Relations of Midlife Exercise Blood Pressure, Heart Rate and Fitness to Late Life Brain Structure and Function

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Background

Exaggerated blood pressure (BP) and vascular stiffness have been associated with lower cognitive performance and brain atrophy in older age. The brain is a high-flow, low impedance organ that is susceptible to fluctuation in BP. Poor cardiovascular (CV) fitness is also emerging as a factor associated with cognitive decline in older age. The BP and heart rate (HR) response to exercise are impacted by CV fitness; and exercise BP is also highly determined by vascular stiffness. The objective of this investigation was to examine whether poor fitness and exaggerated BP and HR response to exercise in midlife are associated with worse brain morphology in later life.

Methods

A subset of Framingham Offspring Study participants (n=1340, 54.5% F) free from dementia and CV disease underwent an exercise treadmill test (the modified Bruce protocol) in midlife [mean age of 41±9 y] and continued until exhaustion or until 85% HR maximum (age- and sex- predicted) was reached. Exercise test duration was used to estimate VO2max. BP and HR were measured during stage 2. MRI scans of the brain and neurocognitive tests (Trail Making Tests [Trails] B-A) were administered in later life [mean age of 59±9 y].

Results

A greater exercise systolic (S)BP and HR response at midlife was associated with smaller total cerebral brain volume (TCBV) in later life (β=-0.09 ±0.04, p=0.042; β=-0.10 ±0.05, p=0.033) after adjustment models including resting SBP and HR; an effect equal to approximately 0.5 y brain aging for every 11.1 mm Hg increase in SBP or 10 beats per min increase in HR. Higher estimated VO2max at midlife was associated with larger TCBV in later life (β=0.03 ±0.01, p=0.014). Additionally, greater exercise HR response at midlife was associated with smaller frontal lobe volume in later life (β=-0.012 ±0.05, p=0.002). Exercise diastolic (D)BP at midlife was associated with poorer performance on Trails B-A in later life (β=-0.009 ±0.004, p=0.017) and the achievement of target HR during exercise was associated with better performance on Trails B-A in later life (β=0.03 ±0.01, p=0.044). Resting SBP at midlife was associated with greater white matter hyperintensity volume in later life (β=0.05 ±0.02, p=0.031); and resting SBP and DBP at midlife were also associated with smaller frontal lobe volume in later life (β=-0.17 ±0.07, p=0.011; β=-0.21 ±0.10, p=0.030). Our investigation provides new evidence that lower midlife fitness and worse exercise BP and HR responses are associated with smaller brain volumes and poorer cognitive performance nearly two decades later. Promotion of midlife physical fitness may be an important step towards ensuring healthy brain aging in the population.

Disclosure

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