

## **Progressive resistance training for concomitant increases in muscle strength and bone mineral density in older adults: A systematic review and meta-analysis**

Steven J. O'Bryan<sup>1</sup>, Catherine Guiliano<sup>1</sup>, Mary N. Woessner<sup>1</sup>, Sara Vogrin<sup>2</sup>, Cassandra Smith<sup>1,2</sup>, Gustavo Duque<sup>2,3</sup>, Itamar Levinger<sup>1,2,3</sup>

<sup>1</sup>Institute for Health and Sport (IHeS), Victoria University, Melbourne, Victoria, Australia

<sup>2</sup>Australian Institute for Musculoskeletal Science (AIMSS), The University of Melbourne and Western Health, Melbourne, VIC, Australia

<sup>3</sup>Department of Medicine-Western Health, Melbourne Medical School, The University of Melbourne, Melbourne, VIC, Australia

Journal: Sports Medicine

### **Corresponding author:**

Steven Jeffery O'Bryan

Institute for Health and Sport

Victoria University – Footscray Park Campus

Melbourne, Victoria 3134

Australia

Email: [steven.obryan@vu.edu.au](mailto:steven.obryan@vu.edu.au)

**Supplement 2.** Secondary outcome measures reported from studies included in the meta-analysis.

<b>Reference</b>	<b>Body mass and composition</b>	<b>Functional/performance outcomes</b>	<b>Falls</b>	<b>Self-efficacy</b>
Pruitt et al. [1]	–	–	–	–
Taaffe et al. [2]	G1: ↑ thigh type I and II muscle fibre CSA; ↔ thigh LM G2: ↑ thigh type I and II muscle fibre CSA; ↔ thigh LM	–	–	–
McCartney et al. [3]	G1: ↑ thigh CSA	G1: ↑ endurance in cycling, treadmill walking and stair climbing	–	–
Taaffe et al. [4]	G1: ↑ LM; ↔ FM G2: ↑ LM; ↔ FM G3: ↑ LM; ↔ FM	G1: ↑ chair stand x5; ↔ 6 m backward walk G2: ↑ chair stand x5; ↔ 6 m backward walk G3: ↑ chair stand x5; ↔ 6 m backward walk	–	–
Rhodes et al. [5]	G1: ↔ BM, BF	G1: ↔ trunk flexion flexibility, grip strength	–	–
Vincent and Braith [6]	–	–	–	–
Jessup et al. [7]	G1: ↓ BM	G1: ↓ postural sway	–	G1: ↔ osteoporosis self-efficacy scale

Reference	Body mass and composition	Functional/performance outcomes	Falls	Self-efficacy
Bunout et al. [8]	G1: ↔ BM	G1: ↑ short physical performance test battery (3 tasks), timed up and go; ↔ postural sway, 12 min walk speed	–	–
Karinkanta et al. [9]	G1: ↔ BM G2: ↔ BM	G1: ↔ figure of 8 running G2: ↑ figure of 8 running	–	G1: ↔ self-rated physical functioning scale G2: ↑ self-rated physical functioning scale
Bocalini et al. [10]	G1: ↓ BM; ↔ BF, LM	G1: ↑ 30-s Chair stand, sit and reach flexibility, one-leg stance (static balance); ↔ timed up and go, VO <sup>2</sup> Max	–	–
Marques et al. [11]	G1: ↑ LM; ↓ FM	G1: ↑ one-leg stance (static balance), timed up and go; ↓ postural sway	–	–
Marques et al. [12]	G1: ↓ FM; ↔ LM	G1: ↑ one-leg stance (static balance), handgrip strength; ↓ postural sway; ↔ timed up and go, 6 min walk speed	–	–
Villareal et al. [13]	G1: ↔ BM; ↑ LM; ↓ FM	G1: ↑ Physical performance test battery (7 tasks), VO <sup>2</sup> Peak, one-leg stance (static balance), obstacle course speed (dynamic balance), 25 m gait speed	–	G1: ↑ health-related quality of life survey
Uusi-Rasi et al. [14]	G1: ↔ BM, BF	G1: ↑ 4 m gait speed, backward walking (dynamic balance), chair stand x5; ↔ timed up and go	G1: ↔ total number of falls; ↓ number of injurious falls	–

G1 = intervention group 1; G2 = intervention group 2; ↑ = statistical increase post-training compared to control group ( $p \leq 0.05$ ); ↓ statistical decrease post-training compared to control group ( $p \leq 0.05$ ); ↔ = no statistical difference post-training compared to the control group ( $p > 0.05$ ); CSA = cross sectional area; BM = body mass; LM = lean mass; FM = fat mass; BF = body fat %;

1. Pruitt, L.A., D.R. Taaffe, and R. Marcus, Effects of a one-year high-intensity versus low-intensity resistance training program on bone mineral density in older women. *J Bone Miner Res*, 1995. **10**(11): p. 1788-1795.
2. Taaffe, D.R., L. Pruitt, G. Pyka, et al., Comparative effects of high- and low-intensity resistance training on thigh muscle strength, fiber area, and tissue composition in elderly women. *C Physiol*, 1996. **16**(4): p. 381-392.
3. McCartney, N., A.L. Hicks, J. Martin, et al., A longitudinal trial of weight training in the elderly: continued improvements in year 2. *J Gerontol A Biol Sci Med Sci*, 1996. **51**(6): p. B425-B433.
4. Taaffe, D.R., C. Duret, S. Wheeler, et al., Once-weekly resistance exercise improves muscle strength and neuromuscular performance in older adults. *J Am Geriatr Soc*, 1999. **47**(10): p. 1208-1214.
5. Rhodes, E.C., A.D. Martin, J.E. Taunton, et al., Effects of one year of resistance training on the relation between muscular strength and bone density in elderly women. *Br J Sports Med*, 2000. **34**(1): p. 18-22.
6. Vincent, K.R. and R.W. Braith, Resistance exercise and bone turnover in elderly men and women. *Med Sci Sports Exerc*, 2002. **34**(1): p. 17-23.
7. Jessup, J.V., C. Horne, R. Vishen, et al., Effects of exercise on bone density, balance, and self-efficacy in older women. *Biol Res Nurs*, 2003. **4**(3): p. 171-180.
8. Bunout, D., G. Barrera, L. Leiva, et al., Effects of vitamin D supplementation and exercise training on physical performance in Chilean vitamin D deficient elderly subjects. *Exp Gerontol*, 2006. **41**(8): p. 746-752.
9. Karinkanta, S., A. Heinonen, H. Sievänen, et al., A multi-component exercise regimen to prevent functional decline and bone fragility in home-dwelling elderly women: randomized, controlled trial. *Osteoporos Int*, 2007. **18**(4): p. 453-462.
10. Bocalini, D.S., A.J. Serra, and L. Dos Santos, Moderate resistive training maintains bone mineral density and improves functional fitness in postmenopausal women. *J Aging Res*, 2010. **2010**.
11. Marques, E.A., F. Wanderley, L. Machado, et al., Effects of resistance and aerobic exercise on physical function, bone mineral density, OPG and RANKL in older women. *Exp Gerontol*, 2011a. **46**(7): p. 524-532.
12. Marques, E.A., J. Mota, L. Machado, et al., Multicomponent training program with weight-bearing exercises elicits favorable bone density, muscle strength, and balance adaptations in older women. *Calcif Tissue Int*, 2011b. **88**(2): p. 117-129.
13. Villareal, D.T., S. Chode, N. Parimi, et al., Weight loss, exercise, or both and physical function in obese older adults. *N Engl J Med*, 2011. **364**(13): p. 1218-1229.
14. Uusi-Rasi, K., R. Patil, S. Karinkanta, et al., Exercise and vitamin D in fall prevention among older women: a randomized clinical trial. *JAMA Intern Med*, 2015. **175**(5): p. 703-711.