

ABSTRACT

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PhD Thesis: Effects of aging and training on sprint performance, muscle structure and contractile function in athletes

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Cross-sectional studies were conducted to examine sprint running, anaerobic energy production and muscle properties in male sprinters aged 17-88 years. In addition, a 20-week training intervention was carried out to determine whether older runners can further improve their neuromuscular and performance characteristics by a greater emphasis on strength training. With age, sprint performance declined gradually (5-6%/decade). The slowing of maximum speed was characterized by a reduction in stride length and an increase in contact time along with lower ground reaction forces (GRF) and smaller leg and vertical stiffness during the contact phase. Stride frequency showed small decline while swing time remained unaffected with age. Variability in the biomechanical parameters that showed good repeatability (CV 1-6%) was the same in the older as younger runners, and no age effect was seen in the symmetry of the measures. $[La]_{b\ peak}$ declined with age after races over 100-400 m, the decrease becoming more evident from age 70. Running times correlated inversely with $[La]_{b\ peak}$. Leg muscle thickness, type II fiber size and myosin heavy chain (MyHC) II isoform content decreased with age, while type I fiber size, fiber distribution and fascicle length showed no age differences. In single type I and IIa MyHC fibers, neither force adjusted for fiber size nor contractile speed differed between the groups. There was an age-related decline in maximal (8-9%/decade) and explosive (10-11%/decade) isometric and dynamic leg strength. The differences in maximal, but not in explosive, isometric strength were eliminated when normalized for muscle thickness. Muscle thickness was the strongest predictor of GRF in the braking phase, while the countermovement jump explained most of the variance in push-off GRF. The sprint training, including heavy-resistance and high-power strength exercises, resulted in significant gains in maximal and explosive strength and improvements in force production during running. The improvements were mainly related to hypertrophic adaptations. The results show that the deterioration in sprint performance with age is a complex phenomenon that may be affected by the interaction of changes in biomechanical, neuromuscular and metabolic factors. A major contributor appears to be reduced muscle mass, caused partially by decreased type II fiber size, which affects the GRFs required to achieve fast running speeds. However, habitual sprint training seems to maintain speed, strength and glycolytic energy production at high levels into older age and is effective in preventing the age-related decline in single fiber function and fascicle length. The data also suggest that to maximize the training effects on fast fibers, rapid strength and speed performance, the optimal training regimen requires a strength training component.

Key Words: aging, master athlete, muscle, single fiber, speed, sprint running, strength