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High-intensity exercise training induces morphological and biochemical changes in skeletal muscles

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Skeletal muscle shows an elevated plasticity and can adapt its metabolic and contractile properties in response to a variety of stimuli such as physical exercise. This implies a series of biochemical and morphological changes in the recruited muscle, in order to produce the more appropriate functional response dependent on the specific stimulation. To determine the effective role of physical exercise in the muscle plasticity, in the present study we investigated the effect of two different exercise protocols on fiber composition and metabolism of two specific muscles of mice: the quadriceps -a fast-twitch muscle- and the gastrocnemius -a typical slow-twitch muscle.

Mice were run daily on a motorized treadmill for 8 weeks, at a velocity corresponding to 60% (low-intensity exercise) or 90% (high-intensity exercise) of the maximal running velocity previously determined by an incremental exercise test. We found that at the end of training the body weight was significantly increased in high-intensity exercise mice (18.2 ± 1.4 %) compared to low-intensity exercise (8.7 ± 0.6 %) and control (12.7 ± 0.5 %) groups, and it was lesser in low-intensity exercise mice compared to controls.

In contrast, the food intake of both exercise training mice was greater compared to control group. Whereas low-intensity exercise mice, despite consumed significantly more food compared to control mice, increased the weight lesser, the weight increase of high-intensity exercise mice, that consumed significantly more food compared to other experimental groups, was significantly greater. These effects were accompanied by a progressive reduction in blood lactate levels at the end of training in both the exercised mice compared with controls; in particular, blood lactate levels after high-intensity exercise were significantly lower than those measured in low-intensity exercise mice. Moreover, in the present study we demonstrated that high-intensity exercise training produced a significant increase in the expression of mitochondrial complex enzymes (significant for the enzymes corresponding to the Complex IV, II and I of mitochondrial chain) both in gastrocnemius and quadriceps muscle, compared with controls. These changes were associated with an increase in the amount of slow fibers in both these muscle of high-intensity exercise mice.

No changing in the expression of mitochondrial enzymes and in the percentage of slow fibers were found in low-intensity exercise mice.

Keywords: Exercise training, skeletal muscle plasticity, mitochondrial respiratory chain, immunohistochemistry.