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Leg stiffness during running in highly cushioned shoes with a carbon-fiber plate and traditional shoes

(カーボンプレート内蔵厚底ミッドソールシューズと従来構造のシューズ間におけるランニング中の脚スティフネスの相違)

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Abstract

The highly cushioned shoes with a carbon-fiber plate shoes, such as Nike ZoomX Vaporfly shoes (NVF) improves running economy (Hoogkamer et al., 2018) compared to the traditional racing shoes (TRAD). The biomechanical mechanisms of these shoes are not fully understood, although thicker midsoles and carbon fiber plates are considered to play an important role in the spring-like leg characteristics during running. The spring-like function of the leg and shoe contributes to running efficiency. We speculated that an appropriate adjustment of leg stiffness for characteristics of midsole foam is one of the determining factors in running economy. Therefore, we aimed to clarify the differences in leg stiffness during running in the NVF and TRAD shoes.

The running experiment was conducted with 20 male long-distance runners. The participants' lower limb was modeled in a spring-mass model during running at 20 km/h, and leg stiffness was calculated. Statistically significant differences in mean values between the shoe conditions were determined using paired t-test for discrete parameters and statistical parametric mapping for continuous parameters. The level of significance was set at $\alpha = 0.05$.

The main results of this study were shown that the leg stiffness was not significantly different between the shoe conditions. The characteristics of NVF are the curved carbon-fiber plate for increasing the longitudinal bending stiffness and midsole form, which has greater resilience. Basically, it has been suggested that carbon plates act as levers by increasing the longitudinal bending stiffness, but the contribution of its to vertical spring is small (Hoogkamer et al., 2019). In contrast, the midsole is considered an additional spring in series with the lower leg spring. Moreover, leg stiffness was increased when lower midsole stiffness during running (Kulumara et al., 2018). In addition, it was indicated that the elastic energy return assists the runner's leg spring (Kerdock et al., 2002). These previous studies suggest that the lower stiffness and high resilience characteristic of the VF midsole would lead to the present main result of no significant differences in leg stiffness between the shoe conditions. In conclusion, leg stiffness was not significantly different when top-level

runners ran in the NVF compared to TRAD at 20 km/h.