Abstract of Doctoral Thesis

Title：Physiological and mechanical loading characteristics of fast walking.
- Comparison with running at equivalent speed -

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Purpose

Aerobic exercise is known to be effective in preventing lifestyle-related diseases, and several exercise modalities, including walking, running, and swimming, are utilized. Among these exercise modalities, walking is highly accessible, without any equipment. In addition, the usefulness of fast walking (FW), consisting of faster speed than normal walking speed, has been increasing an attention. However, few studies have examined the loading characteristics of exercise programs using fast walking from both physiological and mechanical perspectives. Furthermore, no studies have compared the physiological and mechanical variables between FW exercise and running exercise.

Methods and Results

【Study 1】

Thirty-four university students (18 males and 16 females) were recruited. The Study 1 consisted of two different trials (walk trial and run trial) on different days. Energy metabolism during incremental exercise tests was evaluated. The results from the experiment indicated that energy expenditure (EE) and carbohydrate oxidation during walking were significantly higher compared with running at equivalent speed above 92 ± 2 % of maximum walking speed (MWS). During walking, EE and carbohydrate oxidation increased non-linearly with increasing speed, and energy metabolism was enhanced during FW compared with running at the equivalent speed. Furthermore, a speed around 80% MWS was recommended as a speed during FW training because EE was enhanced compared with running at the equivalent speed.

【Study 2】

Eight healthy males were recruited. In the study 2, ground reaction force (GRF) and lower limb muscle activity between fast walking (FW) and running at equivalent speed were compared. The results from the experiment indicated that FW resulted in significantly lower the vertical GRF compared to running at the equivalent speed. The averaged surface electromyography (aEMG) of the

lower limb (gluteus maximus muscle, rectus femoris muscle and soleus muscle(SOL)) was not significantly different between FW and running. However, the muscle activity patterns of the lower limb showed different characteristics between FW and running. In running, all muscle activities except biceps femoris long muscle and tibialis anterior muscle increased mainly in the braking phase, while in FW, SOL muscle activity increased mainly in the propulsive phase. These results revealed that the mechanical stress was less in FW than in running at the equivalent speed, and the muscle activity of the lower limbs muscles increased especially in the propulsive phase.

【Study 3】

Nine healthy males were recruited. The Study 3 consisted of two different trials (interval FW and normal walk trial and run trial at equivalent speed from FW trial). The results from the experiment indicated that interval FW caused a greater exercise-induced glucose metabolism (i.e., augmented blood lactate elevation) compared to running. On the other hand, exercise-induced serum glycerol and growth hormone (GH) elevations were significantly lower in interval FW compared to running at the equivalent speed. In addition, exercise-induced serum myoglobin elevation was significantly lower in FW compared to running, suggesting that exercise-induced muscle damage was attenuated in FW. These results suggest that FW enhances glucose metabolism, while reducing muscle damage compared with running. On the other hand, interval FW-induced GH response was not enhanced compared with running at the equivalent speed.

Conclusion

These results suggest that FW increases EE and glucose metabolism compared to running at the equivalent speed. Moreover, vertical GRF during exercise was significantly smaller in FW compared to running at the equivalent speed. During FW, the soleus muscle was further activated during the propulsive phase, and exercise-induced muscle damage was mitigated compared to running. Therefore, the present findings provide characteristics of FW (interval FW) exercise from physiological and mechanical viewpoints. The data also suggested that these characteristics differed from the characteristics observed during running at the equivalent speed.