Gaining skeletal muscle strength by exercising

This is an excerpt from Exercise and Physical Activity for Older Adults by Danielle R. Bouchard.

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A large body of evidence suggests that progressive, regular resistance training has a significant effect on skeletal muscle strength, specifically due to adaptations in the nervous and skeletal muscle systems (Russ, Gregg-Cornell, Conaway, & Clark, 2012). As such, resistance training activities can improve the decline in muscle and strength associated with aging (Burton & Sumukadas, 2010). Additionally, low physical activity levels are extremely common among older adults, which also leads to losses in skeletal muscle mass and strength (Clark, 2009; Troiano et al., 2008). Thus, resistance training activities are used to treat, slow, and prevent dynapenia (Resnick & Boltz, 2016). Currently, there are no standardized resistance training guidelines for improving skeletal muscle strength or power among older adults. However, resistance training has been shown to be both safe and feasible in this population. Resistance training guidelines for the general public such as those put forth by the American College of Sports Medicine (ACSM) may be well tolerated by older adults when training at appropriate workloads and may allow older adults to achieve musculoskeletal benefits (American College of Sports Medicine, 2009; Esco, 2013; Kraemer et al., 2002).

There are several training variables in the ACSM resistance training guidelines (American College of Sports Medicine, 2009; Esco, 2013; Kraemer et al., 2002):

- *Frequency:* The number of exercise sessions per week
- *Duration:* The length of each training session
- *Intensity:* The relative amount of weight being lifted (i.e., percentage of maximum)
- *Repetitions:* The number of times an individual performs a complete movement of a given exercise
- *Progression:* Also known as *overload*; gradually increasing the load or the stress placed on the skeletal muscle during exercise

Engaging in different resistance training exercise types, particularly multijoint exercises (exercises where more than one joint is involved) versus unijoint exercises (exercises where only one joint is involved), may have an impact on the outcome of resistance training among older adults (Resnick & Boltz, 2016).

Liu and Latham (2009) performed a large review including 6,700 older adults and found that resistance training is an effective intervention to improve strength and the performance of simple and complex activities, thus leading to improved physical functioning. Many other studies support this conclusion, demonstrating that resistance training has positive effects on both neural and skeletal muscle mechanisms, leading to strength gains. In terms of neural factors, it was found that six weeks of high intensity resistance training led to an increase in maximal motor unit discharge rates of 49% in a group of older adults aged 67 to 81 (Kamen & Knight, 2004). The resistance training protocol involved three training sessions each week, using three sets of 10 dynamic knee extension contractions at 85% one-repetition maximum (1RM) and three 5 s maximal isometric contractions. For older adults, six months of resistance training performed twice a week is enough to significantly increase maximal isometric strength, 1RM skeletal muscle strength, skeletal muscle power, improvement in neural adaptations, and a significant increase in the percentage of type II fibers (Hakkinen, Kraemer, Newton, & Alen, 2001).

Furthermore, Taaffe and colleagues (1999) assessed the impact of resistance training frequency (one, two, and three times per week) on skeletal muscle strength and its relation to neuromuscular performance measured by the timed chair rise test. Skeletal muscle strength increased significantly (one day per week: 37.0%; two days per week: 41.9%; three days per week: 39.7%) after 24 weeks of resistance training, independent of resistance training frequency.

Although skeletal muscle has a high capacity for regeneration following physiological stress induced by exercise, aging decreases its reparative potential (Sorensen, Skousen, Holland, Williams, & Hyldahl, 2018). Nevertheless, skeletal muscle still adapts to these stimuli, even at advanced ages (Liu & Latham, 2009). Resistance training induces changes in the skeletal muscle, including functional, structural, and molecular skeletal muscle plasticity (Fluck, 2006; Z'Graggen, Trautmann, & Bostock, 2016). Because aging is associated with a reduction in these factors (Fathi et al., 2010), resistance training reverses or minimizes these typical effects. Moreover, resistance training causes hyperpolarization of the resting membrane potential of the skeletal muscle (Z'Graggen, Trautmann, & Bostock, 2016). This adaptation is beneficial to counter the effects of aging. Finally, other skeletal muscle characteristics in older adults improve following resistance training, including skeletal muscle fiber fascicle length and tendon stiffness (Narici, Ciuffreda, Baldi, & Capodaglio, 2000; Reeves, Maganaris, & Narici, 2003). In a group of older adults (average age = 73.5 ± 14.9 years old), 14 weeks of resistance training (three days per week) focusing on leg extension and leg press exercises induced a 65% increase in tendon stiffness and a 27% larger rate of torque development. Hence, resistance training among older adults reduces the risk of injury and positively contributes to contractile force production as well as enhances capability to perform motor tasks (Reeves, Maganaris, & Narici, 2003).

Thank you to Human Kinetics for providing this excerpt.