METABOLIC COSTS OF FORWARD PROPULSION AND LEG SWING AT DIFFERENT RUNNING SPEEDS

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INTRODUCTION

We further investigated the cost of forward propulsion and the cost of leg swing across a range of submaximal running speeds by using an applied horizontal force (AHF) at the waist and external swing assist (ESA) forces at the feet. We hypothesized that the absolute costs of forward propulsion and leg swing would be greater at faster speeds.

METHODS

Seven well trained runners volunteered and ran at three different speeds: 2, 3 and 4 m/s. At each speed, they ran normally and completed five trials with 10% body weight (BW) AHF in combination with 0, 1, 2, 3 and 4% BW ESA force, afterwards. The AHF was applied continuously at the waist. ESA was applied at the feet and helped to initiate and propagate leg swing during the first half of the swing phase.

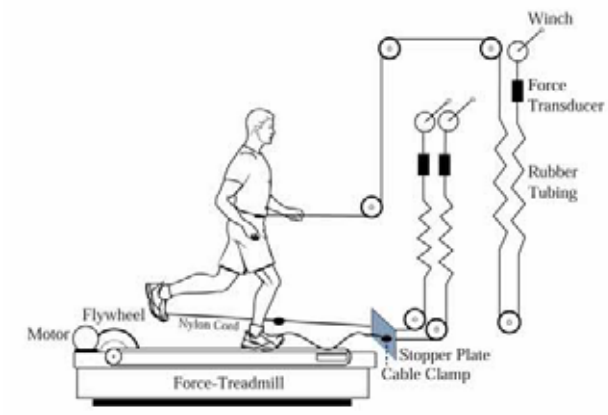

Figure 1: Schematic of the experimental set-up.

Oxygen consumption and carbon dioxide production were measured during a standing trial and were subtracted from gross running values to yield net metabolic rate (W/kg). We estimated the absolute cost of forward propulsion as the difference in metabolic rate between normal running and running with 10% AHF. The difference between running with 10% AHF and the minimum metabolic rate of the 10% AHF combined with ESA, reflected the absolute cost of leg swing.

Kinematic variables (step time, contact time and swing time) and kinetic variables (braking and propulsive impulse of the ground reaction force) were measured for each step, using a force-treadmill.

RESULTS AND DISCUSSION

The absolute costs of forward propulsion and leg swing both increased with speed. The relative costs of propulsion and swing remained at nearly the same percentage of the total.
The increase in the absolute cost of forward propulsion with speed may be explained by shorter contact times and greater braking and propulsive impulses [1]. The increase in the absolute cost of leg swing may be explained by a greater mechanical internal work rate at faster speeds [2].

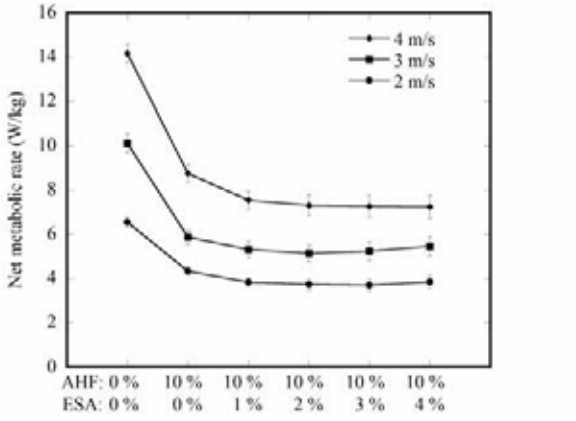

Figure 2: Net metabolic rate versus running condition for each speed. Data points are means ± SEM (error bars).

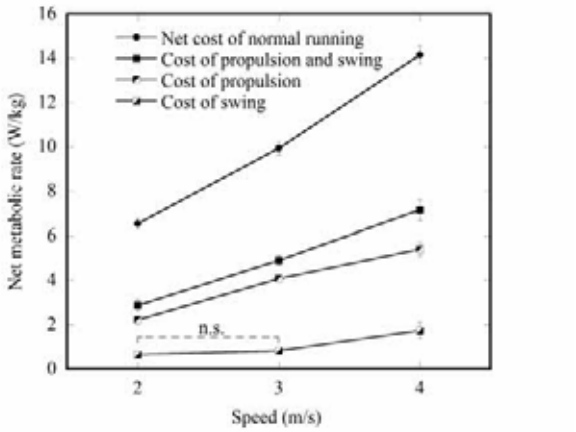

Figure 3: Net metabolic rate versus speed for the cost of normal running, cost of propulsion, cost of leg swing, and the sum of the cost of propulsion and leg swing.

The relative costs of leg swing (~10%), forward propulsion (~40%) and supporting body weight (suggested to be the remaining part; ~50%) are compatible with previous studies [1,3,4].

REFERENCES

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ACKNOWLEDGEMENTS

This research project was sponsored by VBS-Fund 2004 and the VU-Fund 2004 to B. Moed.