



REDUCING VERTICAL CENTER OF MASS MOVEMENT DURING HUMAN WALKING DOESN'T NECESSARILY REDUCE METABOLIC COST

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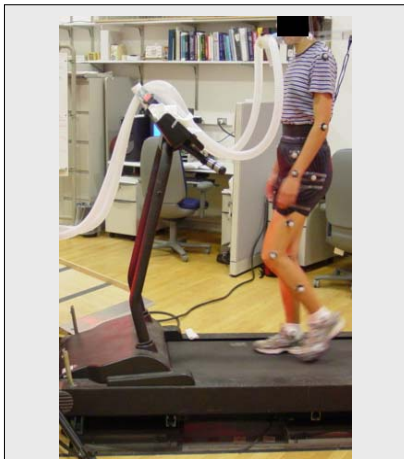
INTRODUCTION

In 1953, Saunders et al. published a highly influential and controversial paper relating the mechanics and energetics of human walking. It proposed that minimizing displacements of the center of mass (COM) during gait minimizes metabolic cost. Recent research has questioned the legitimacy of this proposal.

The purpose of this study was to directly test the hypothesis that minimizing COM displacement leads to minimal metabolic cost during human walking.

METHODS

We recorded metabolic cost in two cases where subjects decreased their COM displacement compared to normal walking. In the first experiment, subjects walked at 1.2 m/s with varied stride lengths. In the second experiment, speed and stride length were constant but subjects viewed real time visual feedback about the position of their sacrum. We instructed subjects to use the feedback to minimize their COM vertical movement (Farley & Ortega, 2003). For each condition we calculated metabolic cost (W/kg) from oxygen consumption and carbon dioxide production and COM vertical displacement from segmental analysis.

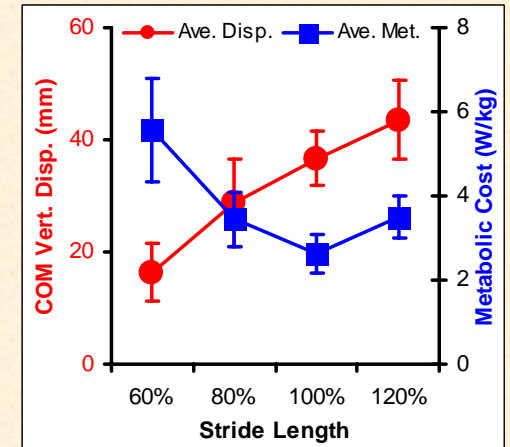


We used markers to collect kinematics and calculate COM position. A metabolic cart sampled oxygen consumption to calculate metabolic cost.

RESULTS

EXPERIMENT 1 – VARYING STRIDE LENGTH

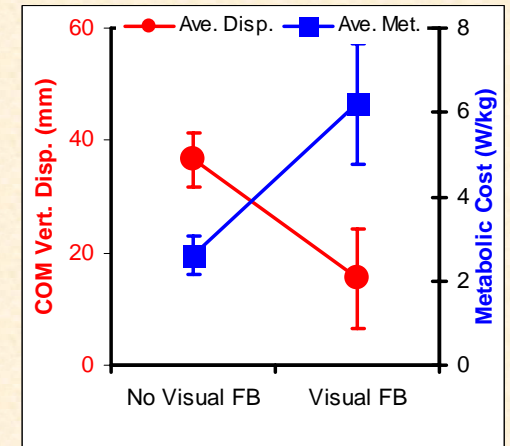
- ❑ COM DISPLACEMENT INCREASED AS STRIDE LENGTH INCREASED
- ❑ CHANGES IN STRIDE LENGTH FROM PREFERRED RESULTED IN A SIGNIFICANT INCREASE IN METABOLIC COST ($p < 0.0001$)
- ❑ MINIMUM METABOLIC COST DID NOT CORRESPOND WITH MINIMUM COM DISPLACEMENT



EXPERIMENT 2 – VISUAL FEEDBACK

- ❑ SUBJECTS WERE ABLE TO USE VISUAL FEEDBACK TO SIGNIFICANTLY DECREASE COM DISPLACEMENT ($p = 0.0074$)
- ❑ MINIMIZING COM DISPLACEMENT RESULTED IN A SIGNIFICANT INCREASE IN METABOLIC COST ($p = 0.0024$)

The results of experiment 2 concur with the study of Farley and Ortega (2003) using force platform analysis for calculating COM movement.



DISCUSSION

The most energetically efficient gait pattern is not the same as the pattern that minimizes COM displacement. Clearly, humans are capable of walking in a manner that will minimize COM displacement beyond what they will normally choose to do. The fact that humans do not choose to minimize COM displacement suggests that 1) factors other than COM displacement play an important role in the metabolic costs of human walking and 2) factors other than minimizing COM displacement determine why humans select the gait patterns that they do.

REFERENCES

Saunders, J.B., Inman, V.T., Eberhart, H.D. (1953). *J Bone Joint Surg Am* 35, 543-58.
Farley, C.T., Ortega, J.(2003). *Proc. ASB*, Toledo OH.

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