

Acute impact of barefoot running on running economy in recreational runners: A conceptual framework.

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This project does not attempt to produce generalizable knowledge. It is dedicated to the practice of developing skills and demonstrating understanding of the research process.



Abstract

Barefoot (BF) running is associated with biomechanical alterations that improve performance by increasing running economy (RE). The purpose of this study was to examine the impact of acute BF running on RE in recreational runners. Participants ($n = 20$) completed treadmill trials in conventional running shoes (CRS) and BF at 60% and 80% of VO_{2max} . A two-way repeated measures analysis of variance ($p < 0.05$) measured the effects of shoe condition on RE. Results were expected to reflect the speed-dependent nature of RE, reduced shoe weight in the BF condition, individualized biomechanical and stride adjustments, and the physiological cost of task novelty. Future directions include expanding population, duration, and variable analysis.

Introduction

Over the past decade, barefoot (BF) running has exploded among professional and recreational running communities. Proponents suggest that BF running can improve performance by increasing running economy (RE) (Tam et al., 2014).

Previous studies have shown that 6 to 12 weeks of BF or minimalist footwear (MFW) training increases RE (Fuller et al., 2016; Fuller et al., 2016; Lindlein et al., 2018; Perl et al., 2012; Tam et al., 2015; Warne et al., 2015). Possible biomechanical mechanisms behind improved efficiency are illustrated below in Figure 1.

Few studies have examined immediate responses to BF running. While acute biomechanical adjustments could improve RE, efficiency may initially decrease due to task novelty (Melcher et al., 2017).

Cochrum et al. (2017) and Kalina et al. (2012) observed no acute changes in RE between BF, MFW, and conventional running shoe (CRS) conditions, but used runners with previous BF experience, small sample size, and elite populations, which may respond differently than recreational populations due to optimized running parameters.

The purpose of this study was to determine the immediate effect of an acute transition to BF running on RE in recreational runners with no prior experience in BF or MFW running. It was hypothesized that runners would exhibit immediate improvements in RE, despite task novelty and the individualized nature of biomechanical changes.

Figure 1. Biomechanical responses to BF running

Stride Characteristics	Decrease in stride length and increase in stride frequency (Fleming et al., 2015; Fuller et al., 2016) Shorter ground contact time (Abolins et al., 2018)
Strike Pattern	Variable; BF or MFW running may encourage a forefoot or midfoot strike rather than a rearfoot strike (Perl et al., 2012; Latorre-Roman et al., 2019)
Joint Kinematics	Greater plantarflexion and knee extension at stance; increased ankle and knee ROM for shock absorption (Leblanc & Ferkanus, 2018; Melcher et al., 2017)
Kinetics + Muscle Activity	Higher ground reaction forces (Abolins et al., 2018) Increased ankle plantar flexor activity at toe off (Latorre-Roman et al., 2019; Melcher et al., 2017)

Operational Definitions

Running Economy (RE) - The oxygen cost of running at a constant velocity while in aerobic steady state, corrected for bodyweight and speed ($mL \cdot kg^{-1} \cdot km^{-1}$) (Mendonca et al., 2020).

Recreational Runners - Individuals who have run at least 3 times weekly for the past 6 months and are not involved in college athletics or qualification events; VO_{2max} is between 120-180% of age- and gender-predicted norms (Mendonca et al., 2020).

Barefoot (BF) Running - Running without any shoes; similar but not identical to running in minimalist footwear (MFW), zero-drop, low-mass shoes with minimal cushioning.

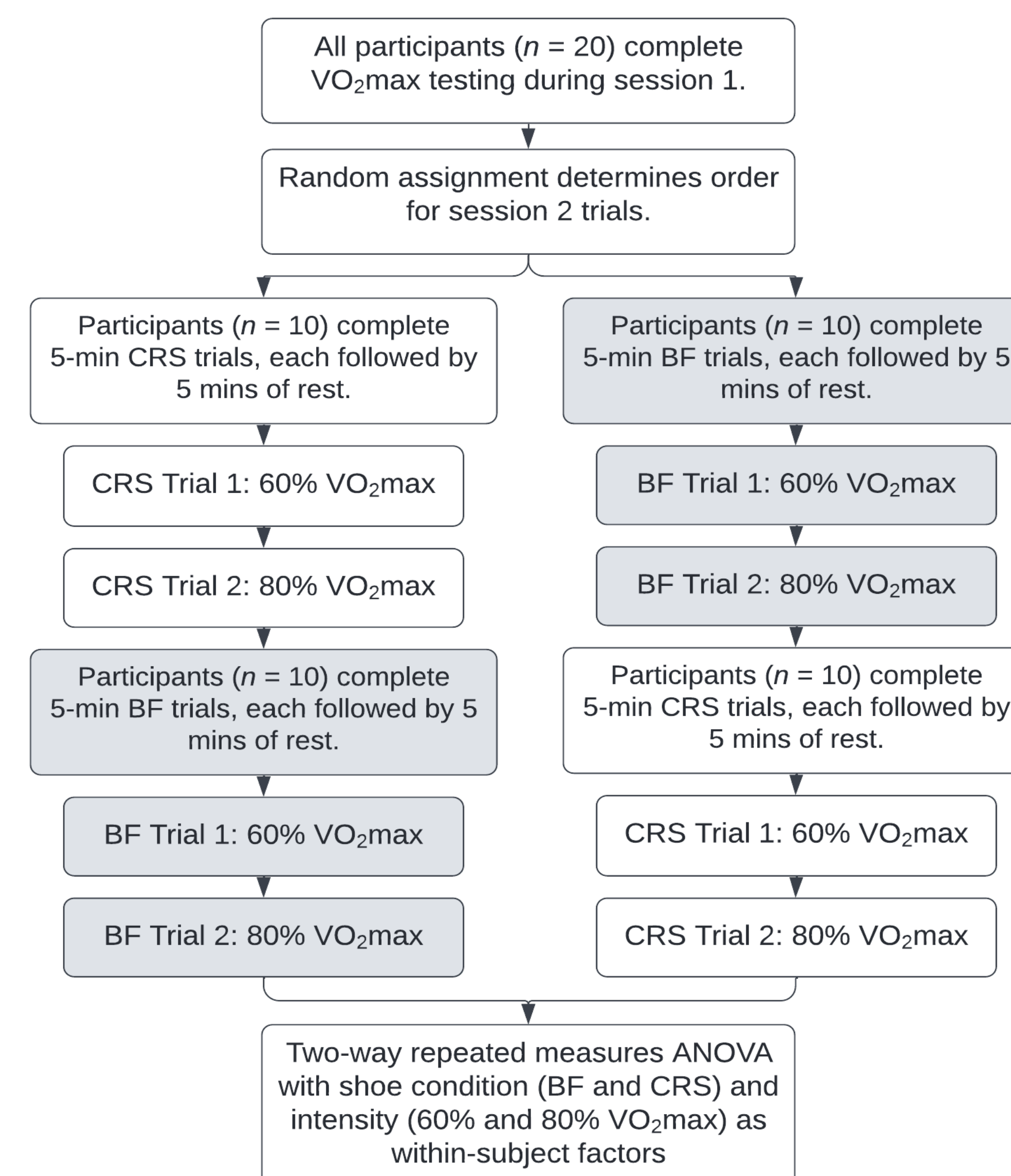
Methodology

Participants were 20 recreational runners between the ages of 18 and 55 (female $n = 10$, male $n = 10$) with no prior experience in MFW or BF running and no musculoskeletal injury or pain preventing running for 3 months prior to participation.

This study was authorized by the Institutional Review Board at the host institution and all participants were required to sign an informed consent form. Data was kept confidential and participants were given an explanation of results if desired.

This study used a repeated-measures design with intra-subject control (CRS) and experimental (BF) conditions. During session 1, VO_{2max} testing was performed. Session 2, completed a minimum of 3 days and a maximum of 14 days after Session 1, included control and experimental trials (see Figure 2).

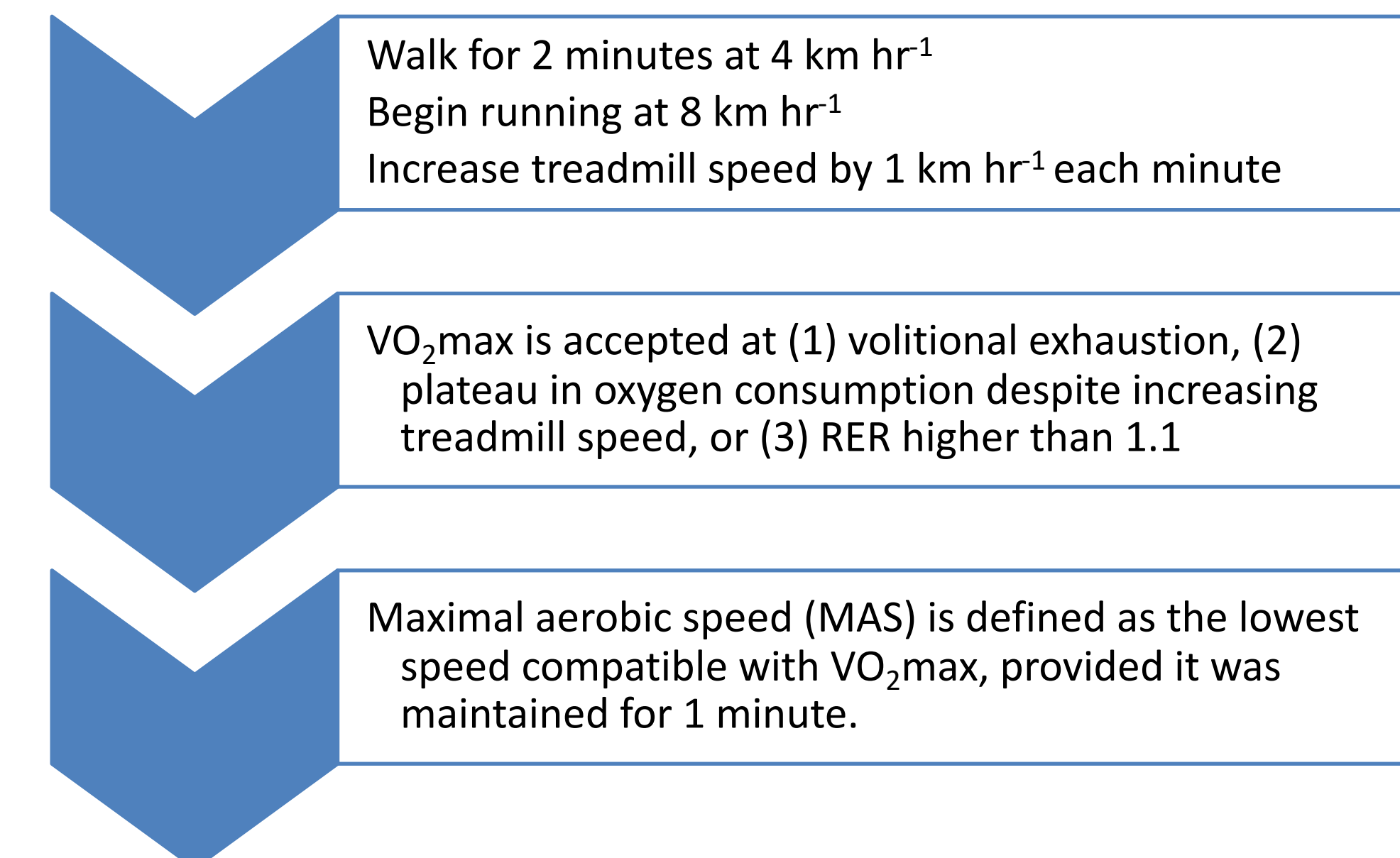
Figure 2. Study design



VO_{2max} protocol (see Figure 3) was based on Cochrum et al. (2017) and used to determine maximal aerobic speed (MAS). MAS was used to calculate speeds representing 60% and 80% of individual VO_{2max} .

Measured VO_{2max} was compared to age- and gender-predicted values from the equation used by Mendoca et al. (2020) to verify participants' status as recreational runners.

Figure 3. VO_{2max} testing protocol



During 5-minute experimental trials, pulmonary gas exchange was measured on a breath-by-breath basis using a Parvo Medics 2400 TrueOne system.

RE was determined based on 15-second averages from the last minute of testing, provided RER was under 1.00 representing aerobic steady-state.

In between trials, participants completed 5 minutes of standing rest. HR was monitored using Polar HR monitors and a HR below 120 bpm was required for continuation (Cochrum et al., 2017).

Participants wore their own self-selected CRS for CRS trials.

The treadmill used for sessions 1 and 2 was a Matrix Ultimate Deck TF 30 set at a 1% grade.

Data was assessed for normality using the Kolmogorov-Smirnov test and statistical analysis was performed using a two-way repeated measures ANOVA (see Figure 2; $p < 0.05$).

Future Directions

Measure changes in stride characteristics, strike pattern, kinetics, joint kinematics, and muscle activation patterns to enhance understanding of factors driving individual changes in RE.

Expand study framework to include measurements of RE throughout 8 to 12 weeks of training to examine how biomechanical changes are selected and integrated by neuromuscular control systems over time.

Expand participation to include participants of varying levels of training to explore the population-specific nature of RE adjustments.

Significance

This proposed framework provides data on acute RE responses in a previously little explored population: recreational runners. It increases the applicability of BF training recommendations while highlighting the net effect of biomechanical adjustments and increasing understanding of BF running as a potential method to improve efficiency and performance for all running populations.



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