CHILDHOOD OBESITY, SEDENTARY BEHAVIOR AND BRAIN HEALTH

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Childhood obesity rates across the world have increased 3- to 6-fold over the last few decades. The latest estimates suggest that about 12% of children and adolescents are obese.[1] Alongside increasing obesity rates, sedentary behavior has reached alarming levels, with many children spending more than 60% of the waking day sedentary.[2] Sedentary behavior is a common form of physical inactivity that has been defined as 'sitting without otherwise moving'.[3] Current guidelines recommend children should minimize daily sedentary time by limiting screen-based entertainment to no more than two hours a day and limiting other sedentary activities such as transport in motorized vehicles and extended sitting.[4] Yet, children under 10 years of age are spending up to five hours per day with seated screen-based entertainment, which rises to more than 7 hours per day in 12-18 year-old youngsters.[5,6] This is particularly concerning given the evidence that childhood obesity is linked to poor vascular health[7] and the obese child experiences significantly longer sedentary bouts (Fig 1, panel B) and fewer active breaks (Fig 1, panel A) compared to the healthy weight child.[8,9]

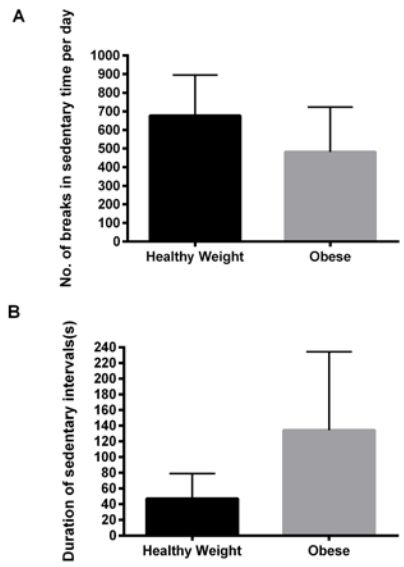

Figure 1. A. Active breaks in sedentary time per day and B. duration of sedentary bouts in healthy weight and obese 8-10

Obesity and sedentary aging are associated with a longitudinal decline in psychological health and increased cardiovascular disease risk, particularly the risk of cognitive decline, stroke and coronary heart disease.[10] In contrast, exercise activates metabolic pathways that appear to impact positively on both psychological and cardiovascular function in the young.[6,11] Far less is understood about the impact obesity coupled with excessive sedentary time has on brain health during childhood. There is some evidence that taking short (10-20 minute) exercise breaks from seated cognitive work results

in greater attention scores in children.[12] Cognitive function appears to be sensitive to changes in hemodynamic state; one explanation is that improved attention scores from acute exercise breaks are an outcome of cerebral perfusion or cerebrovascular reactivity.[13]

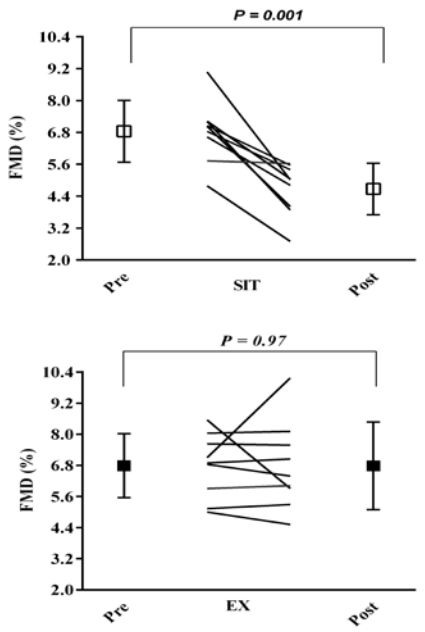

Figure 2. Flow mediated dilation of the superficial femoral artery before and after 3 hours of sitting with (EX) and without (SIT) hourly exercise breaks in 7-10 year-old girls.[15]

The use of experimental models of sedentary behavior are extending pre-existing epidemiological research showing that increasing levels of sedentary time are associated with increasing risks of cardiovascular disease. The use of experimental models of sitting in children and adolescents are scarce. There has been one study of adolescents, which did not find any deficits in insulin, glucose or lipids following an 8-hour period of sitting.[14] More recent findings in healthy weight children have found individualized moderate intensity exercise breaks are effective in offsetting metabolic and vascular dysfunction created by an acute period of sitting for three hours.[15,16] Breaking up sitting with three minutes of exercise at an individualized moderate intensity every 30 minutes resulted in a 32% reduction in insulin compared to continuous sitting in 7-11 year-olds.[16] Likewise, we have shown a relative decline of 33% in superficial femoral artery flow mediated dilation (an index of vascular health) following three hours of sitting in 7-10 year-old girls. This decline was prevented by taking a 10-minute moderate intensity exercise break each hour.[15] The decrease in superficial femoral artery flow mediated dilation from 7.04% at baseline to 4.71% (Fig. 2, top panel) is important because reductions in vascular function are predictive of poorer cardiovascular outcomes and worse vascular health, with a 1% decline in FMD (%) estimated to increase risk of a future cardiac event by up to 13%.[17] The protective effect of interrupting sitting with regular exercise breaks (Fig. 2, bottom panel) illustrates how detrimental, yet preventable, prolonged sitting is for vascular health.

The physiological consequences of obesity on the cerebrovasculature of the child have yet to be described. There is limited information on resting cerebrovascular function using transcranial Doppler in healthy weight childhood, with evidence of sex disparities in cerebral blood flow velocity and autoregulation.[18,19] Reduced cerebrovascular reactivity is apparent in obese hypertensive children and is associated with poorer executive function.[20]

Clinically this is important as reductions in cerebrovascular reactivity are associated with stroke risk, at least in adults.[21,22] Moreover, in adults, there is evidence that elevations in cerebral blood flow are related to better executive function.[23] There is limited information on the association between cognitive performance and cerebrovascular blood flow velocities in healthy weight or obese children.[24]

Taken together, the extant literature would suggest obese children sit more than health weight children and prolonged sitting poses a significant health risk. Prolonged sitting results in peripheral vascular dysfunction in children, but we know little about the effect of excessive sitting on cerebrovascular function, whether this is exacerbated in obesity and importantly whether any sitting induced decrements can be prevented by interrupting sitting with exercise.

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