Muscular Fatigue Increases Ground Reaction Loading Rate During Walking

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Military personnel are commonly afflicted by overuse injuries such as tibia stress fracture during basic physical training. Muscular fatigue is thought to reduce the leg muscles’ ability to attenuate dynamic load on human musculoskeletal system during locomotion (Voloshin, et al. 1998). However, it is not clear if or how muscular fatigue influences mechanical loading of the lower extremities and increases the risk of developing tibia stress fracture.

**Purpose:** Compare peak ground impact forces and loading rates during a fatigued and unfatigued walking task.

**Methods:** Fourteen healthy male subjects (age: 21±2 yr.; body mass: 81.5±11.3 kg; body height: 182±4 cm) participated in the study. Subjects participated in a fatiguing protocol which involved a series of metered step-ups and heel raises while wearing a 16 kg rucksack. The presence of fatigue was determined by a decline in performance of a vertical jump test (< 80% of vertical jump max) Prior to and immediately after the fatiguing protocol, subjects performed level walking at 1.67 m/s on a force instrumented treadmill (AMTI). The following variables were analyzed: Peak vertical and antero-posterior ground reaction forces and peak instantaneous vertical and braking loading rates during first half of the stance. A one way repeated measures MANOVA was used to determine differences in these variables between unfatigued and fatigued conditions. $\alpha$ = 0.05.

**Results:** Compared to unfatigued condition, during the fatigued condition the subjects exhibited greater vertical ground reaction forces (1.36 ± 0.11 vs. 1.30 ± 0.07 BW, respectively) ($p = 0.000$), greater instantaneous vertical loading rates (24.46 ± 9.92 vs. 18.28 ± 4.51 BW/s, respectively.) ($p = 0.000$), and greater instantaneous braking loading rates (-10.48 ± 3.02 vs.-8.61 ± 1.99 BW/s, respectively.) ($p =0.001$).

**Conclusion:** Increased vertical loading rate has been linked to higher risk of tibia stress fracture for distance runners (Milner et al. 2006). In this study, muscular fatigue seems to lead to increases of vertical ground impact and instantaneous loading rates during walking at the given speed. It is possible that military personnel under
the influence of muscular fatigue may face increased risk of tibia stress fracture when participating in intensive physical training programs.

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