No
Examines HIIT: No</td></tr>
<tr><td>Outcomes Addressed: Quality of life: measured with multiple tools, including the SF-12, SF-36, World Health Organization Quality of Life instruments, Behavioral Risk Factor Surveillance System, and other scales and questionnaires.
Examine Cardiorespiratory Fitness as Outcome: No</td></tr>
<tr><td>Populations Analyzed: Age ≥60</td><td>Author-Stated Funding Source: Fundacao Araucaria and Coordenacao de Aperfeicoamento de Pessoal de Nivel Superior.</td></tr>
</table>

Meta-Analysis

Citation: Van Abbema R, De Greef M, Craje C, Krijnen W, Hobbelen H, Van Der Schans C. What type, or combination of exercise can improve preferred gait speed in older adults? A meta-analysis. *BMC Geriatr.* 2015;15:72. doi:10.1186/s12877-015-0061-9.

Purpose: To determine the meta-effects of different types or combinations of exercise interventions from randomized controlled trials on improvement in preferred gait speed.

Timeframe: 1990–December 2013

Total # of Studies: 28

Exposure Definition: PA intervention ranged from 9 to 48 weeks and involved single component exercise such as (progressive) resistance training, tai chi, balance training, salsa-dancing training, or agility training with varying intensity. The remaining studies involved multi-component exercise. Nearly all interventions were supervised; only 1 study was home-based.
Measures Steps: No
Measures Bouts: No
Examines HIIT: No

Outcomes Addressed: Physical function: preferred gait speed (meters per second).
Examine Cardiorespiratory Fitness as Outcome: No

Abstract: BACKGROUND: Improved preferred gait speed in older adults is associated with increased survival rates. There are inconsistent findings in clinical trials regarding effects of exercise on preferred gait speed, and heterogeneity in interventions in the current reviews and meta-analyses. OBJECTIVE: to determine the meta-effects of different types or combinations of exercise interventions from randomized controlled trials on improvement in preferred gait speed. METHODS: DATA SOURCES: A literature search was performed; the following databases were searched for studies from 1990 up to 9 December 2013: PubMed, EMBASE, EBSCO (AMED, CINAHL, ERIC, Medline, PsycInfo, and SocINDEX), and the Cochrane Library. STUDY ELIGIBILITY CRITERIA: Randomized controlled trials of exercise interventions for older adults >/= 65 years, that provided quantitative data (mean/SD) on preferred gait speed at baseline and post-intervention, as a primary or secondary outcome measure in the published article were included. Studies were excluded when the PEDro score was </=4, or if participants were selected for a specific neurological or neurodegenerative disease, Chronic Obstructive Pulmonary Disease, cardiovascular disease, recent lower limb fractures, lower limb joint replacements, or severe cognitive impairments. The meta-effect is presented in Forest plots with 95 % confidence STUDY APPRAISAL AND SYNTHESIS METHODS: intervals and random weights assigned to each trial. Homogeneity and risk of publication bias were assessed. RESULTS: Twenty-five studies were analysed in this meta-analysis. Data from six types or combinations of exercise interventions were pooled into sub-analyses. First, there is a significant positive meta-effect of resistance training progressed to 70-80 % of 1RM on preferred gait speed of 0.13 [CI 95 % 0.09-0.16] m/s. The difference between intervention- and control groups shows a substantial meaningful change (>0.1 m/s). Secondly, a significant positive meta-effect of interventions with a rhythmic component on preferred gait speed of 0.07 [CI 95 % 0.03-0.10] m/s was found. Thirdly, there is a small significant positive meta-effect of progressive resistance training, combined with balance-, and endurance training of 0.05 [CI 95 % 0.00-0.09] m/s. The other sub-analyses show non-significant small positive meta-affects. CONCLUSIONS: Progressive resistance training with high intensities, is the most effective exercise modality for improving preferred gait speed. Sufficient muscle strength seems an important condition for improving preferred gait speed. The addition of balance-, and/or endurance training does not contribute to the significant positive effects of progressive resistance training. A promising component is exercise with a rhythmic component. Keeping time to music or rhythm possibly trains higher

	cognitive functions that are important for gait. LIMITATIONS: The focus of the present meta-analysis was at avoiding as much heterogeneity in exercise interventions. However heterogeneity in the research populations could not be completely avoided, there are probably differences in health status within different studies.
Populations Analyzed: Adults ≥60	**Author-Stated Funding Source:** Research and Innovation Group in Health Care and Nursing, Hanze University Groningen.

Systematic Review **Citation:** van der Vorst A, Zijlstra GA, de Witte N, et al. Limitations in activities of daily living in community-dwelling people aged 75 and over: a systematic literature review of risk and protective factors. *PLoS One.* 2016;11(10):e0165127. doi:10.1371/journal.pone.0165127.	
Purpose: To obtain insight into risk factors for and protective factors against developing limitations in activities of daily living in community-dwelling older adults.	**Abstract:** BACKGROUND: Most older people wish to age in place, for which functional status or being able to perform activities of daily living (ADLs) is an important precondition. However, along with the substantial growth of the (oldest) old, the number of people who develop limitations in ADLs or have functional decline dramatically increases in this part of the population. Therefore, it is important to gain insight into factors that can contribute to developing intervention strategies at older ages. As a first step, this systematic review was conducted to identify risk and protective factors as predictors for developing limitations in ADLs in community-dwelling people aged 75 and over. METHODS: Four electronic databases (CINAHL (EBSCO), EMBASE, PsycINFO and PubMed) were searched systematically for potentially relevant studies published between January 1998 and March 2016. RESULTS: After a careful selection process, 6,910 studies were identified and 25 were included. By far most factors were examined in one study only, and most were considered risk factors. Several factors do not seem to be able to predict the development of limitations in ADLs in people aged 75 years and over, and for some factors ambiguous associations were found. The following risk factors were found in at least two studies: higher age, female gender, diabetes, hypertension, and stroke. A high level of physical activity and being married were protective in multiple studies. Notwithstanding the fact that research in people aged 65 years and over is more extensive, risk and protective factors seem to differ between the 'younger' and 'older' olds. CONCLUSION: Only a few risk and protective factors in community-dwelling people aged 75 years and over have been analysed in multiple studies. However, the identified factors could serve both detection and prevention purposes, and implications for future research are given as well.
Timeframe: 1998–March 2016	
Total # of Studies: 25	
Exposure Definition: PA: performing activities weekly, >2/<2 hours (no activity) weekly, 4 hours/vigorous sports > twice weekly (<4 hours), involvement in activities, involved in physical exercise program. **Measures Steps:** No **Measures Bouts:** No **Examines HIIT:** No	
Outcomes Addressed: Activities of daily living: needed to include at least three of the following activities: bathing, dressing, eating, toileting, and transferring. **Examine Cardiorespiratory Fitness as Outcome:** No	
Populations Analyzed: Adults ≥75	**Author-Stated Funding Source:** The Flemish Government Agency for Innovation by Science and Technology

<table>
<tr><td colspan="2">Meta-Analysis
Citation: Youkhana S, Dean CM, Wolff M, Sherrington C, Tiedemann A. Yoga-based exercise improves balance and mobility in people aged 60 and over: a systematic review and meta-analysis. Age Ageing. 2016;45(1):21-29. doi:10.1093/ageing/afv175.</td></tr>
<tr><td>Purpose: To determine the impact of yoga-based exercise on balance and physical mobility in people aged 60+ years.</td><td rowspan="5">Abstract: OBJECTIVE: one-third of community-dwelling older adults fall annually. Exercise that challenges balance is proven to prevent falls. We conducted a systematic review with meta-analysis to determine the impact of yoga-based exercise on balance and physical mobility in people aged 60+ years. METHODS: searches for relevant trials were conducted on the following electronic databases: MEDLINE, EMBASE, Cochrane Central Register of Controlled Trials, CINAHL, Allied and Complementary Medicine Database and the Physiotherapy Evidence Database (PEDro) from inception to February 2015. Trials were included if they evaluated the effect of physical yoga (excluding meditation and breathing exercises alone) on balance in people aged 60+ years. We extracted data on balance and the secondary outcome of physical mobility. Standardised mean differences and 95% confidence intervals (CI) were calculated using random-effects models. Methodological quality of trials was assessed using the 10-point Physiotherapy Evidence Database (PEDro) Scale. RESULTS: six trials of relatively high methodological quality, totalling 307 participants, were identified and had data that could be included in a meta-analysis. Overall, yoga interventions had a small effect on balance performance (Hedges' g = 0.40, 95% CI 0.15-0.65, 6 trials) and a medium effect on physical mobility (Hedges' g = 0.50, 95% CI 0.06-0.95, 3 trials). CONCLUSION: yoga interventions resulted in small improvements in balance and medium improvements in physical mobility in people aged 60+ years. Further research is required to determine whether yoga-related improvements in balance and mobility translate to prevention of falls in older people. PROSPERO Registration number CRD42015015872.</td></tr>
<tr><td>Timeframe: Inception–February 2015</td></tr>
<tr><td>Total # of Studies: 6</td></tr>
<tr><td>Exposure Definition: Yoga-based interventions; yoga was defined as the practice of standing postures that aim to improve strength and balance. Interventions ranged from 8 to 24 weeks, for 1–2 times per week of 60–90 minute sessions.
Measures Steps: No
Measures Bouts: No
Examines HIIT: No</td></tr>
<tr><td>Outcomes Addressed: Standardized mean differences of balance measures (Berg Balance Scale, one leg stand, short physical performance battery) and mobility.
Examine Cardiorespiratory Fitness as Outcome: No</td></tr>
<tr><td>Populations Analyzed: Age ≥60 (mean age range 63–84)</td><td>Author-Stated Funding Source: National Health and Medical Research Council of Australia.</td></tr>
</table>

<table>
<tr><td colspan="2">Systematic Review
Citation: Zanotto T, Bergamin M, Roman F, et al. Effect of exercise on dual-task and balance on elderly in multiple disease conditions. Curr Aging Sci. 2014;7(2):115-136.</td></tr>
<tr><td>Purpose: To summarize and analyze articles that investigated exercise protocols and their effects on dual task performance in elderly subjects.</td><td rowspan="4">Abstract: Investigations on how exercise and physical activity affect dual-task (DT) performance in the elderly are growing rapidly due to the fact that DT activities are commonplace with activities of daily living. Preliminary evidence has shown the benefit in exercise on DT balance, though it is unclear to what extent the effect exercise has on DT performance in elderly subjects with disease conditions, including subjects with a high risk of falls. Hence, the objective of this study was to critically review the existing evidence of a potential relationship between exercise and improvement of static and dynamic balance during DT conditions as well as secondary outcomes in elderly subjects with different disease conditions. A systematic search using online databases was performed to source documents. Inclusion criteria sourced articles classified as randomized controlled trials (RCT), controlled trials (CT) and uncontrolled trials (UT). Moreover, the studies had to administrate an exercise or physical activity protocol in the intervention. Seventeen studies met the eligibility criteria and were comprised of 12 RCTs, 3 CTs, and 2 UTs. Overall, 13 studies supported exercise being effective to improve parameters of static and dynamic balance during single or DT conditions. Despite the heterogeneity of pathologic conditions, exercise showed similar benefits to improve function in two main areas: neurological conditions and frailty conditions. The lack of a common method to assess DT performance limited the ability to compare different interventions directly. Future research is warranted to study the optimal dose and exercise modalities to best reduce the risk of falls in the elderly with multiple disease conditions.</td></tr>
<tr><td>Timeframe: Inception–October 2013</td></tr>
<tr><td>Total # of Studies: 17</td></tr>
<tr><td>Exposure Definition: Exercise programs varied and included different modalities, intensities, frequencies, and durations. Some programs included concurrent cognitive tasks, music-based activities, and virtual reality; some did not include secondary concurrent tasks; and one was performed in a water-based environment.
Measures Steps: No
Measures Bouts: No
Examines HIIT: No</td></tr>
<tr><td>Outcomes Addressed: Static or dynamic balance or dual task performance.
Examine Cardiorespiratory Fitness as Outcome: No</td></tr>
<tr><td>Populations Analyzed: Adults >59, Stroke, Parkinson’s disease, Dementia, Frail elderly</td><td>Author-Stated Funding Source: Not reported.</td></tr>
</table>

Table 3. Existing Systematic Reviews, Meta-Analyses, and Pooled Analysis Quality Assessment Chart

	Baker, 2007	Bouaziz, 2016	Bouaziz, 2017	Chase, 2012	Chase, 2017	Donath, 2016	Fernandez-Arguelles, 2015	Fritz, 2015
Review questions and inclusion/exclusion criteria delineated prior to executing search strategy.	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Population variables defined and considered in methods.	No	No	No	No	Yes	No	No	No
Comprehensive literature search performed.	Yes	Yes	Yes	Yes	Yes	Yes	Partially Yes	Yes
Duplicate study selection and data extraction performed.	No	No	No	No	No	Yes	Yes	Yes
Search strategy clearly described.	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Relevant grey literature included in review.	No	No	No	No	Yes	No	No	No
List of studies (included and excluded) provided.	No	No	No	Yes	No	No	No	No
Characteristics of included studies provided.	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes
FITT defined and examined in relation to outcome effect sizes.	N/A	N/A	N/A	N/A	Yes	Yes	N/A	N/A
Scientific quality (risk of bias) of included studies assessed and documented.	Yes	Yes	Yes	Partially Yes	Yes	Yes	Yes	Yes
Results depended on study quality, either overall, or in interaction with moderators.	Yes	Yes	Yes	Yes	Yes	Yes	No	No
Scientific quality used appropriately in formulating conclusions.	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Data appropriately synthesized and if applicable, heterogeneity assessed.	N/A	N/A	N/A	N/A	Yes	Partially Yes	N/A	N/A
Effect size index chosen justified, statistically.	N/A	N/A	N/A	N/A	Yes	Yes	N/A	N/A
Individual-level meta-analysis used.	N/A	N/A	N/A	N/A	No	No	N/A	N/A
Practical recommendations clearly addressed.	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Likelihood of publication bias assessed.	No	No	No	No	Yes	Yes	No	No
Conflict of interest disclosed.	No	No	No	No	No	Yes	No	Yes

	Gobbo, 2014	Gu, 2008	Hanson, 2015	Hill, 2015	Hortobágyi, 2015	Howe, 2011	Kelley, 2009	Keogh, 2009
Review questions and inclusion/exclusion criteria delineated prior to executing search strategy.	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Population variables defined and considered in methods.	No	No	No	No	No	Yes	No	No
Comprehensive literature search performed.	Yes	Partially Yes	Yes	Yes	Yes	Yes	Yes	Yes
Duplicate study selection and data extraction performed.	No	No	No	No	No	Yes	Yes	No
Search strategy clearly described.	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes
Relevant grey literature included in review.	No	No	Yes	No	No	Yes	Yes	Yes
List of studies (included and excluded) provided.	Yes	No	No	No	No	Yes	No	No
Characteristics of included studies provided.	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes
FITT defined and examined in relation to outcome effect sizes.	N/A	No	No	No	No	Yes	No	N/A
Scientific quality (risk of bias) of included studies assessed and documented.	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes
Results depended on study quality, either overall, or in interaction with moderators.	Yes	N/A	Yes	No	No	Yes	Yes	Yes
Scientific quality used appropriately in formulating conclusions.	Yes	N/A	Yes	No	No	Yes	Yes	Yes
Data appropriately synthesized and if applicable, heterogeneity assessed.	N/A	Yes	Yes	Yes	Yes	Yes	Yes	N/A
Effect size index chosen justified, statistically.	N/A	Yes	Yes	Yes	Yes	Yes	Yes	N/A
Individual-level meta-analysis used.	N/A	No	No	No	No	No	No	N/A
Practical recommendations clearly addressed.	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Likelihood of publication bias assessed.	No	No	Yes	No	No	Yes	Yes	No
Conflict of interest disclosed.	Yes	No	Yes	Yes	Yes	Yes	No	No

	Lesinski, 2015	Leung, 2011	Liberman, 2017	Liu, 2011	Liu, 2009	Lopopolo, 2006	Morey, 2008	Orr, 2008
Review questions and inclusion/exclusion criteria delineated prior to executing search strategy.	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Population variables defined and considered in methods.	No	No	No	No	No	No	Yes	Yes
Comprehensive literature search performed.	Yes	Partially Yes	Yes	Yes	Yes	Yes	N/A	Yes
Duplicate study selection and data extraction performed.	No	No	No	Yes	Yes	Yes	N/A	No
Search strategy clearly described.	Yes	Yes	Yes	Yes	Yes	Yes	N/A	Yes
Relevant grey literature included in review.	No	No	No	Yes	Yes	Yes	N/A	No
List of studies (included and excluded) provided.	No	No	No	No	Yes	No	N/A	No
Characteristics of included studies provided.	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
FITT defined and examined in relation to outcome effect sizes.	Yes	No	N/A	No	Yes	Yes	No	N/A
Scientific quality (risk of bias) of included studies assessed and documented.	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes
Results depended on study quality, either overall, or in interaction with moderators.	Yes	No	No	No	Yes	Yes	N/A	Yes
Scientific quality used appropriately in formulating conclusions.	Yes	No	No	Yes	Yes	Yes	N/A	Yes
Data appropriately synthesized and if applicable, heterogeneity assessed.	Yes	No	N/A	Yes	Yes	Yes	No	N/A
Effect size index chosen justified, statistically.	Yes	Partially Yes	N/A	Yes	Yes	Yes	Yes	N/A
Individual-level meta-analysis used.	No	No	N/A	No	No	No	No	N/A
Practical recommendations clearly addressed.	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Likelihood of publication bias assessed.	No	No	No	No	No	Yes	N/A	No
Conflict of interest disclosed.	Yes	No	Yes	No	Yes	No	Yes	Yes

	Paterson, 2010	Pichierri, 2011	Plummer, 2015	Rodrigues, 2014	Rogers, 2009	Stathokostas, 2012	Tak, 2013	Taylor, 2016
Review questions and inclusion/exclusion criteria delineated prior to executing search strategy.	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Population variables defined and considered in methods.	No	Yes	No	No	No	No	Yes	No
Comprehensive literature search performed.	Yes	Yes	Partially Yes	Partially Yes	Yes	Yes	Partially Yes	Partially Yes
Duplicate study selection and data extraction performed.	Yes	No	Yes	Yes	No	Yes	Yes	Yes
Search strategy clearly described.	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Relevant grey literature included in review.	No	No	No	No	No	No	No	No
List of studies (included and excluded) provided.	No	No	Yes	No	No	No	No	No
Characteristics of included studies provided.	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes
FITT defined and examined in relation to outcome effect sizes.	N/A	N/A	No	No	N/A	N/A	No	No
Scientific quality (risk of bias) of included studies assessed and documented.	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes
Results depended on study quality, either overall, or in interaction with moderators.	Yes	No	Yes	No	N/A	Yes	Yes	No
Scientific quality used appropriately in formulating conclusions.	Yes	Yes	Yes	Yes	N/A	Yes	Yes	Yes
Data appropriately synthesized and if applicable, heterogeneity assessed.	N/A	N/A	Yes	Partially Yes	N/A	N/A	Yes	Yes
Effect size index chosen justified, statistically.	N/A	N/A	Yes	Yes	N/A	N/A	Yes	Yes
Individual-level meta-analysis used.	N/A	N/A	No	No	N/A	N/A	No	No
Practical recommendations clearly addressed.	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Likelihood of publication bias assessed.	No	No	Yes	No	No	No	Yes	No

Conflict of interest disclosed.	Yes	No	No	Yes	No	No	No	No

	Tschopp, 2011	Vagetti, 2014	Van Abbema, 2015	van der Vorst, 2016	Youkhana, 2016	Zanotto, 2014
Review questions and inclusion/exclusion criteria delineated prior to executing search strategy.	Yes	Yes	Yes	Yes	Yes	Yes
Population variables defined and considered in methods.	No	Yes	No	Yes	No	Yes
Comprehensive literature search performed.	Yes	Yes	Yes	Yes	Yes	Yes
Duplicate study selection and data extraction performed.	Yes	No	Yes	No	Yes	No
Search strategy clearly described.	Yes	Yes	Yes	Yes	Yes	Yes
Relevant grey literature included in review.	Yes	No	No	No	No	No
List of studies (included and excluded) provided.	No	No	No	No	No	No
Characteristics of included studies provided.	Yes	No	Yes	Yes	Yes	Yes
FITT defined and examined in relation to outcome effect sizes.	No	N/A	No	N/A	No	N/A
Scientific quality (risk of bias) of included studies assessed and documented.	Partially Yes	Yes	Yes	Yes	Yes	Yes
Results depended on study quality, either overall, or in interaction with moderators.	No	No	No	Yes	No	Yes
Scientific quality used appropriately in formulating conclusions.	Yes	Yes	No	Yes	Yes	Yes
Data appropriately synthesized and if applicable, heterogeneity assessed.	Yes	N/A	Yes	N/A	Yes	N/A
Effect size index chosen justified, statistically.	Yes	N/A	Yes	N/A	Yes	N/A
Individual-level meta-analysis used.	No	N/A	No	N/A	No	N/A
Practical recommendations clearly addressed.	Yes	Yes	Yes	Yes	Yes	Yes

Likelihood of publication bias assessed.	No	No	Yes	No	No	No
Conflict of interest disclosed.	No	Yes	Yes	Yes	Yes	No

Appendices

Appendix A: Analytical Framework

Topic Area
Aging

Systematic Review Questions

What is the relationship between physical activity and physical function among the general aging population?

a. Is there a dose-response relationship? If yes, what is the shape of the relationship?
b. Does the relationship vary by age, sex, race/ethnicity, socio-economic status, or weight status?
c. What type(s) of physical activity are effective for improving or maintaining physical function?
d. What impairment(s) modify the relationship between physical activity and physical function among the general aging population?

Population
Adults, 50 years and older (Lower age range for included data must be a minimum of 50 years)

Exposure
All types and intensities of physical activity, including sedentary behavior

Comparison
Adults, 50 years and older, who participate in varying levels of physical activity, including no reported physical activity

Endpoint Health Outcomes
Physical function
Functional ability
"Move around"
Behavioral ability
Behavioral disability
Functional limitations
Loss of physical function
Physical disability
Physical intrinsic capacity

Key Definitions

"Physical function" and "physical functioning" are regarded as synonyms that refer to: "the *ability* of a person to move around and to perform types of physical activity."

For example, measures of physical function include measures of ability to walk (e.g., usually gait speed), run, climb stairs, carry groceries, sweep the floor, stand up, and bath oneself.

As measures of behavioral abilities, physical function measures do not include:

- Physiologic measures, including measures of physiologic capacity (e.g., maximal lung capacities, maximal aerobic capacity, maximal muscle strength, bone density).
- Measures of the environment or of the host-environmental interaction (e.g., disability accommodation).
- Measures of what a person usually does (e.g., physical activity level) (as opposed to what a person is capable of doing).

Appendix B: Final Search Strategy

Search Strategy: PubMed (Systematic Reviews, Meta-Analyses, Pooled Analyses, and High-Quality Reports)

Database: PubMed; Date of Search: 2/24/17; 1,144 results

Set	Search Terms
Limit: Language	(English[lang])
Limit: Exclude animal only	NOT ("Animals"[Mesh] NOT ("Animals"[Mesh] AND "Humans"[Mesh]))
Limit: Exclude child only	NOT (("infant"[Mesh] OR "child"[mesh] OR "adolescent"[mh]) NOT (("infant"[Mesh] OR "child"[mesh] OR "adolescent"[mh]) AND "adult"[Mesh]))
Limit: Publication Date (SR/MA)	AND ("2006/01/01"[PDAT] : "3000/12/31"[PDAT])
Limit: Publication Type Include (SR/MA)	AND (systematic[sb] OR meta-analysis[pt] OR "systematic review"[tiab] OR "systematic literature review"[tiab] OR metaanalysis[tiab] OR "meta analysis"[tiab] OR metanalyses[tiab] OR "meta analyses"[tiab] OR "pooled analysis"[tiab] OR "pooled analyses"[tiab] OR "pooled data"[tiab])
Limit: Publication Type Exclude (SR/MA)	NOT ("comment"[Publication Type] OR "editorial"[Publication Type])
Physical Activity	AND (("Exercise"[mh] OR "Exercise"[tiab] OR "Physical activity"[tiab] OR "Sedentary lifestyle"[mh] OR "Lifestyle activities"[tiab] OR "Lifestyle activity"[tiab] OR "Recreational activities"[tiab] OR "Recreational activity"[tiab] OR "Tai ji"[mh] OR "Yoga"[mh] OR "Balance training"[tiab] OR "Qigong"[mh] OR "Functional training"[tiab]) OR (("Aerobic activities"[tiab] OR "Aerobic activity"[tiab] OR "Cardiovascular activities"[tiab] OR "Cardiovascular activity"[tiab] OR "Endurance activities"[tiab] OR "Endurance activity"[tiab] OR "Physical activities"[tiab] OR "Physical conditioning"[tiab] OR "Resistance training"[tiab] OR "strength training"[tiab] OR "Sedentary"[tiab] OR "Tai chi"[tiab] OR "Tai ji"[tiab] OR "Yoga"[tiab] OR "Walk"[tiab] OR "Walking"[tiab] OR "Chi kung"[tiab] OR "Qigong"[tiab] OR "stretching"[tiab]) NOT medline[sb]))
Physical Function	AND ("Physical function"[tiab] OR "Physical functioning"[tiab] OR "Physical ability"[tiab] OR "Physical disability"[tiab] OR "Gait speed"[tiab] OR "Walking speed"[tiab] OR "Mobility"[tiab] OR "Chair stands"[tiab] OR "Activities of daily living"[tiab] OR "Activity of daily living"[tiab] OR "Tandem walk"[tiab] OR "Health status"[ti] OR "Health related quality of life"[ti] OR "HRQOL"[ti] OR "Physical performance"[tiab] OR ("Functional"[tiab] AND "Physical"[tiab]))

Search Strategy: CINAHL (Systematic Reviews, Meta-Analyses, Pooled Analyses, and High-Quality Reports)

Database: CINAHL; Date of Search: 2/24/17; 56 results
Terms searched in title or abstract, aside from those in *italics* which are only searched in title

Set	Search Terms
Physical Activity	("Aerobic activities" OR "Aerobic activity" OR "Cardiovascular activities" OR "Cardiovascular activity" OR "Endurance activities" OR "Endurance activity" OR "Exercise" OR "Physical activity" OR "Physical activities" OR "Physical conditioning" OR "Resistance training" OR "strength training" OR "Sedentary" OR "Lifestyle activities" OR "Lifestyle activity" OR "Recreational activities" OR "Recreational activity" OR "Tai chi" OR "Tai ji" OR "Yoga" OR "Walk" OR "Walking" OR "Balance training" OR "Chi kung" OR "Qigong" OR "Functional training" OR "stretching")
Physical Function	AND ("Physical function" OR "Physical functioning" OR "Physical ability" OR "Physical disability" OR "Gait speed" OR "Walking speed" OR "Mobility" OR "Chair stands" OR "Activities of daily living" OR "Activity of daily living" OR "Tandem walk" OR *"Health status" OR "Health related quality of life" OR "HRQOL"* OR "Physical performance" OR (Functional AND Physical))
Limit: Publication Type Include (SR/MA)	AND (“systematic review” OR “systematic literature review” OR "metaanalysis" OR "meta analysis" OR metanalyses OR "meta analyses" OR "pooled analysis" OR “pooled analyses” OR "pooled data")
Limits	2006-present English language Peer reviewed Exclude Medline records Human

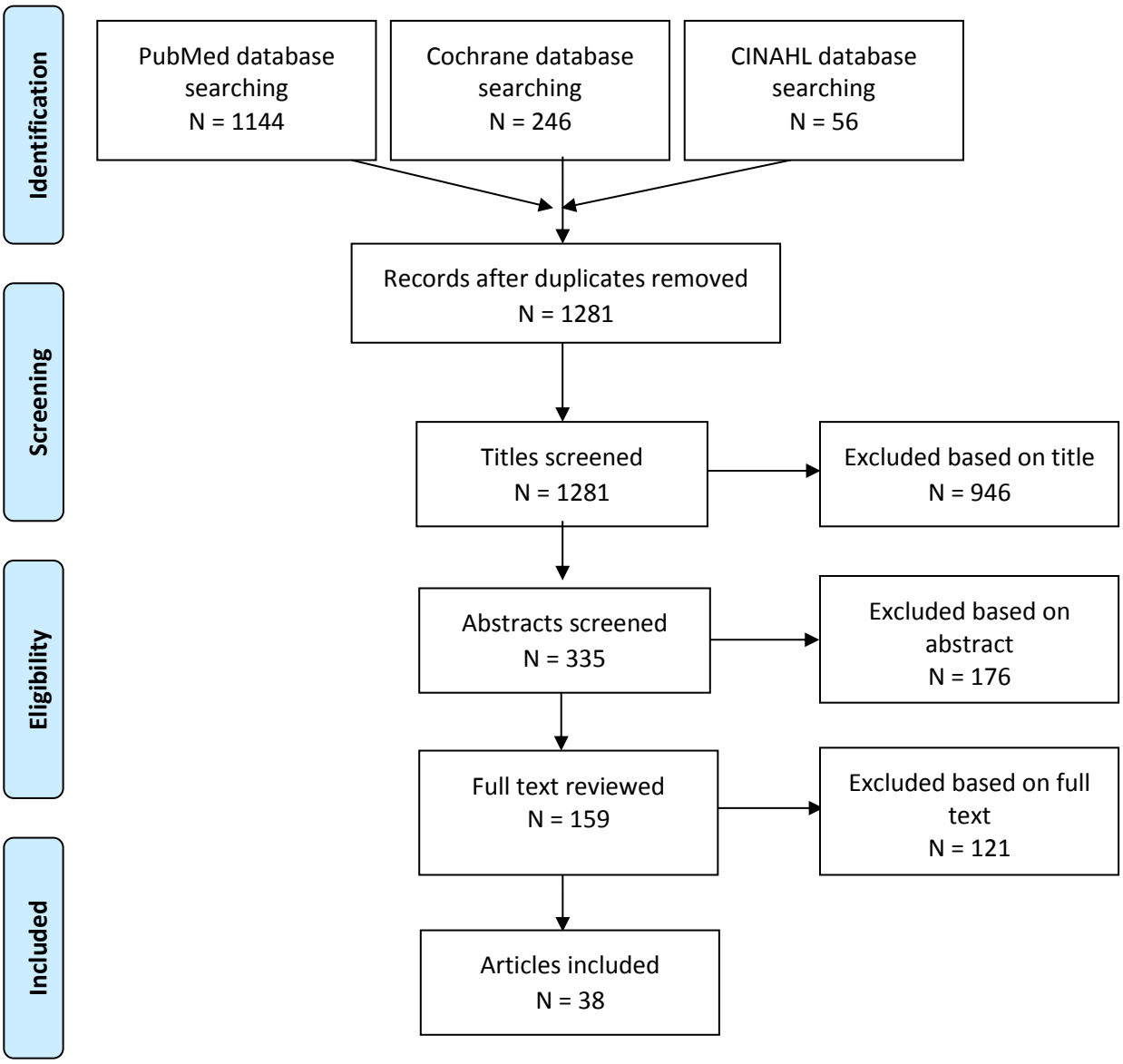
Search Strategy: Cochrane (Systematic Reviews, Meta-Analyses, Pooled Analyses, and High-Quality Reports)

Database: Cochrane; Date of Search: 2/28/17; 246 results
Terms searched in title, abstract, or keywords, aside from those in *italics* which are only searched in title

Set	Search Terms
Physical Activity	("Aerobic activities" OR "Aerobic activity" OR "Cardiovascular activities" OR "Cardiovascular activity" OR "Endurance activities" OR "Endurance activity" OR "Exercise" OR "Physical activity" OR "Physical activities" OR "Physical conditioning" OR "Resistance training" OR "strength training" OR "Sedentary" OR "Lifestyle activities" OR "Lifestyle activity" OR "Recreational activities" OR "Recreational activity" OR "Tai chi" OR "Tai ji" OR "Yoga" OR "Walk" OR "Walking" OR "Balance training" OR "Chi kung" OR "Qigong" OR "Functional training" OR "stretching")
Physical Function	AND ("Physical function" OR "Physical functioning" OR "Physical ability" OR "Physical disability" OR "Gait speed" OR "Walking speed" OR "Mobility" OR "Chair stands" OR "Activities of daily living" OR "Activity of daily living" OR "Tandem walk" OR "Physical performance" OR (Functional AND Physical) or *"Health status" or "Health related quality of life" or "HRQOL"*)
Limits	2006-present Cochrane Reviews and Other Reviews Word variations will not be searched

Appendix C: Literature Tree

Existing Systematic Reviews, Meta-Analyses, Pooled Analyses, and Reports Literature Tree



Appendix D: Inclusion/Exclusion Criteria

Aging Subcommittee

Q2. What is the relationship between physical activity and physical function among the general aging population?

a. Is there a dose-response relationship? If yes, what is the shape of the relationship?
b. Does the relationship vary by age, sex, race/ethnicity, socio-economic status, or weight status?
c. What type(s) of physical activity are effective for improving or maintaining physical function?
d. What impairment(s) modify the relationship between physical activity and physical function among the general aging population?

Category	Inclusion/Exclusion Criteria	Notes/Rationale
Publication Language	**Include:** • Studies published with full text in English	
Publication Status	**Include:** • Studies published in peer-reviewed journals • Reports determined to have appropriate suitability and quality by PAGAC **Exclude:** • Grey literature, including unpublished data, manuscripts, abstracts, conference proceedings	
Research Type	**Include:** • Original research • Meta-analyses • Systematic reviews • Pooled analyses • Reports determined to have appropriate suitability and quality by PAGAC	
Study Subjects	**Include:** • Human subjects	
	Exclude: • Athletes only	Exclude studies that do not present data on non-athletes.
Age of Study Subjects	**Include:** • Adults ages 50 and older • When data are analyzed by age groups, only data with lower range of 50 or older may be included (e.g., in a study with individuals 45-90 where data are presented for three age groups: 45-55, 55-65, and 65-90, only data for 55-65 and 65-90 may be included)	Data must be provided for adults ages 50 and older to be relevant to this question.
Health Status of Study Subjects	**Exclude:** • Hospitalized patients only (acute care, admitted into the hospital, rehabilitation facilities)	• Do not exclude emergency room, care

	• Nonambulatory adults only (can't walk, need wheelchair, need walker) • Patients recruited because they have a specific chronic condition	homes, assisted living, long-term care facilities • Do not exclude studies of individuals who need canes to walk.
Comparison	**Include:** • Adults ages 50 and older who participate in varying levels of physical activity, including no reported physical activity	
Funding Source	**No criteria**	
Date of Publication	**Include:** • Original research published 2006 - 2016 • Systematic reviews and meta-analyses published from 2006 – 2016	
Study Design	**Include:** • Randomized controlled trials • Non-randomized controlled trials • Prospective cohort studies • Retrospective cohort studies • Case-control studies • Systematic reviews • Meta-analyses • Pooled reports • PAGAC-Approved reports **Exclude:** • Narrative reviews • Commentaries • Editorials • Cross-sectional studies • Before-and-after studies	
Exposure/Intervention	**Include studies in which the exposure or intervention is:** • All types and intensities of physical activity **Exclude:** • Studies missing physical activity (mental games such as Sudoku instead of physical activities) • Studies of a single, acute session of exercise • Studies of a disease-specific therapeutic exercise delivered by a medical professional (e.g., physical therapist) • Studies with measures of physical fitness as the exposure • Studies of multimodal interventions that do not present data on physical activity alone	

	• Studies that only use physical activity as a confound variable	
Outcome	**Include studies in which the outcome is:** • Physical function • Functional ability • "Move around" • Behavioral ability • Behavioral disability • Functional limitations • Loss of physical function • Physical disability • Physical intrinsic capacity	

Appendix E: Rationale for Exclusion at Abstract or Full-Text Triage for Existing Systematic Reviews, Meta-Analyses, Pooled Analyses, and Reports

The table below lists the excluded articles with at least one reason for exclusion, but may not reflect all possible reasons.

Citation	Outcome	Population	Study Design	Exposure	Not ideal fit for replacement of de novo search	Other
Abariga S, Wang C. P04.29. Tai chi and health related quality of life: a systematic review and meta-analysis of randomized controlled trials. *BMC Complement Altern Med*. 2012;12(suppl 1):1-1. doi:10.1186/1472-6882-12-S1-P299.			X			
Abbruzzese G, Marchese R, Avanzino L, Pelosin E. Rehabilitation for Parkinson's disease: current outlook and future challenges. *Parkinsonism Relat Disord*. 2016;22(suppl 1):S60-S64. doi:10.1016/j.parkreldis.2015.09.005.			X			
Ahlskog JE, Geda YE, Graff-Radford NR, Petersen RC. Physical exercise as a preventive or disease-modifying treatment of dementia and brain aging. *Mayo Clin Proc*. 2011;86(9):876-884. doi:10.4065/mcp.2011.0252.				X		
Alfred T, Ben-Shlomo Y, Cooper R, et al.; HALCyon Study Team. Associations between APOE and low-density lipoprotein cholesterol genotypes and cognitive and physical capability: the HALCyon programme. *Age (Dordr)*. 2014;36(4):9673. doi:10.1007/s11357-014-9673-9.				X		
Alibhai SM, Santa Mina D, Ritvo P, et al. A phase II RCT and economic analysis of three exercise delivery methods in men with prostate cancer on androgen deprivation therapy. *BMC Cancer.* 2015;15:312. doi:10.1186/s12885-015-1316-8.		X				
Allen NE, Schwarzel AK, Canning CG. Recurrent falls in Parkinson's disease: a systematic review. *Parkinsons Dis.* 2013;2013:906274. doi:10.1155/2013/906274.				X		
Alves Da Rocha P, McClelland J, Morris ME. Complementary physical therapies for movement disorders in Parkinson's disease: a systematic review. *Eur J Phys Rehabil Med*. 2015;51(6):693-704.		X				
Amorim JS, Salla S, Trelha CS. Factors associated with work ability in the elderly: systematic review. *Rev Bras Epidemiol.* 2014;17(4):830-841.				X		
Anderiesen H, Scherder EJ, Goossens RH, Sonneveld MH. A systematic review—physical activity in dementia: the influence of the nursing home environment. *Appl Ergon.*	X					

Citation	Outcome	Population	Study Design	Exposure	Not ideal fit for replacement of de novo search	Other
2014;45(6):1678-1686. doi:10.1016/j.apergo.2014.05.011.						
Anderson ND, Damianakis T, Kröger E, et al.; BRAVO Team. The benefits associated with volunteering among seniors: a critical review and recommendations for future research. *Psychol Bull.* 2014;140(6):1505-1533. doi:10.1037/a0037610.				X		
Anthony K, Robinson K, Logan P, Gordon AL, Harwood RH, Masud T. Chair-based exercises for frail older people: a systematic review. *Biomed Res Int.* 2013;2013:309506. doi:10.1155/2013/309506.		X				
Arbesman M, Mosley LJ. Systematic review of occupation- and activity-based health management and maintenance interventions for community-dwelling older adults. *Am J Occup Ther.* 2012;66(3):277-283. doi:10.5014/ajot.2012.003327.				X		
Artaza-Artabe I, Sáez-López P, Sánchez-Hernández N, Fernández-Gutierrez N, Malafarina V. The relationship between nutrition and frailty: effects of protein intake, nutritional supplementation, vitamin D and exercise on muscle metabolism in the elderly. A systematic review. *Maturitas.* 2016;93:89-99. doi:10.1016/j.maturitas.2016.04.009.				X		
Auais MA, Eilayyan O, Mayo NE. Extended exercise rehabilitation after hip fracture improves patients' physical function: a systematic review and meta-analysis. *Phys Ther*. 2012;92(11):1437-1451. doi:10.2522/ptj.20110274.		X				
Barker AL, Talevski J, Morello RT, Brand CA, Rahmann AE, Urquhart DM. Effectiveness of aquatic exercise for musculoskeletal conditions: a meta-analysis. *Arch Phys Med Rehabil.* 2014;95(9):1776-1786. doi:10.1016/j.apmr.2014.04.005.		X				
Batsis JA, Gill LE, Masutani RK, et al. Weight loss interventions in older adults with obesity: a systematic review of randomized controlled trials since 2005. *J Am Geriatr Soc.* 2017;65(2):257-268. doi:10.1111/jgs.14514.		X				
Beckenkamp PR, Lin CW, Chagpar S, Herbert RD, van der Ploeg HP, Moseley AM. Prognosis of physical function following ankle fracture: a systematic review with meta-analysis. *J Orthop Sports Phys Ther.* 2014;44(11):841-851, B2. doi:10.2519/jospt.2014.5199.				X		
Behm DG, Blazevich AJ, Kay AD, McHugh M. Acute effects of muscle stretching on physical performance, range of motion, and injury incidence in healthy active individuals: a	X					

Citation	Outcome	Population	Study Design	Exposure	Not ideal fit for replacement of de novo search	Other
systematic review. *Appl Physiol Nutr Metab.* 2016;41(1):1-11. doi:10.1139/apnm-2015-0235.						
Bernhardt J, Thuy MN, Collier JM, Legg LA. Very early versus delayed mobilisation after stroke. *Cochrane Database Syst Rev.* 2009;(1):CD006187. doi:10.1002/14651858.CD006187.pub2.				X		
Birch L, Perry R, Penfold C, Beynon R, Hamilton-Shield J. What change in body mass index is needed to improve metabolic health status in childhood obesity: protocol for a systematic review. *Syst Rev.* 2016;5:120. doi:10.1186/s13643-016-0299-0.		X				
Bize R, Johnson JA, Plotnikoff RC. Physical activity level and health-related quality of life in the general adult population: a systematic review. *Prev Med.* 2007;45(6):401-415.	X					
Blankevoort CG, van Heuvelen MJ, Boersma F, Luning H, de Jong J, Scherder EJ. Review of effects of physical activity on strength, balance, mobility and ADL performance in elderly subjects with dementia. *Dement Geriatr Cogn Disord*. 2010;30(5):392-402. doi:10.1159/000321357.		X				
Block VA, Pitsch E, Tahir P, Cree BA, Allen DD, Gelfand JM. Remote physical activity monitoring in neurological disease: a systematic review. *PLoS One.* 2016;11(4):e0154335. doi:10.1371/journal.pone.0154335.				X		
Blyton F, Chuter V, Walter KE, Burns J. Non-drug therapies for lower limb muscle cramps. *Cochrane Database Syst Rev.* 2012;1:Cd008496. doi:10.1002/14651858.CD008496.pub2.				X		
Bohannon RW, Glenney SS. Minimal clinically important difference for change in comfortable gait speed of adults with pathology: a systematic review. *J Eval Clin Pract.* 2014;20(4):295-300. doi:10.1111/jep.12158.				X		
Boone-Heinonen J, Evenson KR, Taber DR, Gordon-Larsen P. Walking for prevention of cardiovascular disease in men and women: a systematic review of observational studies. *Obes Rev.* 2009;10(2):204-217. doi:10.1111/j.1467-789X.2008.00533.x.	X					
Booth V, Hood V, Kearney F. Interventions incorporating physical and cognitive elements to reduce falls risk in cognitively impaired older adults: a systematic review. *JBI Database System Rev Implement Rep.*			X			

Citation	Outcome	Population	Study Design	Exposure	Not ideal fit for replacement of de novo search	Other
2016;14(5):110-135. doi:10.11124/JBISRIR-2016-002499.						
Booth J, Skelton D, Howe T, Ballinger C, MacInnes C. The effects of lifestyle and behavioural interventions for urinary incontinence on mobility, physical activity and falls in older people: a comprehensive systematic review. *JBI Libr Syst Rev*. 2009;7(16)(suppl):1-25. doi:10.11124/jbisrir-2009-520.				X		
Borde R, Hortobágyi T, Granacher U. Dose-response relationships of resistance training in healthy old adults: a systematic review and meta-analysis. *Sports Med.* 2015;45(12):1693-1720. doi:10.1007/s40279-015-0385-9.	X					
Borschmann K, Pang MY, Bernhardt J, Iuliano-Burns S. Stepping towards prevention of bone loss after stroke: a systematic review of the skeletal effects of physical activity after stroke. *Int J Stroke.* 2012;7(4):330-335. doi:10.1111/j.1747-4949.2011.00645.x.	X					
Bossers WJ, van der Woude LH, Boersma F, Scherder EJ, van Heuvelen MJ. Recommended measures for the assessment of cognitive and physical performance in older patients with dementia: a systematic review. *Dement Geriatr Cogn Dis Extra.* 2012;2(1):589-609. doi:10.1159/000345038.	X					
Bray NW, Smart RR, Jakobi JM, Jones GR. Exercise prescription to reverse frailty. *Appl Physiol Nutr Metab.* 2016;41(10):1112-1116.			X			
Brett L, Traynor V, Stapley P. Effects of physical exercise on health and well-being of individuals living with a dementia in nursing homes: a systematic review. *J Am Med Dir Assoc*. 2016;17(2):104-116. doi:10.1016/j.jamda.2015.08.016.		X				
Brienesse LA, Emerson MN. Effects of resistance training for people with Parkinson's disease: a systematic review. *J Am Med Dir Assoc.* 2013;14(4):236-241. doi:10.1016/j.jamda.2012.11.012.		X				
Brosseau L, Wells GA, Tugwell P, et al; Ottawa Panel. Ottawa Panel evidence-based clinical practice guidelines for the management of osteoarthritis in adults who are obese or overweight. *Phys Ther.* 2011;91(6):843-861. doi:10.2522/ptj.20100104.		X				
Brown CJ, Flood KL. Mobility limitation in the older patient: a clinical review. *JAMA.* 2013;310(11):1168-1177. doi:10.1001/jama.2013.276566.			X			
Bu B, Haijun H, Yong L, Chaohui Z, Xiaoyuan Y, Singh MF. Effects of martial arts on health		X				

Citation	Outcome	Population	Study Design	Exposure	Not ideal fit for replacement of de novo search	Other
status: a systematic review. *J Evid Based Med.* 2010;3(4):205-219. doi:10.1111/j.1756-5391.2010.01107.x.						
Buechter RB, Fechtelpeter D. Climbing for preventing and treating health problems: a systematic review of randomized controlled trials. *Ger Med Sci*. 2011;9:Doc19. doi:10.3205/000142.		X				
Bullo V, Bergamin M, Gobbo S, et al. The effects of Pilates exercise training on physical fitness and wellbeing in the elderly: a systematic review for future exercise prescription. *Prev Med.* 2015;75:1-11. doi:10.1016/j.ypmed.2015.03.002.					X	
Burge E, Kuhne N, Berchtold A, Maupetit C, von Gunten A . Impact of physical activity on activity of daily living in moderate to severe dementia: a critical review. *Eur Rev Aging Phys Act*. 2012;9(1):27-39.		X				
Byrne C, Faure C, Keene DJ, Lamb SE. Ageing, muscle power and physical function: a systematic review and implications for pragmatic training interventions. *Sports Med.* 2016;46(9):1311-1332. doi:10.1007/s40279-016-0489-x.				X		
Cadore EL, Rodriguez-Manas L, Sinclair A, Izquierdo M. Effects of different exercise interventions on risk of falls, gait ability, and balance in physically frail older adults: a systematic review. *Rejuvenation Res.* 2013;16(2):105-114. doi:10.1089/rej.2012.1397.		X				
Carmeli E, Sheklow SL, Coleman R. A comparative study of organized class-based exercise programs versus individual home-based exercise programs for elderly patients following hip surgery. *Disabil Rehabil.* 2006;28(16):997-1005.			X			
Cerimele JM, Katon WJ. Associations between health risk behaviors and symptoms of schizophrenia and bipolar disorder: a systematic review. *Gen Hosp Psychiatry.* 2013;35(1):16-22. doi:10.1016/j.genhosppsych.2012.08.001.	X					
Chan D, Cheema BS. Progressive resistance training in end-stage renal disease: systematic review. *Am J Nephrol.* 2016;44(1):32-45. doi:10.1159/000446847.		X				
Chang SF, Lin PL. Frail phenotype and mortality prediction: a systematic review and meta-analysis of prospective cohort studies. *Int J Nurs Stud.* 2015;52(8):1362-1374. doi:10.1016/j.ijnurstu.2015.04.005.				X		

Citation	Outcome	Population	Study Design	Exposure	Not ideal fit for replacement of de novo search	Other
Chao YY, Scherer YK, Montgomery CA. Effects of using Nintendo WiiTM exergames in older adults: a review of the literature. *J Aging Health*. 2015;27(3):379-402. doi:10.1177/0898264314551171.		X				
Chen YW, Hunt MA, Campbell KL, Peill K, Reid WD. The effect of tai chi on four chronic conditions—cancer, osteoarthritis, heart failure and chronic obstructive pulmonary disease: a systematic review and meta-analyses. *Br J Sports Med*. 2016;50(7):397-407. doi:10.1136/bjsports-2014-094388.		X				
Chin A Paw MJ, van Uffelen JG, Riphagen I, van Mechelen W. The functional effects of physical exercise training in frail older people: a systematic review. *Sports Med.* 2008;38(9):781-793.		X				
Chodzko-Zajko WJ, Proctor DN, Fiatarone Singh MA, et al.; American College of Sports Medicine. American College of Sports Medicine position stand. Exercise and physical activity for older adults. *Med Sci Sports Exerc.* 2009;41(7):1510-1530. doi:10.1249/MSS.0b013e3181a0c95c.			X			
Chou CH, Hwang CL, Wu YT. Effect of exercise on physical function, daily living activities, and quality of life in the frail older adults: a meta-analysis. *Arch Phys Med Rehabil*. 2012;93(2):237-244. doi:10.1016/j.apmr.2011.08.042.		X				
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Tillman A, Muthalib M, Hendy A, et al. Lower limb progressive resistance training improves		X				

Citation	Outcome	Population	Study Design	Exposure	Not ideal fit for replacement of de novo search	Other
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Citation	Outcome	Population	Study Design	Exposure	Not ideal fit for replacement of de novo search	Other
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Citation	Outcome	Population	Study Design	Exposure	Not ideal fit for replacement of de novo search	Other
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Citation	Outcome	Population	Study Design	Exposure	Not ideal fit for replacement of de novo search	Other
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Yeap BB. Sex steroids and cardiovascular disease. *Asian J Androl.* 2014;16(2):239-247. doi:10.4103/1008-682X.122357.				X		
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