



Review

Muscle capacity and physical function in older women: What are the impacts of resistance training?

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Abstract

The number of older adults (individuals ≥ 65 years), particularly women, in our society is increasing and understanding the impact of exercise on muscle capacity (e.g., strength and power) and subsequently physical function is of utmost importance to prevent disability and maintain independence. Muscle capacity declines with age and this change negatively impacts physical function in older women. Exercise, specifically resistance training, is recommended to counteract these declines; however, the synergistic relationships between exercise, muscle capacity, and physical function are poorly understood. This review will summarize the literature regarding age-related changes in the aforementioned variables and review the research on the impact of resistance training interventions on muscle capacity and physical function in older women. Recommendations for future research in this area will be discussed.

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Keywords: Muscle capacity; Older women; Physical function; Resistance training

1. Introduction

Across the world a demographic shift is occurring; the number of older adults (individuals ≥ 65 years) is expected to nearly triple from 2010 to 2050.¹ Consequently, for the first time ever, the total number of older adults in the world will be greater than the number of young children (≤ 5 years).¹ Moreover, it is predicted that women will continue to outnumber and outlive men.² During aging, men and women are more likely to experience physical limitations (difficulty performing certain tasks, such as walking up 10 steps without resting, stooping, bending, or kneeling, due to health

problems)³ and disability (impairments, activity limitations, and participation restrictions).⁴ Importantly, individuals with disabilities utilize more health-care services than those without disabilities, resulting in higher health-care costs.⁵ In comparison to men, women tend to be at greater risk for disability.⁶ Thus, while women generally live longer than men, they also experience a greater number of years living with physical disability in later adulthood.⁶ Therefore, the aging phenomenon will likely result in a greater number of women living with physical disabilities, negatively impacting health-care systems across the world.

Factors contributing to declines in physical function are numerous and include increased adiposity,^{7–10} as well as inadequate skeletal muscle mass,^{9,11–14} strength,^{15,16} and power.^{17,18} Compared to age-matched males, older women tend to have higher adiposity,^{12,19,20} lower amounts of skeletal muscle mass,^{20,21} lower muscle density (reflecting greater muscle lipid infiltration),²² less muscle strength,²³ and lower muscle power,²⁴ placing them at increased risk for impaired physical function and disability.

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Physical activity (PA) is often recommended to prevent disability and maintain physical function.²⁵ Specifically, resistance training has been recommended as an intervention strategy for improving muscle strength and muscle power, two factors known to impact physical function in older adults.²⁵ However, the 2009 position stand published by the American College of Sports Medicine (ACSM), *Exercise and Physical Activity for Older Adults*,²⁵ clearly states that despite much research highlighting the positive impact of resistance training on muscle strength and power in older adults, the effects of such exercise on physical function are not well-understood. A review article presents an integrated conceptual model to aid in understanding the synergistic impacts of various factors on physical function in older adults.²⁶ Congruent with the ACSM position stand, Brady and colleagues²⁶ highlighted the need to better understand the interrelated factors that impact physical function in older adults, specifically exercise and measures of muscle capacity.

This review will summarize age-related changes in PA levels, muscle capacity (strength and power), and physical function. In addition, we will explore the literature regarding the impact of exercise, specifically resistance training, on muscle capacity measures and physical function in older women. Based on the available literature, recommendations for future research will be presented.

2. PA and physiological changes with aging

Declines in PA may further contribute to detriments in physical function via loss of muscle mass, strength, and power. Muscle strength (maximum force that can be exerted in one muscle contraction) and muscle power (product of muscle force and contraction velocity) are indicators of muscle function and will be referred to as measures of muscle capacity throughout this review. The maintenance of adequate muscle strength and muscle power is vital as both have been associated with physical function in older adults,^{17,23,27–29} although there is currently no consensus as to which has a stronger contribution to overall physical function.²⁶

2.1. PA

According to the Centers for Disease Control and Prevention, PA is defined as any bodily movement produced by skeletal muscle contractions that results in energy expenditure above an individual's basal level. In contrast, exercise is defined as planned, structured, or repetitive PA performed to either maintain or improve one or more components of physical fitness.³⁰ Advancing age is associated with declines in PA,³¹ including total volume of PA,^{32–34} intensity of PA,^{33,35,36} and increases in sedentary time,³⁵ which is particularly evident in older women.³⁵ Furthermore, a recent cross-sectional study among older adults reported that individuals 70–80 years are less active than individuals 60–69 years in all domains, including leisure-time activity, work-related, and housework.³⁷

PA recommendations for older adults include both aerobic exercise and resistance training. However, statistics indicate that only 51.1% and 21.9% of older adults meet the aerobic and resistance training guidelines, respectively.³⁸ Moreover, a sex difference exists such that older men are more active than older women.³⁹ In 2004, the percentage of women aged 18–24 years who reported engaging in resistance training was 20.1%. However, among older women, the percentage decreased considerably to only 10.7% (compared to 14.1% for older males).⁴⁰

Globally, longitudinal studies report conflicting results in the PA trends of older adults. Some studies have reported increases^{41–43} while others have reported declines in PA.^{44,45} In general, a review by Sun and colleagues³⁹ found that among older adults, there tends to be a rise in leisure-time PA, yet most older adults do not engage in a sufficient volume of PA to promote health benefits.³⁹ Despite Sun's conclusions, the percent of older men and women engaging in resistance training in the United States increased significantly between 1998 and 2004 (11.0% to 14.1% for men and 6.8% to 10.7% for women).⁴⁰ In summary, older adults (especially women) are not meeting the recommended PA guidelines, particularly as they relate to resistance training.

2.2. Body composition

Though not the focus of this review, profound changes in body composition (sarcopenia and increased adiposity) are also present during the aging process. In both older men and women, there tends to be an age-related increase in overall adiposity, which has been reported as a leading cause of disability.^{8,10} Moreover, there is a noticeable decline in skeletal muscle mass at ~45 years of age in both sexes, although the age-associated decrease is greater in men compared to women.⁴⁶ In comparison to younger women, older women have lower quadriceps muscle cross-sectional area (CSA) by 33%.⁴⁷ This is important, as multiple studies have observed a relationship between low muscle mass and impaired physical function in older adults.^{13,48} The aging process has also been associated with increases in muscle lipid content,^{46,49,50} an independent risk factor for mobility limitations.⁴⁶ Notably, older women have significantly lower mid-thigh muscle attenuation (greater muscle lipid infiltration) than older men.²² Moreover, there may be sex differences in the relative importance of body composition determinants of physical function. For instance, an analysis from the Health, Aging, and Body Composition (Health ABC) study found that the strongest independent predictor of physical function was total body fat in older women, whereas the most important body composition determinant in men was thigh muscle CSA.⁵¹ Findings from other studies support the notion that excess adiposity has a stronger impact on physical function in older women relative to men.^{20,52,53} Despite these results, it was recently reported that body mass index did not differentially impact the relationship between muscle quality and physical function in older women,⁵⁴ suggesting that muscle capacity is critical for function regardless of body size. In summary, older

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