Aging and Susceptibility to Eccentric-Exercise-Induced Muscle Dysfunction

Decreases in skeletal-muscle function are seen with aging, and this is partially a result of decreases in physical activity. In our daily living, unaccustomed eccentric muscle contractions are known to result in muscle damage, decreased strength, and delayed-onset muscle soreness. In older individuals with low muscle strength, any additional loss in strength (even temporary) can result in impairment in activities of daily living. Ploutz-Snyder and colleagues documented the extent of muscle dysfunction in response to acute unaccustomed eccentric exercise in young and older women. They further studied whether resistance training would protect against possible eccentric-exercise-induced damage in the older women. Six younger (~23 years) and 6 older (~66 years) women were recruited for the study. Initially all participants were tested for unilateral concentric and eccentric knee-extension strength (1-repetition maximum [1RM]). The unaccustomed eccentric exercise consisted of 100 repetitions of knee extension at 75% of 1RM. Strength loss over the next 11 days was measured, as well as MRI changes in muscle function. The older women then participated in 12 weeks of bilateral knee-extension resistance training, after which unilateral concentric and eccentric 1RM were retested. The unaccustomed eccentric-exercise bout was performed, and again muscle changes over the next 11 days were measured. In response to the unaccustomed exercise the older women showed a larger decline in strength, such that 1 day after the eccentric bout there were 24% and 27% reductions in concentric and eccentric strength, respectively. In the younger individuals this resulted in a 6% and 10% reduction in strength. The MRI showed that muscle damage or edema was greater in the older women than in the younger women. In response to 12 weeks of moderate-intensity training in the older women, no greater muscle injury was found than in the younger women. The time course required to recover from the strength loss resulting from the eccentric-exercise bout was longer in the older women (4 days) than in the younger women (3 days). In conclusion, sedentary older women are more susceptible to eccentric-exercise-induced muscle dysfunction than are sedentary young women, and resistance training minimizes this susceptibility. The trained older women had responses to unaccustomed eccentric exercise similar to those of younger women. This study shows that a moderate resistance-training stimulus reduces the susceptibility to muscle dysfunction and might prevent decrements in abilities to perform everyday tasks.


Benefits of Creatine Supplementation in Older Men

Associated with the decrease in muscle mass with aging is a decrease in muscle strength and explosive power. This decrease in strength and power begins between
the ages 30 and 50 years, but after age 50 a steeper, more rapid decline is observed. Eventually a 25–35% reduction in muscle mass is seen by the age of 65. The effects of creatine supplementation on muscle mass have been studied extensively in younger populations, but there have only been a few studies using older participants. Gotshalk et al. studied the increase in muscle strength, explosive power, and lower body activities of daily living after creatine supplementation. Twenty men (59–73 years old) underwent 1 week of creatine supplementation (0.3 g/kg body mass). To reduce the confounding effects of learning, the participants initially underwent 3 weeks of familiarization sessions, followed by 2 days of testing (T1), a week with no supplementation, repeat of the first 2 days of testing (T2), 1 week of supplementation, and then follow-up testing (T3). Testing included body composition (underwater weighing), lower body activities of daily living (tandem-gait test and sit-to-stand chair test), dynamic lower body strength (leg press), dynamic upper body strength (bench press), and upper and lower body anaerobic power. No significant differences were seen between T1 and T2 in any of the variables measured. The creatine group demonstrated significant ($p < .01$) improvement on the bench press, leg press, lower body peak power and mean power, and the sit-to-stand and tandem-gait tests. No significant group differences were found for the upper body peak- or mean-power tests. Fat-free mass was also found to increase significantly (2.2 ± 0.5 kg, $p < .05$) in the creatine group. These findings are the first to show that increased lower body leg strength and increased rate of torque development after creatine supplementation results in improvement in the ability to perform lower body functional tasks of daily living. The effects of short-term creatine supplementation seem to translate into improvement in movements in large muscle groups more than in small muscle groups, because no increases in upper body strength were found. This is one of the first studies to show increases in strength and power with creatine supplementation without adverse effects in older adults, and it indicates that it might be a useful therapeutic strategy.


Minimal Thresholds of Strength Needed for Activities of Daily Living

With aging, muscle strength declines even in active individuals. Loss of muscle strength has the potential to cause a decline in activities of daily living to the extent that an individual can lose his or her independence. In particular, loss of lower limb strength can result in gait disorders, falls, decreased gait velocity, and so on. Resistance exercise is recommended for older individuals, but the minimal strength required to perform many of these activities is unclear. Ploutz-Snyder and colleagues determined functional thresholds of the quadriceps femoris muscle below which function on ambulatory tasks is reduced. In addition, they examined whether a self-report of physical function is related to muscle strength and observed performance of the same task. They studied 100 community-dwelling men and women 52–92 years of age with a wide variety of muscle strengths and functional abilities. These participants were tested for knee-extension peak isometric torque at five different angles, functional tasks (chair rise, gait speed, and stair ascent and
descent), and physical activity questionnaires. Peak isometric strength as a function of body weight (STR/WT) at the 60° angle was most highly correlated with the functional tasks; thus it was used for the data analysis. Thresholds for STR/WT below which function was impaired were calculated for each functional task. The threshold for STR/WT was approximately 3.0–3.5 Nm/kg for all tasks. Specificity and sensitivity of these thresholds as predictors of functional success ranged from 78% to 94% and 76% to 81%, respectively. Furthermore, the self-reports and actual behavior were found to be in agreement, such that 77% of the time the self-report matched the performance. When there were discrepancies, it was usually the case that the participants overestimated their abilities, suggesting that many individuals are not aware of their loss of strength and its impact on their physical abilities. These data indicate the need for resistance training, which will allow older adults to maintain strength above the thresholds indicated.


**Benefits of Water-Based Exercise for Older Women**

Thirty women (60–75 years of age) were randomly divided into a training group and a control group. The training group participated in a 12-week water-based exercise program (70 min/day, 3 days/week) consisting of 20 min of warm-up/stretching exercises, 10 min of strength exercises using devices that provide resistance in water, 30 min of walking and dancing exercises performed in water, and 10 min of cool-down exercises. Significant increases in peak VO₂ (12%) and VO₂ at lactate threshold (20%) were observed after the water-based exercise program. Muscle strength for a variety of muscle groups, vertical jump, side-stepping agility, and trunk extension also increased significantly. There were significant decreases in skinfold thickness, LDL cholesterol, and total cholesterol. The control group did not demonstrate any changes in these variables. The results indicate that a well-rounded water-based exercise program produces improvements in cardiorespiratory fitness, muscle strength, body fat, and total cholesterol in older adult women.


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