Exploiting Arm Swinging Dynamics to Reduce the Metabolic Cost of Walking while Carrying Loads

OBIOMA B. MCREYNOLDS and CHRISTOPHER J. ARELLANO

Center for Neuromuscular & Biomechanics Research; Health & Human Performance; University of Houston, Houston, TX

Category: Undergraduate

Advisor / Mentor: Arellano, Christopher J. (carellano@uh.edu)

ABSTRACT

Arm swing while walking at one's optimal speed is primarily driven by passive pendulum mechanics, an energy saving mechanism that has been speculated to incur little to no metabolic cost. **PURPOSE:** In line with this idea, we set out to determine whether carrying loads on the swinging and non-swinging arms while walking would be less costly than carrying loads at other locations on the body. We hypothesized that carrying loads on the arms while restricted from swinging would demand a greater metabolic cost than carrying loads on the arms while naturally swinging. For relative comparisons, we also explored the cost of carrying the same load on the waist and legs. **METHODS:** Metabolic energy (ParvoMedics) and whole body kinematics (Vicon) data were collected on 12 healthy, young subjects (8 male and 4 female) while they walked on a Bertec dual-belt force measuring treadmill at 1.25 m/s. Subjects began the experiment by standing quietly for 7-min while we measured their rates of oxygen consumption and carbon dioxide production. Subjects then completed five, 7-min randomized conditions that consisted of walking with no-load, an 8-kg load around the waist, an 8-kg load around the legs, an 8-kg load around the arms while restricted from swinging, and an 8-kg load around the arms while naturally swinging. From these data, we computed net metabolic power by subtracting the average standing value from the average walking value. **RESULTS:** As expected, the demand for net metabolic power during walking was greater when carrying loads around the waist, legs, and arms (all $P<0.05$; Fig. 1). While carrying loads around the arms was costly, the demand for net metabolic power was 7% less when the arms were swinging as opposed to when the arms were not swinging ($P=0.01$). **CONCLUSION:** Our findings show that by exploiting the passive pendulum mechanics of arm swing, humans can reduce metabolic cost of carrying a load around the arms while walking. Our future work is focused on understanding the passive pendulum mechanics that govern the dynamics of arm swinging, which we believe will shed light on this metabolic energy saving mechanism.

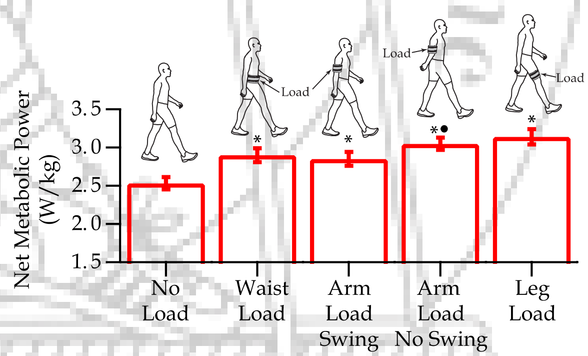

Figure 1. The metabolic cost of carrying an 8-kg load on the body while walking. While carrying the load around the arms was costly, allowing the arms to naturally swing helped to reduce the overall cost. Note that • signifies significantly greater than "arm load swing" condition; * signifies significantly greater than "no load" condition; all comparisons are $P<0.05$.