The relationship between biomechanical and physiological parameters during outdoor running

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Summary

This study investigated the relationship between biomechanical deflection point velocities (V_{BDP}), obtained from outdoor running, and the velocity at the anaerobic threshold (V_{AT}). Twenty-four recreational runners participated in an incremental speed test to capture the deflection points of kinematic parameters. The results revealed no significant differences between the deflection point velocities, and most parameters were strongly correlated (r = .61~.78) to V_{AT}. The findings suggest that predicting V_{AT} using V_{BDP} is feasible. Kinematic parameters can be measured relatively easily, wearable devices hold potential for identifying optimal running speed in real-time.

Introduction

Traditionally, running intensity and pace has been assessed by identifying critical turning points in physiological parameters as speed increases [1]. However, as running speed rises, nonlinear changes in running kinematic may also occur [2]. This raises the question of whether observing deflection points in biomechanical parameters related to running kinematic could serve the same purpose as physiological parameters. This study aimed to identify key kinematic indicators by examining the relationship between biomechanical deflection point velocities (V_{BDP}) and the velocity at the anaerobic threshold (V_{AT}) during outdoor running.

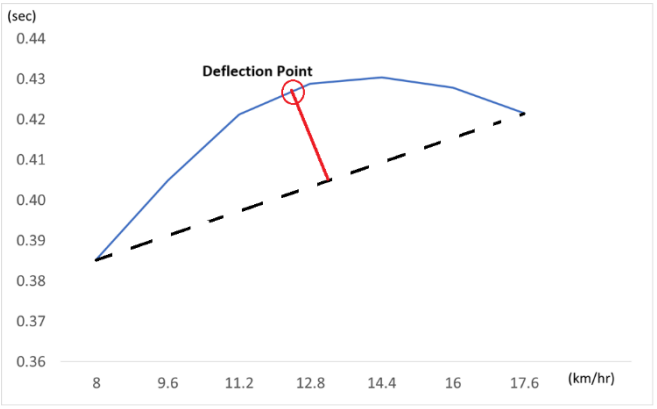
Methods

Twenty-four recreational runners were recruited for this study and participants performed an outdoor incremental exhaustion test. Respiratory analysis was conducted using (Cortex METAMAX® 3B, DE), while running kinematic parameters were measured using two inertial measurement units (Blue Trident - Vicon Motion Systems Ltd, Oxford, UK). These sensors were placed at the lower back, and the right tibias. The D-max method was used to calculate the deflection points for each kinematic parameter as speed increased. One-way repeated measures analysis of variance was conducted to determine whether there were significant differences between V_{BDP}s and V_{AT} and Pearson's correlation analysis was employed to examine the relationships.

Results and Discussion

In the outdoor tests, V_{AT} showed no significant differences compared to V_{BDP}s. However, strong correlations were observed among all parameters (r = .61~.78). The error range of approximately -3.30 to 2.80 km/h. Consistent with previous studies, many biomechanical parameters exhibit nonlinear deflection after reaching critical running speed [3]. This enables the use of the D-max method to identify the deflection points at specific running speeds. In this study, all observed kinematic parameters demonstrated clear deflection points, which occurred in the middle to later stages of the incremental speed test, which coinciding with the timing of the anaerobic threshold. This suggests that both kinematic and physiological parameters undergo nonlinear changes as exercise intensity increases.

Figure 1: Identification of the gait flight times deflection point using the d-max method for determining V_{BDP}



Conclusions

In outdoor running, most V_{BDP}s were highly correlated with V_{AT} and showed no significant differences, indicating their potential for estimating anaerobic threshold velocity. Additionally, the deflection point can be suggesting the usefulness for developing race pace strategies.

Acknowledgments

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