THE EFFECT OF EXHAUSTIVE RUNNING ON POSTURAL DYNAMICS

Mark Walsh[1], Adam Strang[2], Mathias Hieronymus[1], Josh Haworth[1]

Department of Kinesiology and Health, Miami University, Oxford, Ohio, USA[1]
Department of Psychology, Miami University, Oxford, Ohio, USA[2]

KEY WORDS: balance, fatigue, nonlinear dynamics.

INTRODUCTION: Recently, researchers have begun to use nonlinear measures such as the Lyapunovexponent (LyE) and Approximate Entropy (ApEn) to examine temporal structure in the continuous behavior of biological systems. When using these measures a higher score indicates lesser periodicity and greater chaotic behavior. A decrease in LyE and ApEn values have been shown in some cases to indicate pathological conditions. Studies of postural control have found that after a cerebral concussion, an athlete's center of pressure oscillations measured by ApEn are significantly decreased even up to 96 hours post-injury as compared with their preseason ApEn scores, even when the athlete appears steady (Cavanaugh, 2006). In regards to walking gate, local dynamic stability showed decreased variability when assessed amongst ACL reconstruction patients (Stergiou, 2004). The purpose of the current experiment ıs to use ApEn versus a set of traditional postural measure to evaluate a postural sway during upright stance prior to and following a bout of exhaustive running. In published balance studies only about 50% report significant improvements, possibly because traditional measures aren't capturing the improvements in postural control. Promising results from the above cited studies indicate that nonlinear measures may be measuring elements that the traditional measures don't detect.

METHODS: Following warm-up, participants (N=19) ran on a treadmill to exhaustion. Postural sway data was recorded via Center of Pressure (COP) obtained from a forceplate during upright stance for periods of 30s at six times during the experiment (baseline, post warm-up, post exhaustive running, and at 2, 5 and 10 minutes following the exhaustive run). From COP data researchers computed postural sway measures of COP path length, position variability, and ApEn for anterior-posterior and medial-lateral movement planes. It was predicted that measures of postural sway would exhibit a quadratic trend with measures deviating from baseline measures following bouts of exercise, returning to baseline levels with recovery. This would indicate that fatigued subjects would become more periodic and with recovery would return to a state similar to baseline values. To examine this hypothesis we performed a set quadratic contrast for each postural measure ($\alpha = 0.05$).

RESULTS: In both M-L and A-P planes measures of COP variability ($p=0.025$, $p=0.022$) and path length ($p=0.048$, $p=0.002$) displayed significant quadratic trends. Only ApEn values of COP data in M-L plane ($p=0.002$) exhibited the predicted trend. (A-P ApEn was $p=0.078$).

DISCUSSION: Our findings show that both sets of measures were successful detecting changes in postural control due to fatigue. These changes seem to imply that exhaustive running may compromise postural stability for a brief period of time.

CONCLUSION: We conclude that both traditional measures of postural sway and ApEn are effective tools for detecting changes in postural dynamics following exhaustive running. More research is needed in the area of nonlinear measurements and their application to analyzing human movement.

REFERENCES:

Cavanaugh, J.T., Guskiewicz, K.M., Giuliani, C.G., Marshall, S.M., Mercer, V.S., & Stergiou, N. (2006). Recovery of Postural Control After Cerebral Concussion: New Insights Using Approximate Entropy. *41*, 305-313.

Stergiou, N., Buzzi, U.H., Kurz, M.J., & Heidel, J (2004). *Innovative Analyses of Human Movement: Analytical Tools of Human Movement Research*. Champaign, IL:Human Kinetics.