Research on Running Shoe Stability Mechanical Testing Equipment and Evaluation Criteria

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Summary

The research proposed the stability parameter W and designed a set of running shoe stability testing equipment to achieve repeatable and parameter-adjustable tests. By performing parametric correction using real-person data, the equipment's performance and the stability parameter's feasibility were evaluated. Ultimately, mechanical test evaluation standards for running shoe stability were established.

Introduction

Running is globally popular with many health benefits but may cause musculoskeletal injuries [1]. It is crucial to have a pair of sports shoes with good stability. They can reduce lower limb injuries during running and also decrease energy loss.

Existing running shoe motion control evaluation methods require human participation [2], which is time-consuming and costly. Moreover, this method is not suitable for tests related to injury risks, such as shock-absorbing ability. Computer simulation methods face significant challenges in simulating test conditions and the complex geometry of the human foot and may be inaccurate and unrealistic. Therefore, the method using mechanical devices is preferred and urgently needed.

Methods

Based on existing standard [3], we adopted some parameters to form a running-shoe stability parameter:

$$W = \frac{TMRA}{TA \cdot MRA \cdot TRM \cdot V_{peak}}$$

Here, W is the stability parameter. The larger the value of W, the better the stability of the running shoes. TMRA is time to maximum rearfoot, TA is the touchdown angle, MRA is the maximum rearfoot angle, TRM is total rearfoot motion, and V_{peak} is the peak angular velocity.

Based on the parameter W, the running-shoe-stability testing device was designed and manufactured. It is composed of a mechanical main body, a control console, and calculation software (Figure 1A). By adjusting body weight, touchdown angle, and calf muscle force, the touchdown process, which is the most prone to injury during running, can be simulated.

To verify the accuracy of the evaluation indicators and the equipment, 10 running enthusiasts were recruited to participate in a human experiment. The experiment was conducted on a professional treadmill, and the changes in the rear-foot angle were recorded during their running.

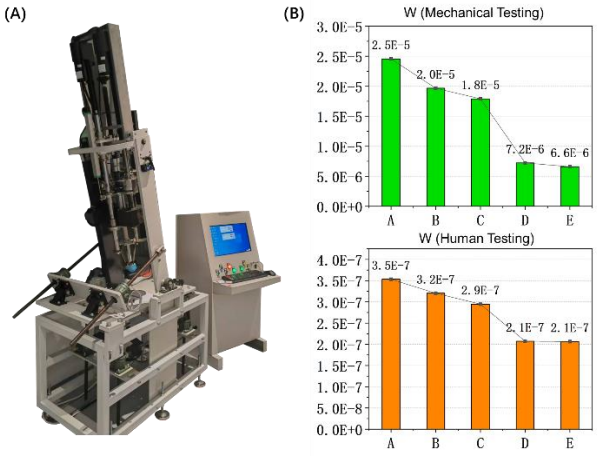

Figure 1: (A)The testing device. (B)The stability parameter W obtained from mechanical testing and human testing.

Results and Discussion

For different shoes, the trends of the stability W measured by the mechanical test and the human experiment are the same, but there is a significant difference in numerical values (Figure 1B). This may be because the accuracy of the ankle joint design in the equipment fails to match the real biological structure. However, the equipment can still effectively reflect the differences in the stability of different shoes.

Conclusions

This research has developed an effective evaluation index for running shoe stability and, based on this index, created a repeatable and parameter-adjustable running shoe stability testing device. This device can replace the original human-based testing method in the evaluation of running shoe stability.

ReferencesAcknowledgments

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