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Effect of Minimalist Footwear on Running Economy Following Exercise-Induced Fatigue

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Abstract : Running economy is a key physiological parameter of an individual's running efficacy and a valid tool for predicting performance outcomes. Of the many factors known to influence running economy (RE), footwear certainly plays a role owing to its characteristics that vary substantially from model to model. Although minimalist footwear is believed to enhance RE and thereby endurance performance, conclusive research reports are scarce. Indeed, debates remain as to which footwear characteristics most alter RE. The purposes of this study were, therefore, two-fold: (a) to determine whether wearing minimalist shoes results in better RE compared to shod and to identify relationships with kinematic and muscle activation patterns; (b) to determine whether changes in RE with minimalist shoes are still evident following a fatiguing bout of exercise. Well-trained male distance runners (n=10; 29.0 ± 7.5 yrs; 71.0 ± 4.8 kg; 176.3 ± 6.5 cm) partook first in a maximal O_2 uptake determination test (VO_{2max} = 61.6 ± 7.3 ml min^{-1} kg^{-1}) 7 days prior to the experimental sessions. Second, in a fully randomized fashion, an RE test consisting of three 8-min treadmill runs in shod and minimalist footwear were performed prior to and following exercise induced fatigue (EIF). The minimalist and shod conditions were tested with a minimum of 7-day wash-out period between conditions. The RE bouts, interspaced by 2-min rest periods, were run at 2.79, 3.33, and 3.89 m s^{-1} with a 1% grade. EIF consisted of 7 times 1000 m at 94-97% VO_{2max} interspaced with 3-min recovery. Cardiorespiratory, electromyography (EMG), kinematics, rate of perceived exertion (RPE) and blood lactate were measured throughout the experimental sessions. A significant main speed effect on RE (p=0.001) and stride frequency (SF) (p=0.001) was observed. The pairwise comparisons showed that running at 2.79 m s^{-1} was less economic compared to 3.33, and 3.89 m s^{-1} (3.56 ± 0.38, 3.41 ± 0.45, 3.40 ± 0.45 ml O_2 kg^{-1} km^{-1}; respectively) and that SF increased as a function of speed (79 ± 5, 82 ± 5, 84 ± 5 strides min^{-1}). Further, EMG analyses revealed that root mean square EMG significantly increased as a function of speed for all muscles (Biceps femoris, Gluteus maximus, Gastrocnemius, Tibialis anterior, Vastus lateralis). During EIF, the statistical analysis revealed a significant main effect of time on lactate production (from 2.7 ± 5.7 to 11.2 ± 6.2 mmol L^{-1}), RPE scores (from 7.6 ± 4.0 to 18.4 ± 2.7) and peak HR (from 171 ± 30 to 181 ± 20 bpm), expect for the recovery period. Surprisingly, a significant main footwear effect was observed on running speed during intervals (p=0.041). Participants ran faster with minimalist shoes compared to shod (3:24 ± 0:44 min [95%CI: 3:14-3:34] vs. 3:30 ± 0:47 min [95%CI: 3:19-3:41]). Although EIF altered lactate production and RPE scores, no other effect was noticeable on RE, EMG, and SF pre- and post-EIF, except for the expected speed effect. The significant footwear effect on running speed during EIF was unforeseen but could be due to shoe mass and/or heel-toe-drop differences. We also cannot discard the effect of speed on foot-strike pattern and therefore, running performance.

Keywords : exercise-induced fatigue, interval training, minimalist footwear, running economy
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