Incremental Innovations: How Small Design Changes Enhance Running Economy in Footwear

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Summary

This study investigated the effects of design changes between two versions of advanced footwear technology (AFT) on running economy (RE) in trained runners. Results showed a 1.31% improvement in running economy for the newer shoe model, likely due to reduced mass, altered midsole geometry, and cushioning stiffness. The findings demonstrate the potential for performance enhancement through incremental design changes.

Introduction

Marathon performance is influenced by physiological factors like RE and external factors, including footwear [1]. AFT improves RE by ~4% through innovations such as carbon fiber plates and compliant and resilient foams, although individual performance improvements vary [2]. Manufacturers frequently release updated versions of these shoes, introducing incremental design changes from year to year. However, the impact of incremental design changes between successive AFT models remains unclear. This study investigates whether consecutive iterations of an AFT shoe model from the same brand yield measurable RE improvements. Findings can guide athletes in footwear selection and manufacturers in product development.

Methods

Nineteen trained male runners (37.5 ± 12.4 years; 70.9 ± 5.4 kg; mean ± 1 SD) participated. Two top-tier racing shoes (adidas Adios Pro 3 and Pro 4) were tested in randomized order at individualized submaximal running speeds (~13.4 ± 1.1 km/h) during a single lab session on a force-instrumented treadmill.

Gas exchange data were collected during 6 minutes of steady-state running, and RE was defined as average oxygen consumption between 2:30–5:30 min of each trial. Wilcoxon signed-rank test was conducted to compare RE between shoe conditions.

Results and Discussion

The adidas Adios Pro 4 showed a 1.31% improvement in RE compared to the Pro 3 ($p < .001$), with oxygen consumption decreasing from 46.4 ± 4 to 45.8 ± 4.1 $mL \cdot min^{-1} \cdot kg^{-1}$ at 13.4 ± 1.1 km/h. This improvement corresponds to a potential 0.87% time advantage, suggesting performance benefits for elite-level competitions [3]. The improvement is likely due to the 30 g reduced shoe mass, altered midsole rocker geometry, and adjusted bending stiffness collectively contributing to lower energy expenditure. The study highlights the potential for performance enhancement through incremental design changes in AFT. However, as technological advancements in shoe design approach their theoretical limits, further improvements may face diminishing returns, restricted by engineering constraints and regulatory guidelines. Limitations include the absence of biomechanical data, single-trial assessments, and an all-male sample. Future studies should incorporate repeated measures, biomechanical analyses, and more diverse participants to better understand individual responses to shoe technology to provide valuable insights for athletes and manufacturers.

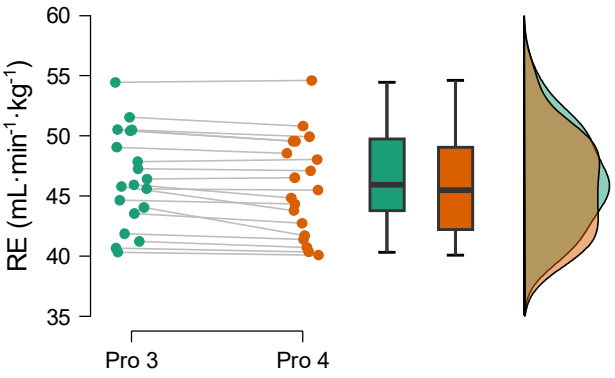

Figure 1: Comparison of running economy (RE) between adidas Adios Pro 3 (green) and Pro 4 (orange) conditions.

Conclusions

This study demonstrates a 1.31% improvement in running economy through incremental design changes in a high-performance running shoe, highlighting the potential for performance enhancement through shoe design, while emphasizing the importance of objective measurements.

Acknowledgments

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References

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