EFFECTS OF EXERCISE ON MITOCHONDRIAL BIOGENESIS AND FUNCTION: ARE MITOCHONDRIA IMPAIRED IN DIABETES AND OBESITY?

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Obesity and Type 2 diabetes (T2DM) have been associated with reduced expression of mitochondrial oxidative phosphorylation genes, proteins, and lower mitochondrial enzyme activities. Rigorous exercise training in healthy individuals results in mitochondrial biogenesis. It is unclear, however, whether the deficiencies of mitochondria in obesity and T2DM are simply due to reduced mitochondrial biogenesis, or alternatively, due to a reduced function of mitochondria. Further, it is not clear to what extent these deficiencies can be rectified by moderate exercise. The purpose of this study was to examine the effects of obesity reduction (weight loss) and/or increased exercise in obesity and T2DM on mitochondrial biogenesis and function.

Obese participants with T2DM and without diabetes (O) completed a 16-week program of diet-induced weight loss ( 8-10% weight loss) combined with 3-5 days per week, 30-45 min per session of moderate (50-70% of VO2max) exercise (WLEX). Other groups of O performed weight loss alone (WL) or exercise alone (EX). EX resulted in an increased mitochondrial content assessed by electron microscopy and by cardiolipin. Activities of succinate dehydrogenase and citrate synthase, enzymes of the TCA cycle, also increased with EX. These increases ( 25-50%) were considerably less than the increases in activities of NADH oxidase ( 80-90%) as a measure of total electron transport chain activity. This mitochondrial biogenesis and increase in function were not observed with WL alone. Therefore, the reduced mitochondrial biogenesis in obesity and T2DM can be improved with moderate exercise, but not with weight loss. Even larger improvements in aspects of mitochondrial function were observed with exercise. These data suggest that there may be defects in mitochondria at specific loci in T2DM, which may be selectively improved with exercise. We conclude that the defects in mitochondria in obesity and T2DM is not simply a matter of reduced mitochondrial biogenesis, and that exercise may restore function of mitochondria in these conditions.

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