Accepted Manuscript

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PII: S0966-6362(17)30977-3
DOI: https://doi.org/10.1016/j.gaitpost.2017.10.021
Reference: GAIPOS 5850

To appear in: Gait & Posture

Received date: 21-3-2017
Revised date: 5-10-2017
Accepted date: 17-10-2017

Please cite this article as: Schütte Kurt H, Seerden Stefan, Venter Rachel, Vanwanseele Benedicte. Influence of outdoor running fatigue and medial tibial stress syndrome on accelerometer-based loading and stability. Gait and Posture https://doi.org/10.1016/j.gaitpost.2017.10.021

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Influence of outdoor running fatigue and medial tibial stress syndrome on accelerometer-based loading and stability

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Abstract
Medial tibial stress syndrome (MTSS) is a common overuse running injury with pathomechanics likely to be exaggerated by fatigue. Wearable accelerometry provides a novel alternative to assess biomechanical parameters continuously while running in more ecologically valid settings. The purpose of this study was to determine the influence of outdoor running fatigue and MTSS on both dynamic loading and dynamic stability derived from trunk and tibial accelerometry. Runners with (n=14) and without (n=16) history of MTSS performed an outdoor fatigue run of 3200m. Accelerometer-based measures averaged per lap included dynamic loading of the trunk and tibia (i.e. axial peak positive acceleration, signal power magnitude, and shock attenuation) as well as dynamic trunk stability (i.e. tri-axial root mean square ratio, step and stride regularity, and sample entropy). Regression coefficients from generalised estimating equations were used to evaluate group by fatigue interactions. No evidence could be found for dynamic loading being higher with fatigue in runners with MTSS history (all measures \( p > 0.05 \)). One significant group by running fatigue interaction effect was detected for dynamic stability. Specifically, in MTSS only, decreases mediolateral sample entropy i.e. loss of complexity was associated with running fatigue \( (p < 0.01) \). The current results indicate that entire acceleration waveform signals reflecting mediolateral trunk control is related to MTSS history, a compensation that went undetected in the non-fatigued running state. We suggest that a practical outdoor running fatigue protocol that concurrently captures trunk accelerometry-based movement complexity warrants further prospective investigation as an in-situ screening tool for MTSS individuals.

Keywords: Accelerometer; Running; Overuse Injury; Fatigue; Body-worn sensor; Complexity

Introduction
Medial tibial stress syndrome (MTSS) is a debilitating overuse injury of the tibia prevalent in runners and military recruits. MTSS is a primary running-related musculoskeletal injury with a prospective incidence rate up to 20\% [1], and a multi-factorial aetiology involving numerous extrinsic and intrinsic factors. The former includes training shoes, surface, interval training and intrinsic factors while the latter includes higher body mass index, fatigability, female gender, running experience, previous MTSS, and faulty biomechanics [2,3].
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