VO2MAX PREDICTS CHANGES IN BODY MASS DURING 75 MINUTES OF MODERATE INTENSITY CYCLING IN THE HEAT

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ABSTRACT

Individuals with greater aerobic fitness may experience enhanced thermoregulation through a variety of mechanisms such as increased plasma volume, earlier sweating onset, and higher sweat rates. Further, inverse relationships between maximal oxygen consumption (VO_2max) and economy (energetic cost of movement) have been observed. These factors, in combination with external heat stress, may contribute to differing changes in physiological stress and hydration status between individuals of varying fitness during prolonged exercise.

PURPOSE: The purpose of this study was to determine the relationship between VO_2max and changes in body mass over 75 minutes of cycling in a hot environment at a power output that elicited 65% VO_2max when wattage (W) is partialled out.

METHODS: Sixteen healthy adults (n = 8 women, n = 8 men; M_{VO2max} = 43.5 ± 4.9 ml/kg/min) who were able to achieve a VO_2max of at least 60% of their age and gender matched normative values completed the study. On three separate days, body mass (BM) and core body temperature (CBT) were recorded before and after a 75 minute cycling bout in a heat chamber (30-32°C and 45-50% relative humidity) at a power output corresponding to 65% of their VO_2max. Participants ingested fluid at a fixed rate of 1.5 ml/kg BM every 15 minutes. A Pearson correlation was used to determine the relationship between VO_2max and W. Partial Pearson correlations were used to assess relationships adjusted for W between VO_2max and average percent changes in BM (M_{DBM}) across the three trials, as well as between VO_2max and average percent changes in core body temperature (M_{DCB}) and between M_{DCB} and M_{DBM}. An alpha level of 0.05 was used to determine statistical significance.

RESULTS: A strong, significant relationship was found between VO_2max and W (r = 0.821, p < 0.001). A strong, significant inverse partial correlation between VO_2max and M_{DBM} when adjusting for W (r = -0.721, p = 0.002) was observed. On average, M_{DCB} was 3.16 ± 2.20%, but no significant partial correlation was found between VO_2max and M_{DCB} (r = 0.175, p = 0.533). On average, M_{DBM} was -0.94% ± 0.33%, but no significant partial correlation was found between M_{DCB} and M_{DBM} (r = -0.004, p = 0.987).

CONCLUSIONS: The strong inverse partial correlation between VO_2max and M_{DBM} indicates that fitter individuals, as estimated by their VO_2max, may be more likely to experience greater losses in BM during moderate-intensity exercise in the heat when W is adjusted for. While thermoregulatory mechanisms may play a role in these changes, we found no significant relationship between VO_2max and M_{DCB} in this study, demonstrating that a higher VO_2max did not equate to improved thermoregulation. Furthermore, the absence of a significant relationship between M_{DCB} and M_{DBM} would imply that changes in CBT were not responsible for differences in body mass changes. Subsequently, it should be considered that exercise at a workload that elicits a given percent of VO_2max may lead to a greater rise in VO_2 and relative stress in those with worse efficiency, which was not assessed in this study. These physiological changes may result in greater body water losses without improved thermoregulation when fluid ingestion rates are matched.

PRACTICAL APPLICATIONS: Perhaps exercise intensity prescriptions based on a snapshot of an individual's economy (e.g., fixed mechanical workloads derived from an unstable physiological intensity) may result in a high degree of variability in relative stress during prolonged exercise, particularly when coupled with heat stress. Future research should further investigate methods of prescribing relative workloads based on capacity measurements (e.g., time to exhaustion at VO_2max power) rather than power measurements (e.g., VO_2max) during prolonged aerobic exercise and should explore the effects of these methods on changes in economy and thermal power.

- Fitter individuals may be more likely to experience greater losses in BM during moderate-intensity exercise in the heat
  - This relationship remains when the influence of mechanical work is partialled out, based on these data
- Mechanical workloads derived from unstable physiological intensities may result in variable relative stress during prolonged exercise in the heat
- Future research should:
  - Investigate methods of prescribing relative workloads based on capacity measurements rather than power measurements (e.g., TTE at VO_2max power rather than VO_2max)
  - Explore the effects of these methods on changes in economy and thermal power during exercise

INTRODUCTION

- Those with greater aerobic fitness may experience enhanced thermoregulation through a variety of mechanisms
- In fit populations, inverse relationships between VO_2max and the energetic cost of movement have been observed
- These factors, coupled with external heat stress, may contribute to variable changes in physiological stress and hydration status during prolonged exercise
- The purpose of this study was to determine the relationship between VO_2max and changes in CBT over 75 minutes of cycling in the heat at 65% of VO_2max when the influence of wattage is partialled out

METHODS

Participants

- Sixteen healthy adults
  - n = 8 men
  - n = 8 women
  - VO_2max of at least 60% of age and gender matched normative values (mean VO_2max ± SD of 43.5 ± 4.9 ml/kg/min)

Exercise-Heat Stress

- 75 minutes at a power output that elicited 65% of VO_2max
- Fluids were ingested at a fixed rate of 1.5 ml/kg BM every 15 minutes
- 30-32°C and 45-50% relative humidity
- Three separate trials were performed

Statistical Analysis

- Individual percent changes in core body temperature (DCB) and body mass (DBM) across the three trials were averaged
- A Pearson correlation was used to assess the relationship between VO_2max and W
- Partial Pearson correlations were used to assess relationships between:
  - VO_2max and average DBM
  - VO_2max and average DCB
  - Average DCB and DBM
- An alpha level of 0.05 was used to determine statistical significance

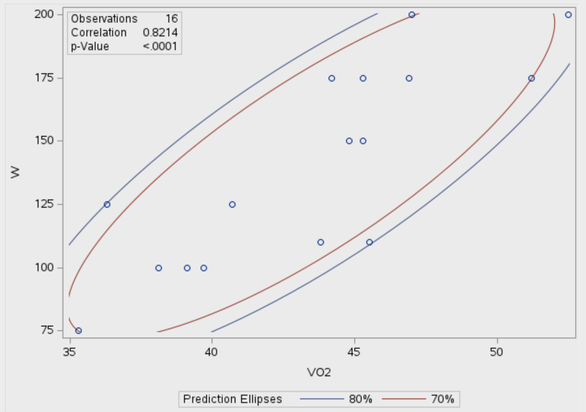
RESULTS

Table 1. Descriptive statistics by variable

Simple Statistics						
Variable	N	Mean	Std Dev	Median	Minimum	Maximum
VO2	16	43.48125	4.94452	44.50000	35.30000	52.50000
DBM	16	0.99065	0.00332	0.98999	0.98561	0.99663
W	16	140.31250	39.64294	137.50000	75.00000	200.00000
DCB	16	1.03165	0.02199	1.02666	1.01309	1.10894

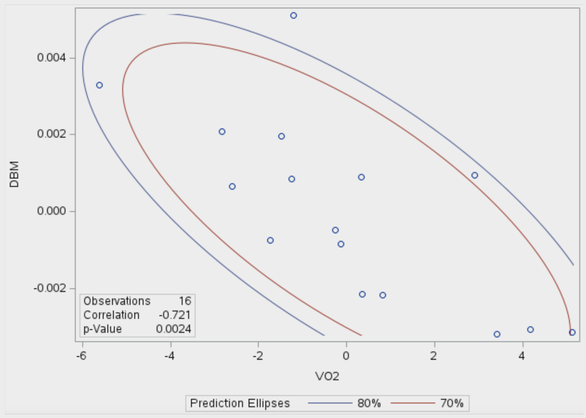
- M_{DCB} was 3.16 ± 2.20% (Table 1)
- M_{DBM} was -0.94% ± 0.33% (Table 1)

Figure 1. Scatter Plot for VO_2 and W



- There was a strong, significant correlation between VO_2max and W (r =0.821, p < 0.001, Figure 1)

Figure 2. Partialled (W) Residual Scatter Plot for VO_2 and DBM



- There was a strong, significant inverse partial correlation between VO_2max and M_{DBM} (r = -0.721, p = 0.002, Figure 2)

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