

PubMed Results:

Benefits of Walking

J Gerontol A Biol Sci Med Sci. 2006 Nov;61(11):1166-70

Aerobic exercise training increases brain volume in aging humans.

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BACKGROUND: The present study examined whether aerobic fitness training of older humans can increase brain volume in regions associated with age-related decline in both brain structure and cognition. **METHODS:** Fifty-nine healthy but sedentary community-dwelling volunteers, aged 60-79 years, participated in the 6-month randomized clinical trial. Half of the older adults served in the aerobic training group, the other half of the older adults participated in the toning and stretching control group. Twenty young adults served as controls for the magnetic resonance imaging (MRI), and did not participate in the exercise intervention. High spatial resolution estimates of gray and white matter volume, derived from 3D spoiled gradient recalled acquisition MRI images, were collected before and after the 6-month fitness intervention. Estimates of maximal oxygen uptake (VO₂) were also obtained. **RESULTS:** Significant increases in brain volume, in both gray and white matter regions, were found as a function of fitness training for the older adults who participated in the aerobic fitness training but not for the older adults who participated in the stretching and toning (nonaerobic) control group. As predicted, no significant changes in either gray or white matter volume were detected for our younger participants. **CONCLUSIONS: These results suggest that cardiovascular fitness is associated with the sparing of brain tissue in aging humans. Furthermore, these results suggest a strong biological basis for the role of aerobic fitness in maintaining and enhancing central nervous system health and cognitive functioning in older adults.**

Hippocampus. 2009 Oct;19(10):1030-9

Aerobic fitness is associated with hippocampal volume in elderly humans.

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Deterioration of the hippocampus occurs in elderly individuals with and without dementia, yet individual variation exists in the degree and rate of hippocampal decay. Determining the factors that influence individual variation in the magnitude and rate of hippocampal decay may help promote lifestyle changes that prevent such deterioration from taking place. Aerobic fitness and exercise are effective at preventing cortical decay and cognitive impairment in older adults and epidemiological studies suggest that physical activity can reduce the risk for developing dementia. However, the relationship between aerobic fitness and hippocampal volume in elderly humans is unknown. In this study, we investigated whether individuals with higher levels of aerobic fitness displayed greater volume of the hippocampus and better spatial memory performance than individuals with lower fitness levels. Furthermore, in exploratory analyses, we assessed whether hippocampal volume mediated the relationship between fitness and spatial memory. Using a region-of-interest analysis on magnetic resonance images in 165 nondemented older adults, we found a triple association such that higher fitness levels were associated with larger left and right hippocampi after controlling for age, sex, and years of education, and larger hippocampi and higher fitness levels were correlated with better spatial memory performance. Furthermore, we demonstrated that hippocampal volume partially mediated the relationship between higher fitness levels and enhanced spatial memory. **Our results clearly indicate that higher levels of aerobic fitness are associated with increased hippocampal volume in older humans, which translates to better memory function.**

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Endurance training enhances BDNF release from the human brain.

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The circulating level of brain-derived neurotrophic factor (BDNF) is reduced in patients with major depression and type-2 diabetes. Since acute exercise increases BDNF production in the hippocampus and cerebral cortex, we hypothesized that endurance training would enhance the release of BDNF from the human brain as detected from arterial and internal jugular venous blood samples. In a randomized controlled study, twelve healthy sedentary males carried out three months of endurance training ($n = 7$) or served as controls ($n = 5$). Before and after the intervention, blood samples were obtained at rest and during exercise. At baseline, the training group (58 ± 106 ng 100 g $^{-1}$ min $^{-1}$), mean \pm SD) and the control group (12 ± 17 ng 100 g $^{-1}$ min $^{-1}$) had a similar release of BDNF from the brain at rest. Three months of endurance training enhanced the resting release of BDNF to 206 ± 108 ng 100 g $^{-1}$ min $^{-1}$ ($P < 0.05$), with no significant change in the control subjects, but there was no training-induced increase in the release of BDNF during exercise. Additionally, eight mice completed a 5-week treadmill running training protocol that increased the BDNF mRNA expression in the hippocampus (4.5 ± 1.6 vs. 1.4 ± 1.1 mRNA/ssDNA; $P < 0.05$), but not in the cerebral cortex (4.0 ± 1.4 vs. 4.6 ± 1.4 mRNA/ssDNA) as compared to untrained mice. **The increased BDNF expression in the hippocampus and the enhanced release of BDNF from the human brain following training suggests that endurance training promotes brain health.**

AJNR Am J Neuroradiol. 2009 Nov;30(10):1857-63. Epub 2009 Jul 9

The effect of exercise on the cerebral vasculature of healthy aged subjects as visualized by MR angiography.

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BACKGROUND AND PURPOSE: Prior studies suggest that aerobic exercise may reduce both the brain atrophy and the decline in fractional anisotropy observed with advancing age. It is reasonable to hypothesize that exercise-induced changes to the vasculature may underlie these anatomic differences. The purpose of this blinded study was to compare high-activity and low-activity healthy elderly volunteers for differences in the cerebrovasculature as calculated from vessels extracted from noninvasive MR angiograms (MRAs). **MATERIALS AND METHODS:** Fourteen healthy elderly subjects underwent MRA. Seven subjects reported a high level of aerobic activity (64 ± 5 years of age; 5 men, 2 women) and 7, a low activity level (68 ± 6 years of age; 5 women, 2 men). Following vessel segmentation from MRA by an individual blinded to subject activity level, quantitative measures of vessel number, radius, and tortuosity were calculated and histogram analysis of vessel number and radius was performed. **RESULTS: Aerobically active subjects exhibited statistically significant reductions in vessel tortuosity and an increased number of small vessels compared with less active subjects. CONCLUSIONS: Aerobic activity in elderly subjects is associated with lower vessel tortuosity values and an increase in the number of small-caliber vessels. It is possible that an aerobic exercise program may contribute to healthy brain aging. MRA offers a noninvasive approach to visualizing the cerebral vasculature and may prove useful in future longitudinal investigations.**

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The transcriptional coactivator PGC-1{alpha} mediates exercise-induced angiogenesis in skeletal muscle.

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Peripheral arterial disease (PAD) affects 5 million people in the US and is the primary cause of limb amputations. Exercise remains the single best intervention for PAD, in part thought to be mediated by increases in capillary density. How exercise triggers angiogenesis is not known. PPARgamma coactivator (PGC)-1alpha is a potent transcriptional co-activator that regulates oxidative metabolism in a variety of tissues. We show here that PGC-1alpha mediates exercise-induced angiogenesis. Voluntary exercise induced robust angiogenesis in mouse skeletal muscle. Mice lacking PGC-1alpha in skeletal muscle failed to increase capillary density in response to exercise. Exercise strongly induced expression of PGC-1alpha from an alternate promoter. The induction of PGC-1alpha depended on beta-adrenergic signaling. beta-adrenergic stimulation also induced a broad program of angiogenic factors, including vascular endothelial growth factor (VEGF). This induction required PGC-1alpha. The orphan nuclear receptor ERRalpha mediated the induction of VEGF by PGC-1alpha, and mice lacking ERRalpha also failed to increase vascular density after exercise. **These data demonstrate that beta-adrenergic stimulation of a PGC-1alpha/ERRalpha/VEGF axis mediates exercise-induced angiogenesis in skeletal muscle.**

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Walking decreased risk of cardiovascular disease mortality in older adults with diabetes.

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OBJECTIVE: This study examines the association of walking with mortality in persons with type 2 diabetes compared to those with normal glucose tolerance. **STUDY DESIGN AND SETTING:** This prospective study included community-dwelling adults from the Rancho Bernardo Study aged 50-90 years in 1984-86 who had type 2 diabetes (n=347) or normal glucose tolerance (n=1,317). During the 10-year follow up, Cox proportional hazards modeling was used to model time until death from all causes (n=538), coronary heart disease (CHD, n=143), other cardiovascular disease (non-CHD CVD, n=138), and other causes (n=257) while adjusting for multiple potential confounders. **RESULTS:** After adjusting for sex, age, smoking, body mass index, alcohol, exercise, history of CHD, and other covariates, adults with diabetes who walked > or =1 mile per day were half as likely to die from all causes combined (hazard ratio [HR]=0.54; 95% confidence interval [CI]: 0.33, 0.88), and less than one-fifth as likely to die from non-CHD CVD (HR=0.19; 95% CI: 0.04, 0.86) compared to adults with diabetes who did not walk. Walking was also protective among adults with normal glucose tolerance (HR=0.55; 95% CI: 0.32, 0.96). **CONCLUSION: Results suggest walking > or =1 mile per day may provide strong protection from all-cause and non-CHD CVD mortality in older adults with diabetes.**

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Aerobic exercise training improves whole muscle and single myofiber size and function in older women.

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To comprehensively assess the influence of aerobic training on muscle size and function, we examined seven older women (71 +/- 2 yr) before and after 12 wk of cycle ergometer training. The decrease in normalized force was likely related to a reduction ($P < 0.05$) in myofibrillar protein concentration after training. In the absence of an increase in P_o , the increase in MHC I peak power was mediated through an increased ($P < 0.05$) maximum contraction velocity (V_o) of MHC I fibers only. The relative proportion of MLC(1s) (Pre: 0.62 +/- 0.01; Post: 0.58 +/- 0.01) was lower ($P < 0.05$) in MHC I myofibers after training, while no differences were present for MLC(2s) and MLC(3f) isoforms. **These data indicate that aerobic exercise training improves muscle function through remodeling the contractile properties at the myofiber level, in addition to pronounced muscle hypertrophy. Progressive aerobic exercise training should be considered a viable exercise modality to combat sarcopenia in the elderly population.**

Stroke. 2008 Nov;39(11):2950-7. Epub 2008 Aug 7

Cardiorespiratory fitness as a predictor of fatal and nonfatal stroke in asymptomatic women and men.

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BACKGROUND AND PURPOSE: Prospective data on the association between cardiorespiratory fitness (CRF) and stroke are largely limited to studies in men or do not separately examine risks for fatal and nonfatal stroke. This study examined the association between CRF and fatal and nonfatal stroke in a large cohort of asymptomatic women and men. **METHODS:** A total of 46,405 men and 15,282 women without known myocardial infarction or stroke at baseline completed a maximal treadmill exercise test between 1970 and 2001. CRF was grouped as quartiles of the sex-specific distribution of maximal metabolic equivalents achieved. Mortality follow-up was through December 31, 2003, using the National Death Index. Nonfatal stroke, defined as physician-diagnosed stroke, was ascertained from surveys during 1982 to 2004. Cox regression models quantified the pattern and magnitude of association between CRF and stroke. **RESULTS:** There were 692 strokes during 813,944 man-years of exposure and 171 strokes during 248,902 woman-years of exposure. Significant inverse associations between CRF and age-adjusted fatal, nonfatal, and total stroke rates were observed for women and men ($P \text{ trend} \leq 0.05$ each). After adjusting for several cardiovascular disease risk factors, the inverse association between CRF and each stroke outcome remained significant ($P \text{ trend} < 0.05$ each) in men. In women, the multivariable-adjusted relationship between CRF and nonfatal and total stroke remained significant ($P \text{ trend} \leq 0.01$ each), but not between CRF and fatal stroke ($P(\text{trend}) = 0.18$). A CRF threshold of 7 to 8 maximal metabolic equivalents was associated with a substantially reduced rate of total stroke in both men and women. **CONCLUSIONS: These findings suggest that CRF is an independent determinant of stroke incidence in initially asymptomatic and cardiovascular disease-free adults, and the strength and pattern of the association is similar for men and women.**