Exercising on the edge: mitochondrial and metabolic responses to intense training

av

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Akademisk avhandling

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Abstract:

Exercise and exercise training induces several physiological adaptations that increase the oxidative capacity of the muscles and improve glucose regulation. While the positive metabolic adaptations and effects on glucose regulation after exercise and exercise training have been extensively studied, negative outcomes have not. This thesis aims to address these questions and investigate possible negative effects of intensified training on mitochondrial parameters and glucose regulation.

In two separate interventions, we studied these outcomes after progressive exercise training, and after different intensities of exercise. Mitochondrial respiration was assessed in muscle biopsies taken from m. vastus lateralis 14 hours after exercise and oral glucose tolerance tests were performed at the same time point.

In paper I, we demonstrate that there is an upper limit of training load that can be tolerated without the manifestation of negative outcomes. After administrating almost daily sessions of high-intensity interval training, mitochondrial function and glucose control were impaired. In paper II, we used mitochondrial function as a novel biomarker of maladaptive training loads and constructed a diagnostic model that can be used for the early detection of maladaptations to exercise training.

In paper III, we further demonstrated that endurance-trained athletes can have decreased glucose tolerance and increased insulin resistance the day after three hours of continuous cycling whereas these responses were not accentuated in healthy controls. Our results indicate that a metabolic switch in favor of lipid metabolism is the probable cause of this phenomenon. In paper IV, we briefly commented on a publication that described changes in whole-body VO2 responses to work rates in the athlete with the highest recorded VO2max. We provided arguments that the observed changes in VO2 and gross efficiency can in part have their origin in the mitochondria.

We here combine measurements in muscle tissue with physiological measurements in an applied context. Using this integrated approach, we investigated the effects of intensified training on health-related and performance outcomes, thereby presenting insights into what maladaptations to exercise can constitute. We hope that our results and conclusions can help to further understand the complex relationship between exercise and health and to guide athletes and coaches to optimize training outcomes.

Keywords: Exercise, training, mitochondria, performance, glucose tolerance, proteins, oxygen uptake, metabolism, cycling
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