

# **FOOTWEAR INDUCED CHANGES OF REARFOOT MOVEMENT AND ENERGY CONSUMPTION IN DISTANCE RUNNING**

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## **INTRODUCTION**

Despite a great deal of research on foot-ground contact mechanics in the past 25 years, little is known about the precise etiology of injuries in running. Recently, the modulation of leg muscle activity by impact forces has been suggested as a promising approach to understand overuse injuries which mainly affect soft tissues and muscles (Nigg, 2001). If muscle activity is modulated by variations in running shoes it is likely that this will influence fatigue during longer training sessions. Increased neuro-muscular effort (Moritani et al, 1993) should then accompany a greater energy consumption during steady state running. Other authors (Derrick et al, 2002) found knee flexion at heel impact increased and the rearfoot becoming more inverted at impact with increased exhaustion during running. Modifications in midsole geometry to vary rearfoot movement were used on trained subjects who performed 12.5 km runs with each shoe modification respectively (Kersting & Newman, 2003). Impact forces and rearfoot motion did not follow predicted values from previous studies (Stacoff et al., 1988). However, results showed large but individually different variations in neuro-muscular effort. It can be expected that variations in muscular activity are associated with running economy. No current literature has compared changes in kinematics to oxygen consumption and muscle activations during running in modified shoes.

The purpose of the current study is to relate exertion levels during treadmill running in three systematically modulated shoes to oxygen consumption, mechanical parameters and muscular activity.

## **METHODS**

Twelve well trained long distance runners were selected for the study. Subjects were allowed a 5-10 min warm up to allow familiarization with treadmill running. Following the warm-up, each subject performed three trials in one training session. Each session consisted of 16 min running on a treadmill (Quinton) in each of the three modified shoes at a constant running speed (lateral wedge, neutral and medial wedge under the heel of a Nike Pegasus running shoe). A  $VO_2$  analyser system (MOXUS Modular  $VO_2$  System) was used to monitor oxygen consumption. Sagittal plane and rearfoot kinematics were assessed using 2D high-speed video system (Simi-Motion, Basler AF602 camera) with reflective markers placed on the shoes and the right leg and a custom-made rearfoot goniometer, respectively. Muscle activations were recorded using bipolar surface EMG on eight muscles of the right leg (Biovision). Rated perceived exertion and shoe comfort were assessed using visual analogue scales. Heart rate was measured relative to oxygen consumption (Polar Heart Rate Monitor). A repeated measures ANOVA was used to test for significant differences ( $p < 0.05$ ).

## **RESULTS**

Rearfoot movement varied according to the wedges inserted to the heel of the running shoe. Differences were statistically significant between shoes (Figure 1A). Oxygen consumption showed significant differences between the lateral and medial insert condition with higher values for the medial wedge. Similarly but not consistently for all subjects the IEMG of several muscles over the whole stride time was increased for the medial wedge condition. Sagittal plane kinematics did only demonstrate marginal differences between shoe conditions.

## DISCUSSION

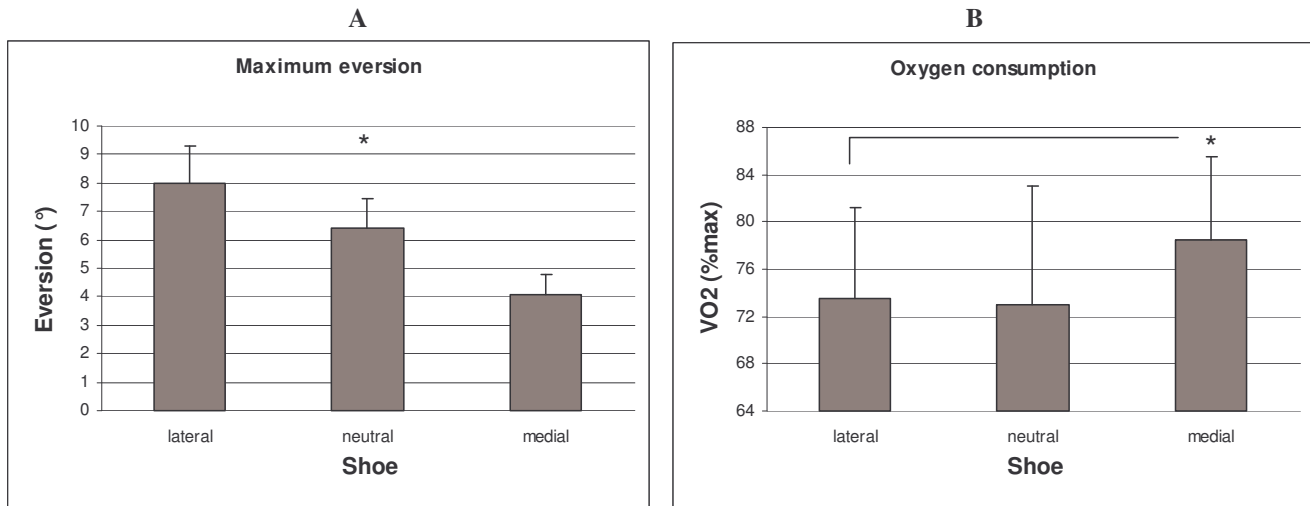


Figure 1: Maximum rearfoot eversion (A) and average oxygen consumption (B) for running with lateral, neutral and medial wedges under the rearfoot.

The assessment of physiological measures for energy expenditure like oxygen consumption are subject to day-to-day variability. Therefore, a test was designed which allows to compare three different shoe conditions with in one testing session. The data clearly indicates that a relationship between oxygen consumption and mechanical changes to the foot-shoe-ground interface exist. The modulation of muscular activity appears to be individually different. Therefore, it might be possible to optimize running shoes with regard to running economy, which in turn may affect the development of overuse injuries.

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## REFERENCES

- Derrick, TR., Dereu, D., McLean, SP. (2002) *Med Sci Sports Exercise* 34(6): 998-1002.
- Kersting, U.G., Newman, K.D. (2003) *Proc. of the XIXth Conf. of the ISB*, p. 200.
- Moritani et al. (1993) *J Appl Physiol* 74: 1729-1734
- Nigg, B.M. (2001) *Clin J Sport Med* 11(1): 2-9.
- Stacoff, A., Denoth, J., Kaelin, X., Stuessi, E. (1988) *Int J of Sport Biomech* 5: 342 – 357.