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Honors Capstone Poster: Does the Metabolic Cost of Load Carriage Differ Between Males and Females?

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Does the Metabolic Cost of Load Carriage Differ Between Males and Females?

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Abstract

PURPOSE: The scientific understanding of energy use during load carriage suggests that the additional metabolic increment necessary to support an external load is determined by the load's percentage of the subject's body weight. Accordingly, for comparison purposes experimental undertakings often adjust the mass of an external load to represent a constant fraction of each subject's mass. However, in occupational and applied settings, individuals are frequently asked to support similar absolute loads irrespective of their body weight. Here, we evaluated whether the energy requirements in male and female subjects differed during treadmill walking across a range of speeds, while supporting a common 20.5kg external load. **METHODS**: We measured VO_2 during three, 5min trials, administered with a 20.5kg pack, on a level treadmill at 1.7, 1.8, 1.9 m s^{-1}, from 20 young adults(age = 22.1±2.4 yrs), who had been assigned as sex-matched pairs on the basis of mass (10 males, M_b = 72.6±6.3 kg; 10 females, M_b = 72.8±6.2 kg; range 63.6-82.7kg, difference between pairs = 0.6±0.5kg, max 1.4kg). **RESULTS**: Measured values of VO_2 in females were 24.7±4.2, 28.9±3.7, and 30.8±3.3ml kg^{-1} min^{-1} at 1.7, 1.8, and 1.9 m s^{-1}, respectively, whereas these values in males, although lower, were statistically(min p-value = 0.08) indistinguishable and were 23.1±3.3, 25.8±3.7, and 30.1±4.6 ml kg^{-1} min^{-1} at the same speeds. Nonetheless, we note our data provide 27 points of comparison, with identical loads, at similar speeds (3 of 10 female subjects were unable to complete the 1.9 m s^{-1} trial), across 10 males and females who are very similar in mass; in 8 of these 27 points of comparison females were more economical than their matched pair. **CONCLUSION**: Our data lend support to the presence of a sex based difference in load carriage economy, warranting further study. We note also that the similar rates of energy expenditure between the sexes observed here, translate to higher relative intensities for females due to their likely lower mass-specific aerobic capacities (i.e. VO_{2max}).

Introduction

- The existing understanding of the energetics of load-carriage indicate that the additional metabolic cost is determined by the load's percentage of the subject's body weight(1&2).
- The ability to meet this elevated demand requires both aerobic fitness and muscular strength.
- Accordingly, due to their lesser quantities of both, female subjects experience relatively greater physiological demand (i.e. elevated heart rates, rate pressure products, and oxygen uptake) when supporting similar loads in their hands(3).
- Here, we asked whether females who where matched on the basis of mass experience greater metabolic rates while supporting similar absolute loads in a more conventional mode of load carriage, i.e. a backpack?

Methods

- Twenty young adult participants (age = 22.1±2.4 yrs [±SD]), provided their written informed consent in accordance with the guidelines of the University of Montana's IRB.
- Female and male subjects where paired on the basis of similar body masses (females, n=10, M_b = 72.8±6.2 kg: males, n=10, M_b = 72.6±6.3 kg; range 63.6-82.7kg, difference between pairs = 0.6±0.5 kg, max 1.4kg).
- Subjects completed three, 5 min trials on a level treadmill with a 20.5 kg backpack at 1.7,1.8, and 1.9 m s^{-1}.
- Steady-state rates of oxygen uptake (VO_2, ml kg^{-1} min^{-1}) were measured from indirect calirometry using a metabolic cart over the final two minutes of each trial.

Results

- Measured values of VO_2 in females were 24.7±4.2, 28.9±3.7, and 30.8±3.3 ml kg^{-1} min^{-1} at 1.7, 1.8, and 1.9 m s^{-1}, respectively.
- In males, these values although lower, were statistically (min *p*-value = 0.08) indistinguishable and were 23.1±3.3, 25.8±3.7, and 30.1±4.6 ml kg-1 min-1 at the same speeds.
- Nonetheless, we note our data provide 27 points of comparison, with identical loads, at similar speeds (3 of 10 female subjects were unable to complete the 1.9 m s^{-1} trial), across 10 males and females who are very similar in mass; in 8 of these 27 points of comparison females were more economical than their matched pair.

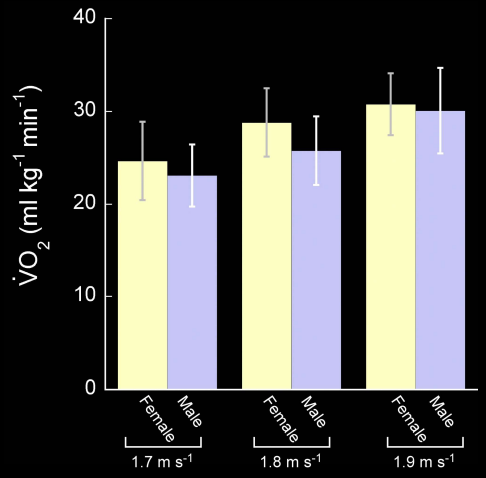

Figure 1: Study means of the Male vs Female differences in Oxygen uptake at the three administered loaded walking speeds. Although male values were lower, none were statistically significant (min *p*-value = 0.08).

Results cont.

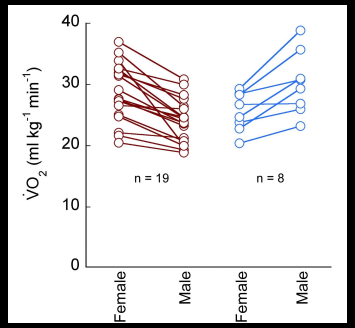

Figure 2: Comparisons for the matched male-female pairs. There were 27 possible comparisons, because 3 female subjects were unable to complete a 5 min trial at the fastest walking speed. In 19 comparisons, females walked with greater rates of O_2 uptake than their matched pair.

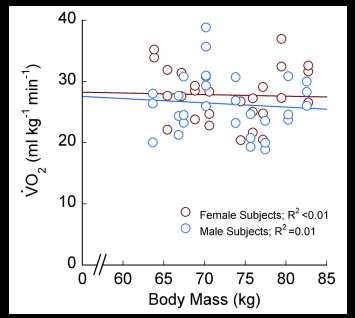

Figure 3: Measured values of O_2 uptake in relation to the subject's body mass (n=57 obs). Neither male nor female subjects exhibited the anticipated decreased metabolic cost with increased body size over the range of masses within the study (64-83 kg)

Conclusions

- Our data lend support to the presence of a sex based difference in load carriage economy, warranting further study. However, these results do indicate that some female subjects can undertake loaded walking with superior economy than their mass-matched male peers.
- A considerable advance in the understanding of the factors determining an individual's economy during load carriage has recently been identified (2), but the speeds and masses used here exceed the typical range studied in the literature.
- Finally, we note that the similar rates of O2 uptake between the sexes, suggest higher relative intensities for females due to their lower aerobic capacities (i.e. VO2max).

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