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# Sex differences in the rate of fatigue development and recovery

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## Abstract

**Background:** Many musculoskeltal injuries in the workplace have been attributed to the repetitive loading of muscle and soft tissues. It is not disputed that muscular fatigue is a risk factor for musculoskeltal injury, however the disparity between gender with respect to muscular fatigability and rate of recovery is not well understood. Current health and safety guidelines do not account for sex differences in fatiguability and may be predisposing one gender to greater risk. The purpose of this study was to quantify the sex differences in fatigue development and recovery rate of lower and upper body musculature after repeated bouts of sustained isometric contractions.

**Methods:** Twenty-seven healthy males (n = 12) and females (n = 15) underwent bilateral localized fatigue of either the knee extensors (male: n = 8; female: n = 8), elbow flexors (male: n = 8; female: n = 10), or both muscle groups. The fatigue protocol consisted of ten 30-second sub-maximal isometric contractions. The changes in maximum voluntary contraction (MVC), electrically evoked twitches, and motor unit activation (MUA) were assessed along with the ability to control the sustained contractions (SLP) during the fatigue protocol using a mixed four-factor repeated measures ANOVA (gender × side × muscle × time) design with significance set at $p < 0.05$.

**Results:** There was a significant loss of MVC, MUA, and evoked twitch amplitude from pre- to post-fatigue in both the arms and legs. Males had greater relative loss of isometric force, a higher rate of fatigue development, and were less capable of maintaining the fatiguing contractions in the legs when compared to the females.

**Conclusion:** The nature of the induced fatigue was a combination of central and peripheral fatigue that did not fully recover over a 45-minute period. The results appear to reflect sex differences that are peripheral, and partially support the muscle mass hypothesis for explaining differences in muscular fatigue.

## Background

Muscular fatigue is a complex process that is most often defined as an exercise induced reduction in the ability of a muscle to generate force [1,2], and has been studied over numerous exercises for decades in an attempt to understand and identify the mechanisms that lead to the loss of force production [1]. Muscle fatigue can occur centrally through the impairment of central drive and neuromuscular propagation, or peripherally through the impairment of muscle function, and more specifically excitation-contraction coupling impairment [2,3]. Therefore, distinctions must be made with respect to the nature of the