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Influence of different longitudinal bending stiffness of running “Super shoes” on biomechanics and running economy.

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INTRODUCTION:

Running performance, particularly in long distance events such as the marathon, depends on an inter-play of several physiological factors, including the metabolic cost of running (RE). Increasing shoe longitudinal bending stiffness (LBS) influenced RE and performance[1], being one of the main features of the new “Super Shoes”. However, results on the effects of increasing LBS using flat carbon fiber plates or insoles are mixed. The main difference of the shoes conditions in these studies compared to “Super Shoes” is that “Super Shoes” have a curved plate instead of a flat plate and new more resilient and compliant foams. The purpose of this study was to evaluate the isolated effects of increased LBS by embedding a curved carbon fiber plate within a PEBA midsole of a “Super Shoe” on RE and biomechanics.

METHODS:

Twenty-one male trained runners participated in this study. Subjects ran 4 x 4 min at 13 km hr⁻¹ with two experimental condition shoes models with curved carbon fiber plate in a “Super shoe” model with different LBS increments (Stiff: 35.5 N·mm⁻¹ and Stiffest: 43.1 N·mm⁻¹) and a control condition (without carbon fiber plate: 20.1 N·mm⁻¹). We measured energy cost of running (W·kg⁻¹), spatiotemporal and neuromuscular parameters in one visit.

RESULTS:

There were significant differences between shoe conditions in RE measured as energy cost ($p < 0.001$; $n_2 = 0.374$). RE improved for the Stiff shoe condition (15.71 ± 0.95 W·kg⁻¹; $p < 0.001$; $n_2 = 0.374$) compared to the control condition (16.13 ± 1.08 W·kg⁻¹) and stiffest condition (16.03 ± 1.19 W·kg⁻¹), without differences between stiffest and control conditions. Moreover, there were an increase of step length and flight time for both experimental conditions in comparison to control condition and an increase of leg stiffness in the Stiff condition in comparison to control condition, but without differences between Stiffest and control conditions.

CONCLUSION:

Changes in LBS on “super shoes” influence RE in a “U-shaped” relationship, decreasing 2.56% energy cost of running (better RE) in the Stiff condition in comparison with the control, and 1.98% when comparing the Stiff condition with the Stiffest, similar to a previous study with flat plates[2]. However, the Stiff and Stiffest condition experienced similar spatiotemporal changes compared to the control condition (increases in step length and flight time) except for leg stiffness. Higher leg stiffness has been related to a better RE [3], thus, it seems that the “optimal” LBS condition caused changes in leg stiffness whereas when the increase in LBS is excessive (Stiffest condition) it did not.

References

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