

## **Muscle endurance: a review and update**

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Following many injuries, a period of disuse or immobilisation is required and muscle is relatively inactive. An inactive muscle undergoes rapid changes in structure and cellular function that are detrimental to performance. For the clinician to rehabilitate patients efficaciously, an understanding of neural and muscular mechanisms associated with endurance is important. Muscle endurance refers to the ability of a muscle to maintain performance over a sustained period of time. Muscle endurance requires central and peripheral mechanisms to be operating effectively. The relative contributions of the neural and peripheral mechanisms are still debated.

Central mechanisms include those proximal to the neuromuscular junction that lead to a decline in performance when attempting to sustain a sub maximal or maximal load. It is apparent that voluntary activation can decrease notably in such tasks and is in part due to reduced drive from the motor cortex. Variations in motor neuron recruitment and firing rate occur accordingly. In addition, the motoneuron pool is influenced by afferent feedback from muscle receptors. It also seems likely that afferent feedback will affect drive from the motor cortex. Furthermore, afferent signals provide a stimulus to invoke powerful vascular responses that regulate blood flow to the activated muscles.

Differences in muscle endurance have been noted between men and women. Studies indicate that supra spinal responses to fatiguing exercise are similar for men and women indicating that the source of the difference is likely to be at spinal and muscle levels. There is some evidence for gender differences in acidosis and increased dependence upon glycolytic metabolism in men during fatiguing tasks. The percentage of type II to type I muscle fibre has also been implicated. Interestingly, these differences are not as apparent under ischemic conditions suggesting that the delivery of oxygen is an important factor.

The type of task being undertaken is a major influence upon the amount of fatigue that will be measured and will also influence training effects. Physiological processes are altered optimally though exercise that is specific. It is apparent that combining training for different goals (e.g. strength or endurance) lessens the optimal physiological adaptations achievable and can therefore influence task performance.

While a single training session may induce signalling pathways to up-regulate cellular processes, they do so for only a few hours after the exercise session is completed, and hence are insufficient to induce a chronic adaptation. With on-going training, acute changes in signalling processes become cumulative and stimulate a higher level of synthesis of specific molecules leading to longer term adaptations within muscle. The optimal training program for improving muscle endurance has yet to be derived, however, there are guidelines associated with repetitions, sets, and work-rest intervals that allow a generalised prescription to be utilised with confidence of reasonable changes in performance being achieved in patients undergoing rehabilitation.