

Biomechanical interrelationship between bodily and movement characteristics in jumping

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1. Purpose

In competitive sports, athletes try to optimise their movements and bodies to achieve higher performance. In the high jump, inter-individual movement variability exists independently of performance, even in theoretically important movement variables such as take-off duration; however, it has been unclear what makes this variability. The purpose of this thesis was to clarify the interrelationships between bodily and movement characteristics in the high jump, and the determinants of inter-individual variability in the high jump.

2. Methods

Study 1: I compared the mechanical properties of the medial gastrocnemius muscle–tendon unit [trained high jumpers (n = 10) vs untrained males (n = 14), a world-elite high jumper vs trained high jumpers] measured by the torque dynamometer and the ultrasound.

Study 2: I captured and analysed the kinematic and kinetic data on the high jumps performed by 16 male high jumpers by force platforms and the motion capture system.

3. Results and Discussion

In Study 1, I found that high jumpers have larger torque exertion ability than controls while maintaining tendon compliance. Maximum torque was correlated with the personal record of the high jump, whereas tendon stiffness was not. Furthermore, a

world-elite jumper had a relatively compliant tendon. These results suggest that a stiffer tendon is not necessary for high jump performance.

In Study 2, I found that maximum joint torque or maximum torque power partly explained the inter-individual variability in performance. Different strategies existed for acquiring jump height: “large vertical force for a short take-off duration” and “small vertical force for a long take-off duration”. The take-off duration was predicted by the leg stiffness and the body height.

4. Conclusion

I found that in the high jump, both *in vivo* tendon and leg stiffness characteristics are not determinants of performance; jumpers can jump high regardless of whether they have stiff or compliant characteristics. It is suggested that stiffness characteristics are reflected in the movement. The existence of inter-individual variability in the take-off duration of the high jump, which persists independently of performance, can be explained by differences in performance acquisition strategies resulting from variability in stiffness characteristics among individuals.

5. Main Reference

- 1) Ae, M., Nagahara, R., Ohshima, Y., Koyama, H., Takamoto, M., Shibayama, K. (2008). Biomechanical analysis of the top three male high jumpers at the 2007 World Championships in Athletics. *New Studies in Athletics*, 23-2: 45–52.