PubMed Results:

Benefits of High-Intensity Strength Training

JAMA. 1990 Jun 13;263(22):3029-34

High-intensity strength training in nonagenarians. Effects on skeletal muscle.

Fiatarone MA, Marks EC, Ryan ND, Meredith CN, Lipsitz LA, Evans WJ. US Department of Agriculture Human Nutrition Research Center on Aging, Tufts University, Boston, MA 02111.

Muscle dysfunction and associated mobility impairment, common among the frail elderly, increase the risk of falls, fractures, and functional dependency. We sought to characterize the muscle weakness of the very old and its reversibility through strength training. Ten frail, institutionalized volunteers aged 90 +/- 1 years undertook 8 weeks of high-intensity resistance training. Initially, quadriceps strength was correlated negatively with walking time (r = -.745). Fat-free mass (r = .732) and regional muscle mass (r = .752) were correlated positively with muscle strength. Strength gains averaged 174% +/- 31% (mean +/- SEM) in the 9 subjects who completed training. Midthigh muscle area increased 9.0% +/- 4.5%. Mean tandem gait speed improved 48% after training. **We conclude that high-resistance weight training leads to significant gains in muscle strength, size, and functional mobility among frail residents of nursing homes up to 96 years of age.**

N Engl J Med. 1994 Jun 23;330(25):1769-75

Exercise training and nutritional supplementation for physical frailty in very elderly people.

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BACKGROUND. Although disuse of skeletal muscle and undernutrition are often cited as potentially reversible causes of frailty in elderly people, the efficacy of interventions targeted specifically at these deficits has not been carefully studied. METHODS. We conducted a randomized, placebo-controlled trial comparing progressive resistance exercise training, multinutrient supplementation, both interventions, and neither in 100 frail nursing home residents over a 10-week period. RESULTS. The mean (+/- SE) age of the 63 women and 37 men enrolled in the study was 87.1 +/- 0.6 years (range, 72 to 98); 94 percent of the subjects completed the study. Muscle strength increased by 113 +/- 8 percent in the subjects who underwent exercise training, as compared with 3 +/- 9 percent in the nonexercising subjects (P < 0.001). Gait velocity increased by 11.8 +/- 3.8 percent in the exercisers but declined by 1.0 +/- 3.8 percent in the nonexercisers (P = 0.02). Stair-climbing power also improved in the exercisers as compared with the nonexercisers (by 28.4 +/- 6.6 percent vs. 3.6 +/- 6.7 percent, P = 0.01), as did the level of spontaneous physical activity. Cross-sectional thigh-muscle area increased by 2.7 +/- 1.8 percent in the exercisers but declined by 1.8 +/- 2.0 percent in the nonexercisers (P = 0.11). The nutritional supplement had no effect on any primary outcome measure. Total energy intake was significantly increased only in the exercising subjects who also received nutritional supplementation. **CONCLUSIONS. High-intensity resistance exercise training is a feasible and effective means of counteracting muscle weakness and physical frailty in very elderly people. In contrast, multi-nutrient supplementation without concomitant exercise does not reduce muscle weakness or physical frailty.**

JAMA. 1994 Dec 28;272(24):1909-14

Effects of high-intensity strength training on multiple risk factors for osteoporotic fractures. A randomized controlled trial.

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OBJECTIVE--To determine how multiple risk factors for osteoporotic fractures could be modified by high-intensity strength training exercises in postmenopausal women. DESIGN--Randomized controlled trial of 1-year duration. SETTING--Exercise laboratory at Tufts University, Boston, Mass. POPULATION--Forty postmenopausal white women, 50 to 70 years of age, participated in the study; 39 women completed the study. The subjects were sedentary and estrogen-deplete. INTERVENTIONS--High-intensity strength training exercises 2 days per week using five different exercises (n = 20) vs untreated controls (n = 19). MAIN OUTCOME MEASURES--Dual energy x-ray absorptiometry for bone status, one repetition maximum for muscle strength, 24-hour urinary creatinine for muscle mass, and backward tandem walk for dynamic balance. RESULTS--Femoral neck bone mineral density and lumbar spine bone mineral density increased by 0.005 +/- 0.039 g/cm2 (0.9% +/- 4.5%) (mean +/- SD) and 0.009 +/- 0.033 g/cm2 (1.0% +/- 3.6%), respectively, in the strength-trained women and decreased by -0.022 +/- 0.035 g/cm2 (-2.5% +/- 3.8%) and -0.019 +/- 0.035 g/cm2 (-1.8% +/- 3.5%), respectively, in the controls (P = .02 and .04). Total body bone mineral content was preserved in the strength-trained women (+2.0 +/- 68 g; 0.0% +/- 3.0%) and tended to decrease in the controls (-33+77 g; -1.2% +/- 3.4%, P = .12). Muscle mass, muscle strength, and dynamic balance increased in the strength-trained women and decreased in the controls (P = .03 to < .001). **CONCLUSIONS--High-intensity strength training exercises are an effective and feasible means to preserve bone density while improving muscle mass, strength, and balance in postmenopausal women.**

Med Sci Sports Exerc. 2010 Jan;42(1):23-34

Effect of progressive resistance training on muscle performance after chronic stroke.

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PURPOSE:: This study investigated the effects of high-intensity progressive resistance training (PRT) and high-intensity cycling (cycling) on muscle performance and the time course of strength gains in a chronic stroke population. METHODS:: Forty-eight individuals with chronic stroke sequelae (mean +/- SD; age = 63 +/- 9 yr, time since stroke = 57 +/- 54 months) were randomly allocated to one of four treatment groups: PRT + cycling, PRT + sham cycling, sham PRT + cycling, or sham PRT + sham cycling groups in a fully factorial clinical trial. Thirty exercise sessions were conducted over a 10- to 12-wk period. The main outcomes investigated were measures of unilateral muscle strength, peak power, and muscle endurance. RESULTS:: Those undergoing PRT improved their lower limb muscle strength, peak power, and endurance compared with participants receiving sham PRT or cycling only (P < 0.05), and combined exercise was not superior to PRT alone. Strength improvements occurred primarily during the first 6 to 8 wk (98%-100% of total gain) and then reached a plateau during the final 2 to 4 wk. **CONCLUSION:: We have shown for the first time in a direct comparison study that high-intensity PRT, but not cycling or sham exercise, can improve muscle strength, peak power, and muscle endurance in both affected and unaffected lower limbs after chronic stroke by a significant and clinically meaningful amount. Although strength gains plateaued earlier than anticipated, adherence to the intended continuous high-intensity progressive overload protocol was largely achieved (average load of 84% +/- 4% of one repetition maximum).**

J Gerontol A Biol Sci Med Sci. 1997 Jan;52(1):M27-35

A randomized controlled trial of progressive resistance training in depressed elders.

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BACKGROUND: Depression in elderly people may be contributed to by the multiple losses of aging. Exercise has the potential to positively impact many of these losses simultaneously. We tested the hypothesis that progressive resistance training (PRT) would reduce depression while improving physiologic capacity, quality of life, morale, function and self-efficacy without adverse events in an older, significantly depressed population. METHODS: We conducted a 10-week randomized controlled trial of volunteers aged 60 and above with major or minor depression or dysthymia. Subjects were randomized for 10 weeks to either a supervised PRT program three times a week or an attention-control group. RESULTS: A total of 32 subjects aged 60-84, mean age 71.3 +/- 1.2 yr, were randomized and completed the study. No significant adverse events occurred. Median compliance was 95%. PRT significantly reduced all depression measures (Beck Depression Inventory in exercisers 21.3 +/- 1.8 to 9.8 +/- 2.4 versus controls 18.4 +/- 1.7 to 13.8 +/- 2, p = .002; Hamilton Rating Scale of Depression in exercisers 12.3 +/- 0.9 to 5.3 +/- 1.3 versus controls 11.4 +/- 1.0 to 8.9 +/- 1.3, p = .008). Quality of life subscales of bodily pain (p = .001), vitality (p = .002), social functioning (p = .008), and role emotional (p = .02) were all significantly improved by exercise compared to controls. Strength increased a mean of 33% +/- 4% in exercisers and decreased 2% +/- 2% in controls (p < .0001). In a multiple stepwise regression model, intensity of training was a significant independent predictor of decrease in depression scores (r2 = .617, p = .0002). **CONCLUSIONS: PRT is an effective antidepressant in depressed elders, while also improving strength, morale, and quality of life.**

Arthritis Rheum. 2009 Dec 15;61(12):1726-34

Effects of high-intensity resistance training in patients with rheumatoid arthritis: A randomized controlled trial.

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OBJECTIVE: To confirm, in a randomized controlled trial (RCT), the efficacy of high-intensity progressive resistance training (PRT) in restoring muscle mass and function in patients with rheumatoid arthritis (RA). Additionally, to investigate the role of the insulin-like growth factor (IGF) system in exercise-induced muscle hypertrophy in the context of RA. METHODS: Twenty-eight patients with established, controlled RA were randomized to either 24 weeks of twice-weekly PRT (n = 13) or a range of movement home exercise control group (n = 15). Dual x-ray absorptiometry-assessed body composition (including lean body mass [LBM], appendicular lean mass [ALM], and fat mass); objective physical function; disease activity; and muscle IGFs were assessed at weeks 0 and 24. RESULTS: Analyses of variance revealed that PRT increased LBM and ALM (P < 0.01); reduced trunk fat mass by 2.5 kg (not significant); and improved training-specific strength by 119%, chair stands by 30%, knee extensor strength by 25%, arm curls by 23%, and walk time by 17% (for objective function tests, P values ranged from 0.027 to 0.001 versus controls). In contrast, body composition and physical function remained unchanged in control patients. Changes in LBM and regional lean mass were associated with changes in objective function (P values ranged from 0.126 to <0.0001). Coinciding with muscle hypertrophy, previously diminished muscle levels of IGF-1 and IGF binding protein 3 both increased following PRT (P < 0.05). **CONCLUSION: In an RCT, 24 weeks of PRT proved safe and effective in restoring lean mass and function in patients with RA. Muscle hypertrophy coincided with significant elevations of attenuated muscle IGF levels, revealing a possible contributory mechanism for rheumatoid cachexia. PRT should feature in disease management.**

J Nutr Health Aging. 2000;4(3):140-2

Sarcopenia: a major modifiable cause of frailty in the elderly.

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Sarcopenia is the loss of muscle mass and strength that occurs with aging. It is a consequence of normal aging, and does not require a disease to occur, although muscle loss can be accelerated by chronic illness. Sarcopenia is a major cause of disability and frailty in the elderly. There are many candidate mechanisms leading to sarcopenia, including age-related declines in alpha-motor neurons, growth hormone production, sex steroid levels, and physical activity. In addition, fat gain, increased production of catabolic cytokines, and inadequate intake of dietary energy and protein are also potentially important causes of sarcopenia. The relative contribution of each of these factors is not yet clear. **Sarcopenia can be reversed with high-intensity progressive resistance exercise, which can probably also slow its development. A major challenge in preventing an epidemic of sarcopenia-induced frailty in the future is developing public health interventions that deliver an anabolic stimulus to the muscle of elderly adults on a mass scale.**

Br J Sports Med. 2009 Jan;43(1):25-7. Epub 2008 Nov 19

Exercise and cognition in older adults: is there a role for resistance training programmes?

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In recent years, there has been a strong interest in physical activity as a primary behavioural prevention strategy against cognitive decline. A number of large prospective cohort studies have highlighted the protective role of regular physical activity in lowering the risk of cognitive impairment and dementia. Most prospective intervention studies of exercise and cognition to date have focused on aerobic-based exercise training. These studies highlight that aerobic-based exercise training enhances both brain structure and function. However, it has been suggested that other types of exercise training, such as resistance training, may also benefit cognition. The purpose of this brief review is to examine the evidence regarding resistance training and cognitive benefits. Three recent randomised exercise trials involving resistance training among seniors provide evidence that resistance training may have cognitive benefits. **Resistance training may prevent cognitive decline among seniors via mechanisms involving insulin-like growth factor I and homocysteine. A side benefit of resistance training, albeit a very important one, is its established role in reducing morbidity among seniors. Resistance training specifically moderates the development of sarcopenia. The multifactorial deleterious sequelae of sarcopenia include increased falls and fracture risk as well as physical disability. Thus, clinicians should consider encouraging their clients to undertake both aerobic-based exercise training and resistance training not only for "physical health" but also because of the almost certain benefits for "brain health".**

Can J Appl Physiol. 2001 Feb;26(1):123-41

The effects of strength training (high intensity resistance training {HIRT}) on sarcopenia.

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In the past decade strength training has been investigated extensively as a means of reversing the muscle mass loss that occurs with aging (sarcopenia). High intensity resistance training (HIRT) has led to increased protein synthesis, along with muscle hypertrophy measured at the whole body, whole muscle, and muscle fibre levels, in older adults. Typically, the strength increments associated with HIRT have been much larger than the hypertrophic response. However, most HIRT periods have been quite short. Less is known about the long-term hypertrophic response to HIRT in older adults**. In order to lessen the effects of sarcopenia, HIRT should continue over the long term in older adults, to improve functional performance and health.**

Diabetes Care. 2002 Oct;25(10):1729-36

High-intensity resistance training improves glycemic control in older patients with type 2 diabetes.

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OBJECTIVE: To examine the effect of high-intensity progressive resistance training combined with moderate weight loss on glycemic control and body composition in older patients with type 2 diabetes. RESEARCH DESIGN AND METHODS: Sedentary, overweight men and women with type 2 diabetes, aged 60-80 years (n = 36), were randomized to high-intensity progressive resistance training plus moderate weight loss (RT & WL group) or moderate weight loss plus a control program (WL group). Clinical and laboratory measurements were assessed at 0, 3, and 6 months. RESULTS: HbA(1c) fell significantly more in RT & WL than WL at 3 months (0.6 +/- 0.7 vs. 0.07 +/- 0.8%, P < 0.05) and 6 months (1.2 +/- 1.0 vs. 0.4 +/- 0.8%, P < 0.05). Similar reductions in body weight (RT & WL 2.5 +/- 2.9 vs. WL 3.1 +/- 2.1 kg) and fat mass (RT & WL 2.4 +/- 2.7 vs. WL 2.7 +/- 2.5 kg) were observed after 6 months. In contrast, lean body mass (LBM) increased in the RT & WL group (0.5 +/- 1.1 kg) and decreased in the WL group (0.4 +/- 1.0) after 6 months (P < 0.05). There were no between-group differences for fasting glucose, insulin, serum lipids and lipoproteins, or resting blood pressure. **CONCLUSIONS: High-intensity progressive resistance training, in combination with moderate weight loss, was effective in improving glycemic control in older patients with type 2 diabetes. Additional benefits of improved muscular strength and LBM identify high-intensity resistance training as a feasible and effective component in the management program for older patients with type 2 diabetes.**

Clin Rheumatol. 2009 Jun;28(6):663-71. Epub 2009 Feb 27

Long-term follow-up of a high-intensity exercise program in patients with rheumatoid arthritis.

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The aims of this study were to describe rheumatoid arthritis patients' compliance with continued exercise after participation in a 2-year supervised high-intensity exercise program and to investigate if the initially achieved effectiveness and safety were sustained. Data were gathered by follow-up of the participants who completed the 2-year high-intensity intervention in a randomized controlled trial (Rheumatoid Arthritis Patient In Training study). Eighteen months thereafter, measurements of compliance, aerobic capacity, muscle strength, functional ability, disease activity, and radiological damage of the large joints were performed. Seventy-one patients were available for follow-up at 18 months, of whom 60 (84%) were still exercising (exercise group: EG), with average similar intensity but at a lower frequency as the initial intervention. Eleven patients (16%) reported low intensity or no exercises (no-exercise group: no-EG). Patients in the EG had better aerobic fitness and functional ability, lower disease activity, and higher attendance rate after the initial 2-year intervention. At follow-up, both groups showed a deterioration of aerobic fitness and only patients in the EG were able to behold their muscle strength gains. Functional ability, gained during the previous participation in high-intensity exercises, remained stable in both groups. Importantly, no detrimental effects on disease activity or radiological damage of the large joints were found in either group**. In conclusion, the majority of the patients who participated in the 24-month high-intensity exercise program continued exercising in the ensuing 18 months. In contrast to those who did not continue exercising, they were able to preserve their gains in muscle strength without increased disease activity or progression of radiological damage.**

Respir Med. 2004 Oct;98(10):1000-7

Heavy resistance training increases muscle size, strength and physical function in elderly male COPD-patients--a pilot study.

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This study investigated the effects of heavy resistance training in elderly males with chronic obstructive pulmonary disease (COPD). 18 Home-dwelling male patients (age range: 65-80 years), with a mean forced expiratory volume in the first second (FEV1) of 46 +/- 3.4% of predicted value, were recruited. Baseline and post-training assessments included: Cross-sectional area (CSA) of quadriceps assessed by MRI, isometric and isokinetic knee extension strength, isometric trunk strength, leg extension power, normal and maximal gait-speed on a 30 m track, stair climbing time, number of chair stands in 30 s, lung function (FEV1) and self-reported health. Subjects were randomized to a resistance training group (RE, n = 9) or a control group conducting breathing exercises (CON, n = 9). RE performed heavy progressive resistance training twice a week for 12 weeks. 6 RE and 7 CON completed the study. In RE the following improved (P < 0.05): Quadriceps CSA: 4%, isometric knee extension strength: 14%, isokinetic knee extension strength at 60 degrees /s.: 18%, leg extension power: 19%, maximal gait speed: 14%, stair climbing time: 17%, isometric trunk flexion: 5% and self-reported health. In CON no changes were found. **In conclusion, 12 weeks of heavy resistance training twice a week resulted in significant improvements in muscle size, knee extension strength, leg extension power, functional performance and self-reported health in elderly male COPD patients.**

Br J Sports Med. 2009 Feb;43(2):114-9. Epub 2008 Jul 15

Initiating and maintaining resistance training in older adults: a social cognitive theory-based approach.

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Numerous research studies performed in "lab-gyms" with supervised training have demonstrated that simple, brief (20-30 min) resistance training protocols performed 2-3/week following the American College of Sports Medicine's guidelines positively affect risk factors associated with heart disease, cancers, diabetes, sarcopenia and other disabilities. For more than a decade, resistance training has been recommended for adults, particularly older adults, as a prime preventive intervention, and increasing the prevalence of resistance training is an objective of Healthy People 2010. However, the prevalence rate for resistance training is only estimated at 10-15% for older adults, despite the leisure time of older adults and access to facilities in developed countries. The reasons that the prevalence rate remains low include public health policy not emphasising resistance training, misinformation, and the lack of theoretically driven approaches demonstrating effective transfer and maintenance of training to minimally supervised settings once initial, generally successful, supervised training is completed. Social cognitive theory (SCT) has been applied to physical activity and aerobic training with some success, but there are aspects of resistance training that are unique including its intensity, progression, precision, and time and place specificity. Social cognitive theory, particularly with a focus on self-regulation and response expectancy and affect within an ecological context, can be directly applied to these unique aspects of resistance training for long-term maintenance.

Ann Intern Med. 1996 Mar 15;124(6):568-72

Weight training improves walking endurance in healthy elderly persons.

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OBJECTIVE: To determine the effect of a resistance-training program on walking endurance in a healthy, community-dwelling elderly population. DESIGN: 12- week randomized, controlled trial comparing a resistance- training group with a nonexercising control group. SETTING: Hospital-affiliated outpatient exercise facility. PATIENTS: 24 healthy men and women who were 65 years of age or older (mean age +/-SD, 70.4 +/- 4 years; range, 65 to 79 years). MEASUREMENTS: The primary outcome variable was exhaustive submaximal walking time measured at an intensity of 80% of baseline peak aerobic capacity. RESULTS: Participants in the resistance-training program increased submaximal walking endurance by 9 minutes (from 25 +/- 4 minutes to 34 +/- 9 minutes; P=0.001), a 38% increase, whereas no change was seen in controls (20 +/- 5 minutes to 19 +/- 10 minutes; P greater than 0.2; P=0.005 between groups). The relation between change in leg strength and change in walking endurance was significant (r=0.48; P=0.02). Neither group showed a change in peak aerobic capacity or in whole-body composition, although fat-free mass of the leg increased in the exercise group. **CONCLUSIONS: Resistance training for 3 months improves both leg strength and walking endurance in healthy, community-dwelling elderly persons. This finding is relevant to older persons at risk for disability, because walking endurance and leg strength are important components of physical functioning.**