Optimising outcomes from exercise programs for community dwelling older adults

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Physical activity and exercise: similarities and differences

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Exercise	Planned, structured, repetitive and intentional movement intended to improve or maintain physical fitness	Resistance training, Yoga, Pilates, Tai chi, cycling, swimming, balance exercises
Therapeutic exercise	Specific forms of exercise that are prescribed to assist in the prevention and/or management of a given health condition	Any of the above examples that may target major symptoms or side-effects of the health condition and/or treatment

Therapeutic exercise: what may be the most important outcomes for most older adults?

- Primary
  - Functional performance of common activities of daily living
  - Cognition
- Secondary
  - Muscular strength/power
  - Balance
  - Body composition including muscle, fat and bone mass
  - Cardiovascular/respiratory function

Improvements in these factors may not only improve their health condition(s) but also their overall health and quality of life.
See Appendix A for some evidence-based support for these recommendations.

Assessment/screening tips

- SARC-F or SARC-F plus calf girth
- Utilise the components of the European Working Group for Sarcopenia in Older People (EWGSOP2)
    - handgrip strength, gait speed or sit to stand tests
    - body composition via DEXA or BIA

- Still some controversy regarding what cut-points to use for muscle mass

Table 1
SARC-F Screen for Sarcopenia

Component	Question	Scoring
Strength	How much difficulty do you have in lifting and carrying 10 pounds?	None = 0 Some = 1 A lot or unable = 2
Assistance in walking	How much difficulty do you have walking across a room?	None = 0 Some = 1 A lot, use aids, or unable = 2
Rise from a chair	How much difficulty do you have transferring from a chair or bed?	None = 0 Some = 1 A lot or unable without help = 2
Climb stairs	How much difficulty do you have climbing a flight of 10 stairs?	None = 0 Some = 1 A lot or unable = 2
Falls	How many times have you fallen in the past year?	None = 0 1–3 falls = 1 4 or more falls = 2

ELSEVIER
JAMDA
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Editorial

SARC-F: A Simple Questionnaire to Rapidly Diagnose Sarcopenia

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VIEWPOINT

Clinical importance of assessing walking speed in older adults in general practice

Samantha Fien, Timothy Henwood, Mike Climstein, Justin William Leslie Keogh

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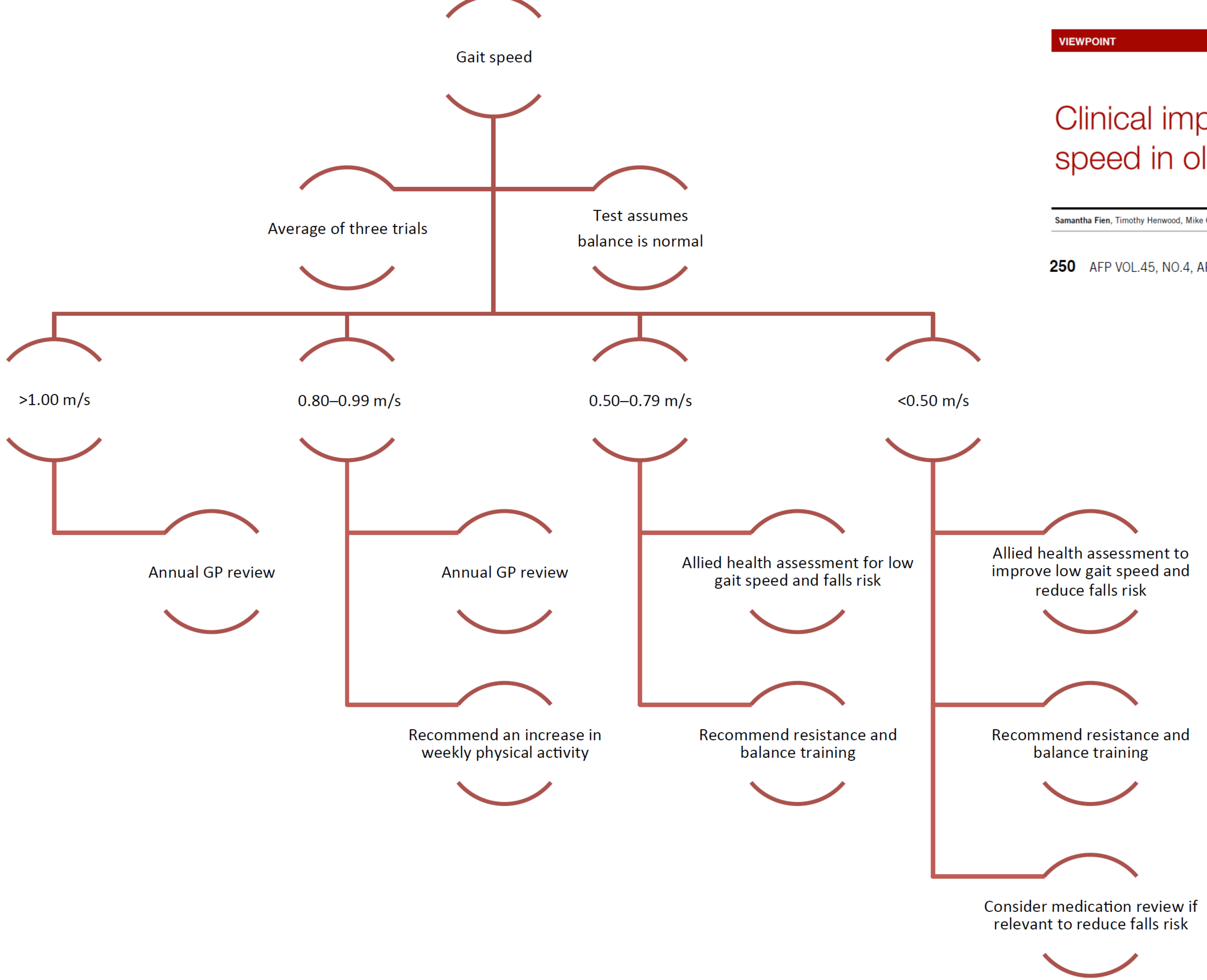

Figure 1. Walking speed flowchart

Muscling Up Against Disability (MUAD) study

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Examining evidence based resistance plus balance training in community-dwelling older adults with complex health care needs: Trial protocol for the Muscling Up Against Disability project

Justin W.L. Keogh[a,b,c,*], Tim Henwood[a,d,e], Paul Gardiner[f,g], Anthony Tuckett[h,i,j], Brent Hodgkinson[k], Kevin Rouse[k]

expression of interest. SVHA is a large Australian non-profit aged care provider that provide services to older adults living in community and in residential aged care. For SVHA, individuals were approached directly by their organisational personal carer, who informed them about the project and opportunity, and requested an expression of interest to participate. Following the expression of interest, the RM contacted the individual by telephone to determine eligibility. The questions asked by the RM in the telephone discussion allowed the RM to provide conditional entry into the program and to give a broader overview of the project, set an assessment date for entry into the project and organise transport for those who would require it. Following the telephone conversation with the RM, potential participants were screened at one of the Burnie Brae centres by an AEP. The AEP focused on criteria such as advanced falls risk, with this defined as an inability to self-mobilise in a safe and steady manner. This assessment was made by an observation of the potential participants' gait and general mobility and a series of related questions if required. To facilitate adherence and overcome a barrier to participation, all participants are offered free minibus return transport for all assessment and training sessions using the Burnie Brae transport service. This is organised and scheduled by the RM, and the schedule determined through discussion with the participant.

Prior to the baseline assessment and entering the study, participants supplied informed consent. General practitioner (GP) consent was also obtained prior to participation. This involved gaining verbal consent from the participant to contact their GP during the initial telephone interview, and then the RM directly mailing the GP with details of the study, the name of the participant and a request for the GP to respond to the RM if they felt any concerns about the participant entering the exercise program. Ethics approval was obtained from the University of Queensland Human Research Ethic Committee (Approval number #2015000879) and Gatekeepers approval through the SVHA Human Research Ethic Committee (Approval reference HREC 15/21). Following the finalisation of the study design and ethics approval, the study was registered with the Australian New Zealand Clinical Trials Registry (ACTRN12615001153505).

2.1.4. Intervention

Exercise consisted of twice weekly machine-based resistance and free standing balance training for 24 weeks under the close supervision of Accredited Exercise Physiologists (AEP) experienced in exercise delivery to older adults with complex health care needs. Exercise session are proceeded by a low intensity five-minute warm-up using ergonomic walking, sit to stands, arm or leg cycling, or machine rowing, and followed by a five-minute warm-down that includes targeted stretching. Within each session participants performed several resistance exercises using air-pressure driven machines proven effective in older disabled adults (HUR Australia Pty Ltd, Birkdale, QLD, Australia) and balance exercises targeting static and dynamic balance, and agility (Henwood et al., 2008; Sherrington et al., 2008). Resistance exercises are:

- Upper-body—Chest press and Back row;
- Lower-body—Leg press; Leg curl/extension and Abduction/adduction; and
- Core—Abdominal/back extension.

All exercises are performed for 3 sets of 8–12 repetitions. Balance exercises are:

- Static standing on one leg (left and right)—2 sets of aiming for 20 s on each leg;
- Tight rope walking—2 sets of 10 steps forward and 10 steps back, and
- Box stepping—5 times clockwise and 5 times anticlockwise.
- Calf raises—2 sets of 10.

For individuals experiencing pain or discomfort when performing a particular exercise, the exercise in question was modified where possible. If a modification did not alleviate the pain or discomfort the exercise was removed completely and not replaced by an alternative. All exercises and the machine on which PRBT occurred have been demonstrated to be safe and effective in this and older more disabled populations previously (Henwood et al., 2008; Hewitt, Refshauge, Goodall, Henwood, & Clemson, 2014).

To ensure technique development and reduce training related delayed on-set of muscle soreness, participants undertake a four-week conditioning phase prior to training at a higher-intensity. Specifically, for the first two weeks' participants complete 2 sets of 8 repetitions for each exercise at 50% of their predicted maximum capacity. For the third and fourth week of training the intensity is increased to 65% with an increase to 3 sets of 8 repetitions.

From the fifth week, the intensity is increased to 75% of the participants predicted maximum capacity. The predicted maximum was a conservatively assumed resistance based on the participant's ability to complete repetitions. At the highest intensity, an accurate resistance was reflected by the participant's capacity to complete eight repetitions before fatigue. This system has been employed safely and effectively in similar populations previously (Henwood et al., 2008; Hewitt et al., 2014). The resistance for each exercise is increased when participants can do 12 repetitions for 3 sets using the correct technique (Henwood et al., 2008).

During the first phase, sessions were delivered in groups of five participants under the supervision of one AEP. As the AEP staff gained more experience in the project and with the delivery, during the subsequent phases, some sessions had increased participant's numbers to accommodate up to eight higher functioning individuals.

Post-PRBT, participants are followed for 24 weeks to assess the residual impact of training on physical, functional and cognitive health. During this period, participants are not restricted in their activities, and are free to become involved in continued gym training or any other exercise or physical activities. However, they are not allowed to continue in the project's gym program, and are not financially supported for alternative exercise programs.

For participants in the EX group, make up sessions are provided within the same week of the missed scheduled session where possible. Participants who discontinue their involvement in the EX group are promptly followed up by telephone and asked about the reasons for dropping out. Participants needed to attend > 50% of all sessions to be included in the final analysis as a member of the EX group.

2.1.5. Control

Participants entering the CON group were asked to continue with their usual activities for a 24-week period. Within this time period there was no restriction on receiving allied health services, attending activity groups or any other physical activities they were not presently receiving or involved in at the baseline randomisation. However, participants were asked not to commit to or become involved in any new ongoing (defined as > 1 session per week) activity groups that they were not referred to by their GP or specialist. Following the completion of the 24-week control phase, all CON participants' direct entry into the PRBT intervention was the same as described above.

To incentivise continued participation among the CON group, individuals were offered monthly education sessions at Burnie

MUAD Publications

Hetherington, S., Henwood, T., Keogh, J., Gardiner, P., Tuckett, A., & Rouse, K. (2017). Muscling Up Against Disability: Project report. Retrieved from https://nla.gov.au/nla.obj-571185542/view

Hetherington, S., Henwood, T., Swinton, P., Keogh, J., Gardiner, P., Tuckett, A., & Rouse, K. (2018). Engineering improved balance confidence in older adults with complex health care needs: Learning from the Muscling Up Against Disability Study. *Archives of Physical Medicine and Rehabilitation, 99*(8), 1525-1532.

Hetherington, S., Swinton, P., Henwood, T., Keogh, J., Gardiner, P., Tuckett, A., . . . Comans, T. (in press). Progressive resistance plus balance training for older Australians receiving in-home care services: Cost-effectiveness analyses alongside the Muscling Up Against Disability stepped-wedge randomized control trial. *Journal of Physical Activity and Aging*. doi:10.1123/japa.2019-0085

Keogh., J. W. L., Henwood, T., Gardiner, P., Tuckett, A., Hodgkinson, B., & Rouse, K. (2017). Examining evidence based resistance plus balance training in community-dwelling older adults with complex health care needs: trial protocol for the Muscling Up Against Disability project. *Archives of Gerontology and Geriatrics, 68*(1), 97–105.

Keogh, J. W. L., Henwood, T., Gardiner, P. A., Tuckett, A. G., Hetherington, S., Rouse, K., & Swinton, P. (2019). Sarc-F and muscle function in community dwelling adults with aged care service needs: baseline and post-training relationship. *PeerJ, 7*, e8140 doi:10.7717/peerj.8140

Journal of Aging and Physical Activity, (Ahead of Print)
https://doi.org/10.1123/japa.2019-0085

Human Kinetics
ORIGINAL RESEARCH

Progressive Resistance Plus Balance Training for Older Australians Receiving In-Home Care Services: Cost-Effectiveness Analyses Alongside the Muscling Up Against Disability Stepped-Wedge Randomized Control Trial

Sharon Hetherington, Paul Swinton, Tim Henwood, Justin Keogh, Paul Gardiner, Anthony Tuckett, Kevin Rouse, and Tracy Comans

In this article, the authors assessed the cost-effectiveness of center-based exercise training for older Australians. The participants were recipients of in-home care services, and they completed 24 weeks of progressive resistance plus balance training. Transport was offered to all participants. A stepped-wedge randomized control trial produced pre-, post-, and follow-up outcomes and cost data, which were used to calculate incremental cost-effectiveness ratios per quality-adjusted life year gained. Analyses were conducted from a health provider perspective and from a government perspective. From a health-service provider perspective, the direct cost of program provision was $303 per person, with transport adding an additional $1,920 per person. The incremental cost–utility ratio of the program relative to usual care was $70,540 per quality-adjusted life year over 6 months, decreasing to $37,816 per quality-adjusted life year over 12 months. The findings suggest that Muscling Up Against Disability offers good value for the money within commonly accepted threshold values.

Table 3 Results of the Cost-Effectiveness Scenarios

Analysis	No.	Intervention	Control	Cost (95% CI)	Effect (95% CI)	ICER (95% CI)	Probability cost effective[a]
Scenario 1: service provider perspective within trial (6 months)							
Cost–utility analysis							
Intention to treat	1A	245	159	$1,082 (1,040 to 1,125)	0.015 (0.012 to 0.019)	$70,540 (57,861 to 89,410)	.38
Per protocol	1B	167	128	$1,141 (1,061 to 1,220)	0.017 (0.013 to 0.021)	$68,714 (57,509 to 84,766)	.40
Cost-effectiveness analysis							
Intention to treat	1C	245	159	$1,082 (1,040 to 1,125)	1.16 (0.97 to 1.35)	$934 (795 to 1,121)	N/A
Per protocol	1D	167	128	$1,141 (1,061 to 1,220)	1.19 (1.02 to 1.37)	$976 (843 to 1,148)	N/A
Scenario 2: service provider perspective within trial with follow-up (12 months)							
Cost–utility analysis							
Intention to treat	2A	245	159	$2,166 (2,079 to 2,253)	0.057 (0.048 to 0.066)	$37,816 (32,415 to 45,307)	.95
Per protocol	2B	129	128	$2,247 (2,131 to 2,360)	0.066 (0.057 to 0.075)	$34,015 (29,589 to 39,558)	.99
Cost-effectiveness analysis							
Intention to treat	2C	245	159	$2,166 (2,079 to 2,253)	1.38 (1.18 to 1.56)	$1,574 (1,375 to 1,841)	N/A
Per protocol	2D	129	128	$2,247 (2,131 to 2,360)	1.35 (1.17 to 1.52)	$1,668 (1,459 to 1,920)	N/A
Scenario 3: government health sector perspective with health care costs (6 months)							
Cost–utility analysis							
Per protocol	3A	124	74	$859 (−419 to 1,307)	0.018 (0.015 to 0.022)	$47,747 (22,645 to 77,236)	.65
Cost-effectiveness analysis							
Per protocol	3B	124	74	$859 (−419 to 1,307)	1.12 (0.92 to 1.32)	$771 (371 to 1,224)	N/A

Note. *Cost–utility analysis outcome* was the quality-adjusted life years. *Cost-effectiveness analysis outcome* was the change in short physical performance battery score. CI = confidence interval; ICER = incremental cost-effectiveness ratio; N/A = not applicable.

[a]Probability based on a willingness to pay estimate for Australia of $64,000.

Table 4 Sensitivity Analysis

No.	Intention-to-treat analysis	Intervention	Control	Cost	Effect (95% CI)	ICER	Probability cost effective[a]
1AS1	No travel	245	159	$303[a]	0.015 (0.012–0.019)	$19,780 (16,281–24,749)	.99
1AS2	100% travel	245	159	$1,823[a]	0.015 (0.012–0.019)	$119,043 (97,988–148,949)	.01

Note. ICER = incremental cost-effectiveness ratio.

[a]Does not include cost of healthy living seminars (usual care control intervention).

[a]Probability based on a willingness to pay estimate for Australia of $64,000.

Calcified Tissue International
https://doi.org/10.1007/s00223-018-0478-1

ORIGINAL RESEARCH

Health Care Costs Associated With Muscle Weakness: A UK Population-Based Estimate

Rafael Pinedo-Villanueva[1] · Leo D. Westbury[2] · Holly E. Syddall[2] · Maria T. Sanchez-Santos[1] · Elaine M. Dennison[2,3] · Sian M. Robinson[2,4] · Cyrus Cooper[2,4,5]

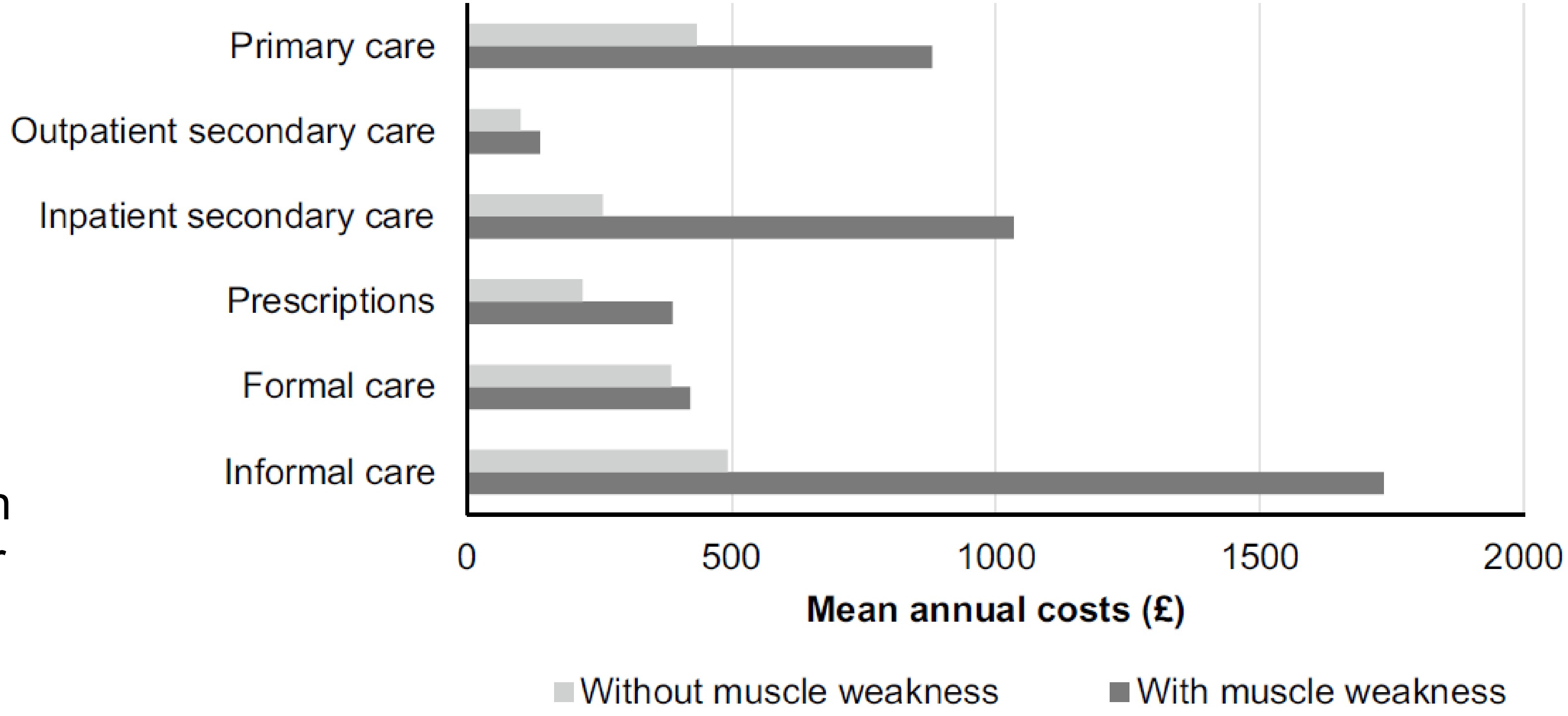

Fig. 1 Annual costs per person for different uses of health and social care according to muscle strength. Muscle weakness was defined using low grip strength (< 26 kg for men, < 16 kg for women)

Total access costs associated with muscle weakness were **£2,707** per person per year

Learnings: Exercise prescription (1)

- Progressive resistance and balance training (PRBT) are the two key forms of therapeutic exercise for most older adults

- A variety of common exercise prescriptions can be useful, but progression is required, focusing on:
  - ↑ magnitude of load lifted for resistance training
  - ↑ progression from static to dynamic, larger to smaller base of support, lower to higher centre of gravity and pro-/re-active balance exercises (functional/step training)

See Appendix B for additional meta analyses and Position Statements that provide further recommendations for Exercise prescription slides 1 and 2

Sports Med (2015) 45:1693–1720
DOI 10.1007/s40279-015-0385-9

CrossMark

SYSTEMATIC REVIEW

Dose–Response Relationships of Resistance Training in Healthy Old Adults: A Systematic Review and Meta-Analysis

Ron Borde[1] · Tibor Hortobágyi[2,3] · Urs Granacher[1]

- Largest ↑strength with:
  - 2 resistance training sessions per week;
  - 2-3 sets per exercise;
  - 7-9 repetitions per set using 70-79% 1RM loads;
  - 6 s repetitions
  - 60 s rest between sets (p = 0.06)

- Largest ↑muscle mass with:
  - **3 resistance training sessions per week**;
  - 2-3 sets per exercise;
  - 7-9 repetitions per set using **51-69% 1RM loads**;
  - 6 s repetitions
  - **120 s rest between sets** (p = 0.06)

Learnings: Exercise prescription (2)

- Supervision by exercise experts e.g. accredited exercise physiologist or physiotherapist is vital, at least over the first few months
- MUAD project may have benefited from the inclusion of more dynamic and pro-/re-active balance exercises (i.e. functional/stepping exercises)
- Functional/stepping exercises can be progressed via additional loads, dual-tasks etc as confidence and technique improve
- Increasing the cognitive challenge of components of the exercise programme may have further benefits to improving cognition, ADL and falls

Keys to success: Include some functional and cognitively challenging exercises

- Prescribe exercises including variations of lunges, stepups and loaded carries
- Utilise alternative forms and directions of resistance for standing/bent over upper body movements such as presses, rows and twists (HUR Pulley)
- Balance training is not just trying to stand still or using unstable surfaces
- Incorporate dual-tasks, unpredictability and other task-representative perturbations and constraints (perhaps in warmups)

Keys to success: cost effectiveness

- Community-based PRBT programs can be highly cost-effective, particularly if the clients adhere to the program and are able to organise their own transport to the exercise clinic

- Have exercise clinics located near bus/train routes or within easy walking distance of other services accessed weekly
  - e.g. supermarkets and retirement village community hall

Keys to success: Maximising retention and adherence

- Create a strong social and supportive environment for your older clients
- Listen to your clients, particularly the issues they routinely face and their fears/barriers regarding exercise
- Ensure your program focuses on improving their ability to perform the activities that provide most meaning in the life and not only their health condition(s)
- Provide them with regular feedback on their progress and gain their feedback on their self-reported changes
- Explain, where possible the importance of different exercises to their unique requirements

See Appendix C for additional detail on some data relating to long-term feasibility of a community-based exercise program focusing on progressive resistance and balance training

Questions?

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Appendix A: Importance of strength, balance and physical performance

REVIEW

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Muscle mass, strength, and physical performance predicting activities of daily living: a meta-analysis

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Abstract

Background

Activities of daily living (ADLs) and instrumental activities of daily living (IADLs) are essential for independent living and are predictors of morbidity and mortality in older populations. Older adults who are dependent in ADLs and IADLs are also more likely to have poor muscle measures defined as low muscle mass, muscle strength, and physical performance, which further limit their ability to perform activities. The aim of this systematic review and meta-analysis was to determine if muscle measures are predictive of ADL and IADL in older populations.

Methods

A systematic search was conducted using four databases (MEDLINE, EMBASE, Cochrane, and CINAHL) from date of inception to 7 June 2018. Longitudinal cohorts were included that reported baseline muscle measures defined by muscle mass, muscle strength, and physical performance in conjunction with prospective ADL or IADL in participants aged 65 years and older at follow-up. Meta-analyses were conducted using a random effect model.

Results

Of the 7760 articles screened, 83 articles were included for the systematic review and involved a total of 108 428 (54.8% female) participants with a follow-up duration ranging from 11 days to 25 years. Low muscle mass was positively associated with ADL dependency in 5/9 articles and 5/5 for IADL dependency. Low muscle strength was associated with ADL dependency in 22/34 articles and IADL dependency in 8/9 articles. Low physical performance was associated with ADL dependency in 37/49 articles and with IADL dependency in 9/11 articles. Forty-five articles were pooled into the meta-analyses, 36 reported ADL, 11 reported IADL, and 2 reported ADL and IADL as a composite outcome. Low muscle mass was associated with worsening ADL (pooled odds ratio (95% confidence interval) 3.19 (1.29–7.92)) and worsening IADL (1.28 (1.02–1.61)). Low handgrip strength was associated with both worsening ADL and IADL (1.51 (1.34–1.70); 1.59 (1.04–2.31) respectively). Low scores on the short physical performance battery and gait speed were associated with worsening ADL (3.49 (2.47–4.92); 2.33 (1.58–3.44) respectively) and IADL (3.09 (1.06–8.98); 1.93 (1.69–2.21) respectively). Low one leg balance (2.74 (1.31–5.72)), timed up and go (3.41 (1.86–6.28)), and chair stand test time (1.90 (1.63–2.21)) were associated with worsening ADL.

Conclusions

Muscle measures at baseline are predictors of future ADL and IADL dependence in the older adult population.

Keywords Muscle mass; Muscle strength; Handgrip strength; Physical performance; Activities of daily living; Aged

Identification of Sarcopenia Components That Discriminate Slow Walking Speed: A Pooled Data Analysis

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JAGS 68:1419-1428, 2020

Outcome	Practical application
Men with Grip strength / BMI of 1.05 kg/kg/m^2 or less were ~4 times more likely to be slow walkers (0.8 m/s) than stronger men	An older man with a relatively normal BMI of 25 and a grip strength < 26.3 kg is 4 times more likely to walk < 0.8 m/s
Women with Grip strength / BMI of 0.65 kg/kg/m^2 or less were ~2 times more likely to be slow walkers (0.8 m/s) than stronger women	An older woman with a relatively normal BMI of 25 and a grip strength < 16.3 kg is 2 times more likely to walk < 0.8 m/s

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JAMDA

journal homepage: www.jamda.com

Original Study

SARC-F for Screening of Sarcopenia Among Older Adults: A Meta-analysis of Screening Test Accuracy

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Keywords:
Sarcopenia
elderly
accuracy
meta-analysis

A B S T R A C T

Objective: To examine the screening ability of SARC-F for older adults using a meta-analysis.
Design: Meta-analysis.
Setting and Participants: The literature review was conducted using MEDLINE, Cochrane Database of Systematic Reviews, and ClinicalTrials.gov. Articles written on and after 1960 that included data regarding the sensitivity and specificity of SARC-F's diagnostic criteria for sarcopenia in older adults were searched.
Measures: The bivariate random effects model was used to calculate the summary estimates of sensitivity, specificity, positive likelihood ratio (PLR), negative likelihood ratio (NLR), and diagnostic odds ratio (DOR). The summary receiver operating characteristic curve was used to summarize the overall test performance.
Results: Seven studies involving a total of 12,800 subjects met the eligibility criteria of our study. The pooled results of sensitivity, specificity, PLR, NLR, and DOR with the European Working Group on Sarcopenia in Older People as the reference standard were 0.21 [95% confidence interval (CI), 0.13-0.31], 0.90 (95% CI, 0.83-0.94), 2.16 (95% CI, 1.51-3.09), 0.87 (95% CI, 0.80-0.95), and 2.47 (95% CI, 1.64-3.74), respectively. Overall, we achieved similar pooled results of sensitivity and specificity for studies using the International Working Group on Sarcopenia and Asian Working Group for Sarcopenia as the reference standards. Because few studies used the Foundation National Institute of Health reference standards, a meta-analysis was not performed.
Conclusions/Implications: Although the screening sensitivity performance of SARC-F was poor, its specificity was high; thus, it is an effective tool for selecting subjects who should undergo further testing for confirming a diagnosis of sarcopenia.

Appendix B: Optimal exercise prescriptions

Resistance Training for Older Adults: Position Statement From the National Strength and Conditioning Association

Maren S. Fragala,[1] Eduardo L. Cadore,[2] Sandor Dorgo,[3] Mikel Izquierdo,[4] William J. Kraemer,[5] Mark D. Peterson,[6] and Eric D. Ryan[7]

[1]Quest Diagnostics, Secaucus, New Jersey; [2]School of Physical Education, Physiotherapy and Dance, Exercise Research Laboratory, Federal University of Rio Grande do Sul, Porto Alegre, Brazil; [3]Department of Kinesiology, University of Texas at El Paso, El Paso, Texas; [4]Department of Health Sciences, Public University of Navarre, CIBER of Frailty and Healthy Aging (CIBERFES), Navarrabiomed, Pamplona, Navarre, Spain; [5]Department of Human Sciences, The Ohio State University, Columbus, Ohio; [6]Department of Physical Medicine and Rehabilitation, University of Michigan-Medicine, Ann Arbor, Michigan; and [7]Department of Exercise and Sport Science, University of North Carolina-Chapel Hill, Chapel Hill, North Carolina

Abstract

Fragala, MS, Cadore, EL, Dorgo, S, Izquierdo, M, Kraemer, WJ, Peterson, MD, and Ryan, ED. Resistance training for older adults: position statement from the national strength and conditioning association. *J Strength Cond Res* 33(8): 2019–2052, 2019—Aging, even in the absence of chronic disease, is associated with a variety of biological changes that can contribute to decreases in skeletal muscle mass, strength, and function. Such losses decrease physiologic resilience and increase vulnerability to catastrophic events. As such, strategies for both prevention and treatment are necessary for the health and well-being of older adults. The purpose of this Position Statement is to provide an overview of the current and relevant literature and provide evidence-based recommendations for resistance training for older adults. As presented in this Position Statement, current research has demonstrated that countering muscle disuse through resistance training is a powerful intervention to combat the loss of muscle strength and muscle mass, physiological vulnerability, and their debilitating consequences on physical functioning, mobility, independence, chronic disease management, psychological well-being, quality of life, and healthy life expectancy. This Position Statement provides evidence to support recommendations for successful resistance training in older adults related to 4 parts: (a) program design variables, (b) physiological adaptations, (c) functional benefits, and (d) considerations for frailty, sarcopenia, and other chronic conditions. The goal of this Position Statement is to a) help foster a more unified and holistic approach to resistance training for older adults, b) promote the health and functional benefits of resistance training for older adults, and c) prevent or minimize fears and other barriers to implementation of resistance training programs for older adults.

Key Words: strength training, elderly, frail, seniors, exercise, resistance exercise

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Table 1

Resistance training general recommendations for healthy older adults.†

Program variable	Recommendation†	Details
Sets	1–3 sets per exercise per muscle group	1 set for beginners and older adults with frailty progressing to multiple sets (2–3) per exercise.
Repetitions	8–12 or 10–15	Perform 6–12 reps with variation for muscular strength for healthy older adults. Perform 10–15 repetitions at a lower relative resistance for beginners.
Intensity	70–85% of 1RM	Begin at a resistance that is tolerated and progress to 70–85% of 1RM using periodization. Lighter loads are recommended for beginners, or individuals with frailty, or special considerations such as cardiovascular disease and osteoporosis. Exercises should be performed in a repetition-range intensity zone that avoids going to failure to reduce joint stress.
Exercise selection	8–10 different exercises	Include major muscle groups targeted through multijoint movements (e.g., chest press, shoulder press, triceps extension, biceps curl, pull-down, row, lower-back extension, abdominal crunch/curl-up, quadriceps extension or leg press, leg curls, and calf raise).
Modality	Free-weight or machine-based exercises	Beginners, frail older adults, or those with functional limitations benefit from machine-based resistance training (selectorized weight or pneumatic resistance equipment), training with resistance bands, and isometric training. High functioning older adults gain added benefit from free-weight resistance training (e.g., barbells, dumbbells, kettlebells, and medicine balls).
Frequency	2–3 days per week, per muscle group	Perform on 2–3 nonconsecutive days per week, per muscle group, may allow favorable adaptation, improvement, or maintenance.
Power/explosive training	40–60% of 1RM	Include power/explosive exercises where high-velocity movements are performed during the concentric phase at moderate intensities (i.e., 40–60% of 1RM) to promote muscular power, strength, size, and functional tasks.
Functional movements	Exercises to mimic tasks of daily living	Healthy, high functioning older adults benefit from the inclusion of multijoint, complex, and dynamic movements, with base of support or body position variations.

*RM = repetition maximum.

†General guidelines are provided. Resistance training programs should include variation in intensity and program variables. Strength exercises should be performed before endurance training during concurrent training sessions to optimize strength gains.

Table 3

Summary of exercise modifications.*

Condition	Modification
Frailty	Start at a lower resistance, progress more slowly, limit end point to volitional fatigue (start at 8–12 reps at 20–30% of 1RM and progress to 80% of 1RM).
Mobility limitations	Consider exercises in seated position.
Mild cognitive impairment	Select simple exercises. May require extrainstruction and demonstration.
Diabetes	Monitor blood glucose before and after training. Consider special considerations of associated cardiovascular disease, nerve disease, kidney disease, eye disease, and orthopedic limitations.
Osteoporosis	Begin at a lower intensity. Train balance, but exert extra care to prevent falls. Focus on form and technique and use caution with bending and twisting. Include postural exercises (spinal extension).
Joint pain or limited range of motion (arthritis)	Double-pinned machines may restrict ROM for joint pain, discomfort, and/or limited ROM. To allow for training through the pain-free part of the ROM and attain a training effect.
Poor vision, equilibrium and balance (falling), low-back pain, and dropping weights	Consider weight machines (as opposed to free weights).

*RM = repetition maximum.

Table 2

Resistance training guidelines for older adults with frailty.†

Variable	Recommendation
Resistance training	Perform 2–3 times per week, with 3 sets of 8–12 repetitions at an intensity that starts at 20–30% of 1RM and progresses to 80% of 1RM.
Power	Include power exercises performed at high speed of motion and low to moderate intensity (i.e., 30–60% of 1RM) to induce marked improvements in the functional task performance.
Functional training	Include exercises in which daily activities are simulated, such as the sit-to-stand exercise, to optimize the functional capacity.
Endurance training	Complements resistance training adaptations. Begin once strength and balance are improved. May include walking with changes in pace, incline and direction, treadmill walking, step-ups, stair climbing, and stationary cycling. Start at 5–10 min and progress to 15–30 min. The Rate of Perceived Exertion scale is an alternative method for prescribing exercise intensity, and an intensity of 12–14 on the Borg scale seems to be well tolerated.
Balance training	Include several exercise stimuli, such as line walking, tandem foot standing, standing on one leg, heel-toe walking, stepping practice, and weight transfers from one leg to the other.
Progression	Include gradual increases in the volume, intensity, and complexity of the exercises.

*RM = repetition maximum.

†Exercises should be performed with proper form and technique. Form and technique should be established before exercise progression and maintained during progression.

Review

Exercise for preventing falls in older people living in the community: an abridged Cochrane systematic review

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Sherrington C, *et al*. *Br J Sports Med* 2020;**54**:885–891. doi:10.1136/bjsports-2019-101512

Table 1 Summary of findings. Rate of falls outcome (falls per person-years) for types of exercise

Type of exercise	Follow-up range	Illustrative comparative risks* (95% CI): Assumed risk	Illustrative comparative risks* (95% CI): Corresponding risk	Relative effect (95% CI)	No. of participants (studies)	Certainty of the evidence (GRADE)	Comments
Exercise† (all types) versus control‡ (eg, usual activities)	3 to 30 months	Control All studies population 850 per 1000§ Not selected for high risk population 605 per 1000§ Selected for high risk population 1200 per 1000§	Exercise (all types) 655 per 1000 (604 to 706) 466 per 1000 (430 to 503) 924 per 1000 (852 to 996)	Rate ratio 0.77 (0.71 to 0.83)¶	12 981 (59 RCTs)	High**	Overall, there is a reduction of 23% (95% CI 17% to 29%) in the number of falls. Guide to the data: If 1000 people were followed over 1 year, the number of falls in the overall population would be 655 (95% CI 604 to 706) compared with 850 in the group receiving usual care or attention control. In the unselected population, the corresponding data are 466 (95%CI 430 to 503) compared with 605 in the group receiving usual care or attention control. In the selected higher-risk population, the corresponding data are 924 (95%CI 852 to 996) compared with 1200 in the control group
Balance, and functional exercises†† versus control‡ (eg, usual activities)	3 to 30 months	Control All studies population 850 per 1000‡‡ Specific exercise population 930 per 1000††	Exercise (gait, balance, and functional (task) training) 646 per 1000 (595 to 689) 707 per 1000 (651 to 754)	Rate ratio 0.76 (0.70 to 0.81)	7920 (39 RCTs)	High	Overall, there is a reduction of 24% (95% CI 19% to 30%) in the number of falls. Guide to the data based on the all-studies estimate:If 1000 people were followed over 1 year, the number of falls would be 646 (95% CI 595 to 689) compared with 850 in the group receiving usual care or attention control
Resistance exercises§§ versus control‡ (eg, usual activities)	4 to 12 months	Control All studies population 850 per 1000¶¶ Specific exercise population 630 per 1000¶¶	Exercise (resistance training) 969 per 1000 (570 to 1675) 719 per 1000 (423 to 1242)	Rate ratio 1.14 (0.67 to 1.97)	327 (5 RCTs)	Very low	The evidence is of very low certainty, hence we are uncertain of the findings of an increase of 14% (95% CI 33% reduction to 97% increase) in the number of falls. Guide to the data based on the all-studies estimate: If 1000 people were followed over 1 year, the number of falls would be 969 (95% CI 570 to 1675) compared with 850 in the group receiving usual care or attention control
3D (Tai Chi) exercise*** versus control‡ (eg, usual activities)	6 to 17 months	Control All studies population 850 per 1000††† Specific exercise population 1020 per 1000†††	Exercise (3D (Tai Chi)) 689 per 1000 (570 to 842) 827 per 1000 (684 to 1010)	Rate ratio 0.81 (0.67 to 0.99)	2655 (7 RCTs)	Low	Overall, there may be a reduction of 19% (95% CI 1% to 33%) in the number of falls. Guide to the data based on the all-studies estimate:If 1000 people were followed over 1 year, the number of falls may be 689 (95% CI 570 to 842) compared with 850 in the group receiving usual care or attention control
3D (dance) exercise‡‡‡ versus control‡ (eg, usual activities)	12 months	Control All studies population 850 per 1000§§§ Specific exercise population 800 per 1000§§§	Exercise (3D (dance)) 1139 per 1000 (833 to 1556) 1072 per 1000 (784 to 1464)	Rate ratio 1.34 (0.98 to 1.83)	522 (1 RCT)	Very low	The evidence is of very low certainty, hence we are uncertain of the findings of an increase of 34% (95% CI 2% reduction to 83% increase) in the number of falls. Guide to the data based on the all-studies estimate: If 1000 people were followed over 1 year, the number of falls may be 1139 (95% CI 833 to 1556) compared with 850 in the group receiving usual care or attention control
General physical activity (including walking) training¶¶¶ versus control‡ (eg, usual activities)	12 to 24 months	Control All studies population 850 per 1000**** Specific exercise population 670 per 1000****	Exercise (general physical activity (including walking)) 969 per 1000 (561 to 1675) 764 per 1000 (443 to 1320)	Rate ratio 1.14 (0.66 to 1.97)	441 (2 RCTs)	Very low	The evidence is of very low certainty, hence we are uncertain of the findings of an increase of 14% (95% CI 34% reduction to 97% increase) in the number of falls. Guide to the data based on the all-studies estimate: If 1000 people were followed over 1 year, the number of falls may be 969 (95% CI 561 to 1675) compared with 850 in the group receiving usual care or attention control
Multiple categories of exercise (often including, as primary interventions: gait, balance, and functional (task) training plus resistance training†††† versus control‡ (eg, usual activities)	2 to 25 months	Control All studies population 850 per 1000‡‡‡‡ Specific exercise population 1180 per 1000‡‡‡‡	Exercise (multiple types (including, as primary interventions: gait, balance, and functional (task) training plus resistance training)) 561 per 1000 (425 to 748) 779 per 1000 (590 to 1039)	Rate ratio 0.66 (0.50 to 0.88)§§§§	1374 (11 RCTs)	Moderate	Overall, there is probably a reduction of 34% (95% CI 12% to 50%) in the number of falls. Guide to the data based on the all-studies estimate If 1000 people were followed over 1 year: the number of falls would probably be 561 (95% CI 425 to 748) compared with 850 in the group receiving usual care or attention control

Continued

ABSTRACT

Objective To examine the effects of stepping interventions on fall risk factors and fall incidence in older people.

Data source Electronic databases (PubMed, EMBASE, CINAHL, Cochrane, CENTRAL) and reference lists of included articles from inception to March 2015.

Study selection Randomised (RCT) or clinical controlled trials (CCT) of volitional and reactive stepping interventions that included older (minimum age 60) people providing data on falls or fall risk factors.

Results Meta-analyses of seven RCTs (n=660) showed that the stepping interventions significantly reduced the rate of falls (rate ratio=0.48, 95% CI 0.36 to 0.65, $p<0.0001$, $I^2=0\%$) and the proportion of fallers (risk ratio=0.51, 95% CI 0.38 to 0.68, $p<0.0001$, $I^2=0\%$). Subgroup analyses stratified by reactive and volitional stepping interventions revealed a similar efficacy for rate of falls and proportion of fallers. A meta-analysis of two RCTs (n=62) showed that stepping interventions significantly reduced laboratory-induced falls, and meta-analysis findings of up to five RCTs and CCTs (n=36–416) revealed that stepping interventions significantly improved simple and choice stepping reaction time, single leg stance, timed up and go performance ($p<0.05$), but not measures of strength.

Conclusions The findings indicate that both reactive and volitional stepping interventions reduce falls among older adults by approximately 50%. This clinically significant reduction may be due to improvements in reaction time, gait, balance and balance recovery but not in strength. Further high-quality studies aimed at maximising the effectiveness and feasibility of stepping interventions are required.

Systematic reviews registration number CRD42015017357.

Step training improves reaction time, gait and balance and reduces falls in older people: a systematic review and meta-analysis

Yoshiro Okubo,[1,2] Daniel Schoene,[3] Stephen R Lord[1,4]

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arm were included. Stepping intervention was defined as 'training of single or multiple volitional or reactive steps in an upright (standing or walking) position in response to an environmental challenge (eg, stepping onto a target, avoiding an obstacle, or responding to a perturbation)'. Regular locomotive (eg, walking), rhythmic (eg, dancing) and multimodal (eg, Tai Chi) exercises that do not exclusively train stepping in response to an environmental challenge were excluded. Controlled studies with

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Human Kinetics
SCHOLARLY REVIEW

Effect of Different Types of Physical Activity on Activities of Daily Living in Older Adults: Systematic Review and Meta-Analysis

Christine E. Roberts, Louise H. Phillips, Clare L. Cooper, Stuart Gray, and Julia L. Allan

Physical activity is associated with greater independence in old age. However, little is known about the effect of physical activity level and activity type on activities of daily living (ADL). This review systematically analyzed the effects of physical activity level and activity type on ADL in older adults (mean age, 60+). Electronic search methods (up to March 2015) identified 47 relevant, randomized controlled trials. Random effects meta-analyses revealed significant, beneficial effects of physical activity on ADL physical performance ($SMD = 0.72$, 95% CI [0.45, 1.00]; $p < .01$), with the largest effects found for moderate physical activity levels, and for activity types with high levels of mental (e.g., memory, attention), physical (e.g., coordination, balance) and social (e.g., social interaction) demands. Inconsistent effects were observed on self-reported ADL measures. Interventions that include moderate physical activity levels with high mental, physical, and social demands may produce the greatest benefits on ADL physical performance.

Keywords: physical activity, activities of daily living, older adults, systematic review

Outcome measures. Studies were required to report at least one ADL or ADL-related outcome. Accepted physical performance measures of ADL were: Timed Up and Go Test (TUG); Berg Balance Scale (BBS); 8-Foot Up and Go (8FUG); Sit Up and Go (SUG); 6-min walk test (6MW); 5-times sit to stand (5STS); Group of Development Latin-American for Maturity (GDLAM's) protocol of Functional Autonomy evaluation (FA); and the Physical Performance Test (PPT). Accepted self-reported ADL measures

Performance Test (PPT). Accepted self-reported ADL measures
were: Medical Outcomes Study (MOS) Short Form, physical functioning subscale (SF36-PF); Barthel Index (BI); Lawton and Brody Instrumental Activities of Daily Living Scale (IADL); Katz Index of Independence in Activities of Daily Living (Katz ADL); Functional Independence Measure (FIM); Groningen Activities Restriction Scale (GARS); and the Assessment of Daily Activity Performance (ADAP). This review only included pre- and posttest

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SYSTEMATIC REVIEW

Effects of Supervised vs. Unsupervised Training Programs on Balance and Muscle Strength in Older Adults: A Systematic Review and Meta-Analysis

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- Results of this meta-analysis indicated supervised PRBT training had significantly greater improvements than unsupervised training for:
  - static balance
  - dynamic balance
  - proactive balance
  - balance test batteries
  - muscle strength and power.
- These differences were typically maximised with 10–29 sessions or ≥30 supervised sessions (Proactive balance and balance test batteries)

According to Shumway-Cook and Woollacott [38], balance control is highly task specific and has to be subdivided into different categories: static/dynamic steady-state balance (i.e., maintaining a stable position in sitting, standing, and walking), proactive balance (i.e., anticipation and accomplishment of a predicted disturbance), and reactive balance (i.e., compensation for an unexpected disturbance). Therefore, our analyses focused on different balance outcome categories: (1) static steady-state balance (e.g., time during SLS), (2) dynamic steady-state balance (e.g., gait speed during 10-m gait test), (3) proactive balance (e.g., time for TUG), (4) reactive balance (e.g., center of pressure displacements after an unexpected perturbation), and (5) balance test batteries. For the assessment of

38. Shumway-Cook A, Woollacott MH. Motor control: translating research into clinical practice. 3rd ed. Philadelphia: Lippincott Williams & Wilkins; 2007.

Exercise interventions for cognitive function in adults older than 50: a systematic review with meta-analysis

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ABSTRACT

Background Physical exercise is seen as a promising intervention to prevent or delay cognitive decline in individuals aged 50 years and older, yet the evidence from reviews is not conclusive.
Objectives To determine if physical exercise is effective in improving cognitive function in this population.
Design Systematic review with multilevel meta-analysis.
Data sources Electronic databases Medline (PubMed), EMBASE (Scopus), PsychINFO and CENTRAL (Cochrane) from inception to November 2016.
Eligibility criteria Randomised controlled trials of physical exercise interventions in community-dwelling adults older than 50 years, with an outcome measure of cognitive function.
Results The search returned 12 820 records, of which 39 studies were included in the systematic review. Analysis of 333 dependent effect sizes from 36 studies showed that physical exercise improved cognitive function (0.29; 95% CI 0.17 to 0.41; p<0.01). Interventions of aerobic exercise, resistance training, multicomponent training and tai chi, all had significant point estimates. When exercise prescription was examined, a duration of 45–60 min per session and at least moderate intensity, were associated with benefits to cognition. The results of the meta-analysis were consistent and independent of the cognitive domain tested or the cognitive status of the participants.
Conclusions Physical exercise improved cognitive function in the over 50s, regardless of the cognitive status of participants. To improve cognitive function, this meta-analysis provides clinicians with evidence to recommend that patients obtain both aerobic and resistance exercise of at least moderate intensity on as many days of the week as feasible, in line with current exercise guidelines.

inactivity and the increasing proportion of older adults in the population.

Although early meta-analyses, such as a study of aerobic exercise interventions,[6] showed large benefits to cognitive function in older adults, more recent systematic reviews[7] and meta-analytical studies[8–10] are much less conclusive. For example, a recent meta-analysis of aerobic, resistance training and tai chi interventions in people older than 50 showed little benefit of exercise on cognitive function.[9] The discrepancy in findings is partly because existing reviews are excessively restrictive in their inclusion criteria, often considering only one mode of exercise (eg, recent reviews of aerobic training only[10 11]) or a narrow range of publication years. Thus, the numerous meta-analyses published provide incomplete summaries of the available evidence in people aged 50 and over. Studies which prescribe a combination of both aerobic and resistance training components in one intervention (here on called multicomponent training) have not been reviewed in healthy older adults since the 2001 study of Colcombe and Kramer[6] despite global guidelines recommending this type of training in older adults.[12 13] Alternative modes of exercise such as yoga[14] or tai chi[15] may also be beneficial to cognitive function, yet randomised controlled trials (RCTs) of these modes in older adults have not been specifically reviewed. Importantly, prior reviews offer relatively little information about the optimal prescription of physical exercise for cognitive health. Physical exercise provides a complex stimulus for adaptation in the body and its dosage can be modulated by various parameters, including duration, frequency, intensity and the mode or type of exercise. Despite this, many reviews do not take into account the importance of exercise prescrip-

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Review

Positive effects of combined cognitive and physical exercise training on cognitive function in older adults with mild cognitive impairment or dementia: A meta-analysis

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ABSTRACT

Combined cognitive and physical exercise interventions have potential to elicit cognitive benefits in older adults with mild cognitive impairment (MCI) or dementia. This meta-analysis aims to quantify the overall effect of these interventions on global cognitive functioning in older adults with MCI or dementia. Ten randomized controlled trials that applied a combined cognitive-physical intervention with cognitive function as an outcome measure were included. For each study effect sizes were computed (i.e., post-intervention standardized mean difference (SMD) scores) and pooled, using a random-effects meta-analysis. The primary analysis showed a small-to-medium positive effect of combined cognitive-physical interventions on global cognitive function in older adults with MCI or dementia (SMD[95% confidence interval] = 0.32[0.17;0.47], $p < 0.00$). A combined intervention was equally beneficial in patients with dementia (SMD = 0.36[0.12;0.60], $p < 0.00$) and MCI (SMD = 0.39[0.15;0.63], $p < 0.05$). In addition, the analysis showed a moderate-to-large positive effect after combined cognitive-physical interventions for activities of daily living (ADL) (SMD = 0.65[0.09;1.21], $p < 0.01$)and a small-to-medium positive effect for mood (SMD = 0.27[0.04;0.50], $p < 0.01$). These functional benefits emphasize the clinical relevance of combined cognitive and physical training strategies.

Appendix C: Long-term feasibility of a community-based progressive resistance training and balance program

Objective benefits, participant perceptions and retention rates of a New Zealand community-based, older-adult exercise programme

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ABSTRACT

INTRODUCTION: Most exercise studies for older adults have been university- or hospital-based. Little is known about the benefits and factors influencing long-term participation in community-based exercise programmes, especially in New Zealand.

AIM: To quantify the objective benefits, participant perceptions and retention rates of a New Zealand community-based exercise programme for adults (60 years or older).

METHODS: Study 1 involved assessing the benefits of 12 weeks' training on a convenience sample of 62 older adults commencing the never2old Active Ageing programme. Study 2 assessed the perceptions of 150 current participants on a variety of programme components that could act as barriers or facilitators to continued engagement. Study 3 assessed the retention rates of 264 participants in the programme over a two-year period.

RESULTS: Significant improvements in many physical functional scores were observed in Study 1 (5–30 percentile points; $p<0.05$). Questionnaire responses from participants in Study 2 indicated many perceived benefits (positive responses from 67–95% on various questions) and that core components of the programme were rated very highly (64–99% on various components). Retention rates were high, with Study 3 finding 57% of participants still engaging in the programme at the end of the two-year period.

DISCUSSION: A community-based exercise programme for older adults can improve many objective and subjective measures of physical fitness and functional performance and have good retention rates. General practitioners and other allied health professionals in New Zealand should consider promoting programmes, such as the never2old Active Ageing programme, to their older patients.

KEYWORDS: Exercise; muscle stretching exercises; older adults; primary health care; resistance training

Introduction

Much research has demonstrated the benefits

New Zealand-based researchers have developed and evaluated a number of effective older-adult community-based exercise programmes—for

J PRIM HEALTH CARE 2014;6(2):114–122.

Table 2. Change in functional fitness test scores and percentiles in female (n=43) and male (n=19) never2old Active Ageing programme participants

Test*	Pre-test score†	Post-test score†	p-value	Pre-test percentile	Post-test percentile	Change in percentile
Females						
Sit-to-stand (repetitions)	15.1 ± 4.2	16.3 ± 3.2‡	0.023	65	75	+10
Bicep curls (repetitions)	16.5 ± 3.5	18.0 ± 4.4§	0.012	60	75	+15
Sit-and-reach (cm)	3.4 ± 6.6	4.1 ± 8.3	0.469	40	45	+5
Back-scratch (cm)	-5.1 ± 6.9	-4.7 ± 7.1	0.503	40	45	+5
8-ft up-and-go (s)	4.79 ± 0.95	4.49 ± 0.81‡	0.035	75	80	+5
6-min walk (m)	529 ± 62	558 ± 61§	<0.001	55	65	+10
Males						
Sit-to-stand (repetitions)	14.7 ± 4.4	18.0 ± 5.2§	<0.001	50	80	+30
Bicep curl (repetitions)	17.4 ± 4.0	19.6 ± 4.1§	<0.001	50	70	+20
Sit-and-reach (cm)	-0.2 ± 10.5	3.5 ± 10.2‡	0.014	50	60	+10
Back-scratch (cm)	-11.5 ± 10.6	-10.6 ± 11.3	0.159	50	50	0
8-ft up-and-go (s)	4.80 ± 1.69	4.35 ± 1.38‡	0.025	65	75	+10
6-min walk (m)	526 ± 103	566 ± 123§	<0.001	35	50	+15

* Functional fitness assessment tests were as outlined in the Seniors Fitness Test[23,24] and used normative data derived for that test

† All data is mean ± SD

‡ $p<0.05$

§ $p<0.01$

*Table 3. Perceived benefits resulting from continual attendance of the never2old Active Ageing programme (n=150)**

Question	Strongly agree	Agree	Neutral	Disagree
My fitness and overall sense of wellbeing has improved through participation in the programme	42%	53%	5%	
My ability to perform daily functional tasks such as rising from a chair, stair climbing and walking have improved through involvement in the programme	34%	48%	17%	
The programme has definitely helped improve my balance and I feel greater movement control and less fear of falling than I did prior to exercising	27%	40%	32%	2%

* Note: All percentages may not necessarily add to 100% due to the rounding of values to the nearest whole number. No participants gave a 'Strongly disagree' response to any of these three questions

*Table 4. Participants' (n=150) ratings of various core components of the never2old Active Ageing exercise programme**

Question	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
My overall never2old exercise programme experience has been very positive	70%	29%	1%		
The four levels of programming (Bronze, Silver, Gold and Platinum) keep me motivated and moving towards improved levels of performance	25%	39%	26%	8%	2%
The staff associated with the programme are knowledgeable, helpful and motivate me to be more active	69%	30%	1%		
The instructors understand my individual health/fitness needs and assist me accordingly	41%	43%	14%	1%	
I am supported and encouraged to participate in the class regardless of my fitness level, physical disabilities and capabilities	62%	32%	5%	1%	

* Note: All percentages may not necessarily add to 100% due to the rounding of values to the nearest whole number

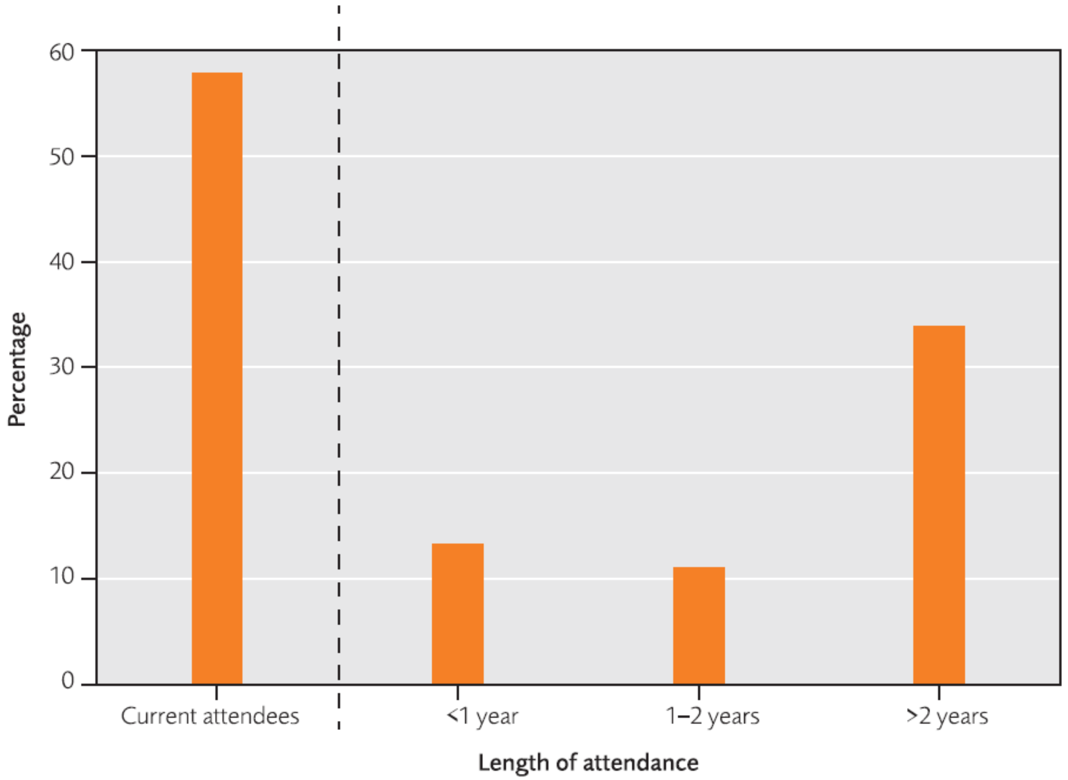
*Table 5. Participants (n=150) ratings of various additional components of the never2old Active Ageing programme**

Additional component	Excellent	Very good	Good	Poor	Very poor	Not applicable
Modified sports days	12%	17%	11%	0%	1%	59%
Outdoor (YAHOO) challenges	18%	10%	10%	0%	1%	60%
Seminars	26%	12%	8%	0%	2%	53%

YAHOO Young at Heart Outdoor Opportunities

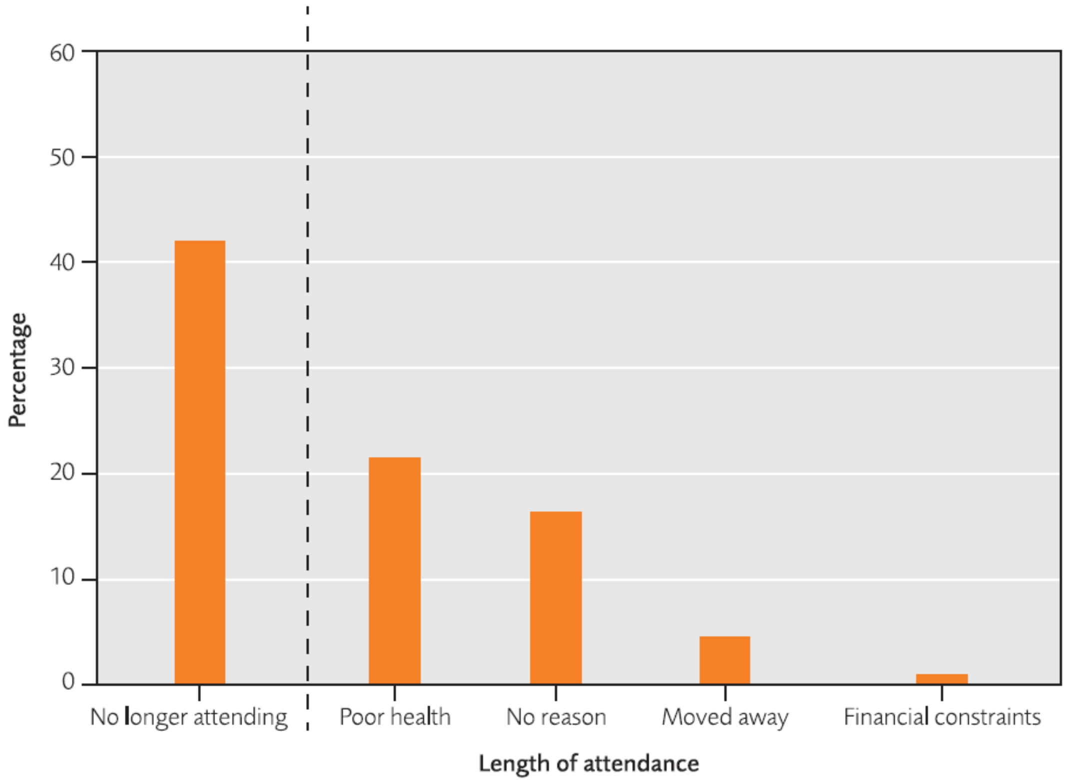
* Note: All percentages may not necessarily add to 100% due to the rounding of values to the nearest whole number

*Figure 1. Percentage of the 264 never2old Active Ageing programme participants (Study 3) who have continued to attend the programme over a two-year period (2007–2008)**



* The column to the left of the dashed line indicates the percentage of those who continue to attend, while the columns to the right of the dashed line indicate the length of their attendance

*Figure 2. Percentage of the 264 never2old Active Ageing programme participants (Study 3) who have stopped attending the programme over a two-year period (2007–2008)**



* The column to the left of the dashed line indicates the percentage of those who stopped attending, while the columns to the right of the dashed line indicate the participant's primary cited reason for discontinuing