

INFLUENCE OF VIGOROUS INTENSITY HEART RATE-CLAMP EXERCISE ON NEUROMUSCULAR EFFICIENCY

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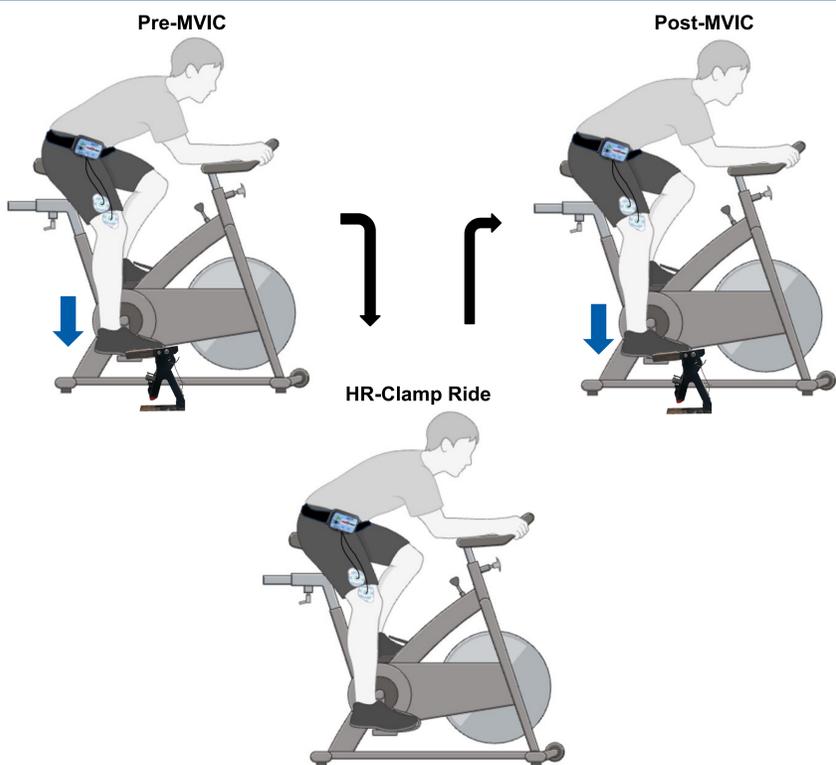
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PURPOSE

- Exercise prescription to improve performance is often based on percentages of the maximum heart rate (HR_{max}) that reflect vigorous intensities (77-95% HR_{max}) to accumulate 20-60 min per day.
- Neuromuscular efficiency (NME: normalized maximal voluntary isometric contraction [MVIC] force divided by normalized electromyographic amplitude [EMG AMP]) provides a noninvasive assessment of neuromuscular fatigue.
- **This study examined the changes in NME following HR-clamp trials within the vigorous intensity range.**

METHODS



- Ten men (25.9 ± 5.0 yr, $HR_{max} = 178 \pm 12$ b \cdot min $^{-1}$) performed a cycle ergometer graded exercise test, followed by three separate HR-clamp trials at 77% HR_{max} (HR_L), 86% HR_{max} (HR_M), and 95% HR_{max} (HR_H) to exhaustion or up to 60 min.
- EMG signals were measured from the vastus lateralis during a 6-sec MVIC before and after the HR-clamp trials using a custom isometric torque collection hardware.
- The total work (TW) for each trial was determined by calculating the product of the average power output (PO) for the HR-clamp trial and the elapsed time in seconds. The pre- and post-test MVIC force and EMG AMP were normalized to the respective pre-test MVIC values and used to calculate NME.
- One-way repeated measures ANOVAs and post-hoc Bonferroni corrected t-tests were used to examine average PO and TW across HR-clamp trials. Separate, t-tests about a single mean (pre-test NME = 1.0) were used to examine NME for each HR-clamp trial.

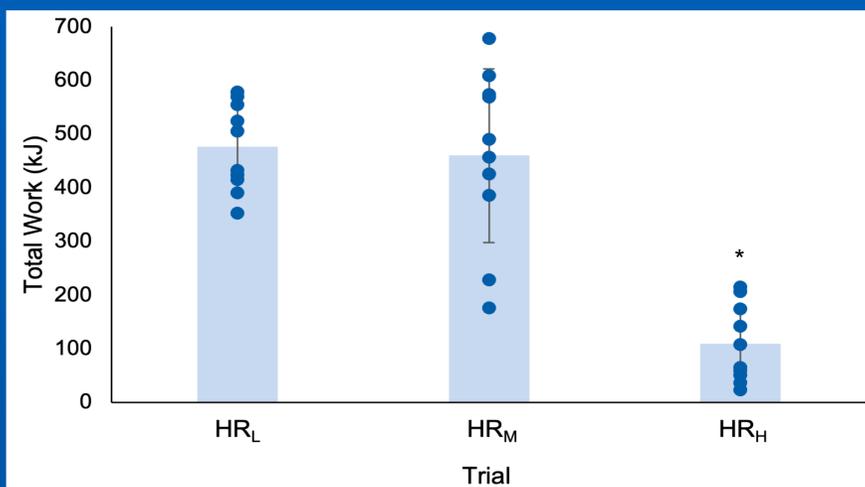


Figure 1. Mean \pm SD and individual responses (circles) for total work performed during the constant heart rate (HR) trials at 77% (HR_L), 86% (HR_M), and 95% (HR_H) of HR_{max} trials. * HR_H performed significantly less total work than HR_L and HR_M .

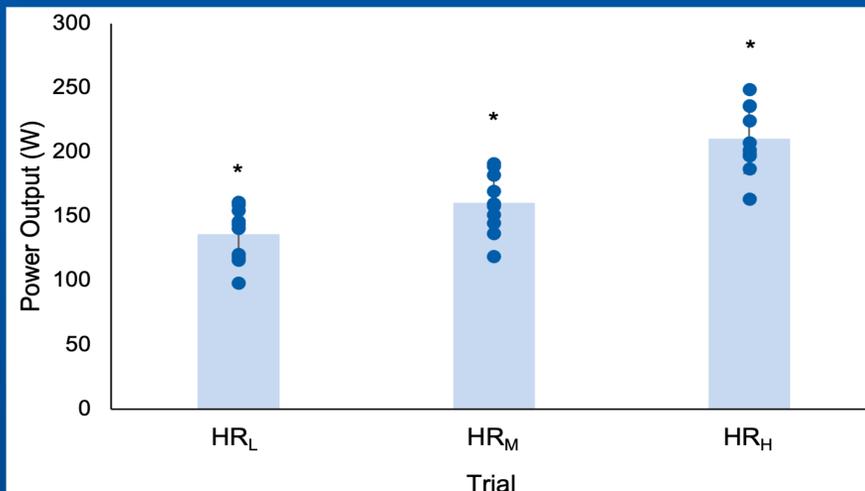


Figure 2. Mean \pm SD and individual responses (circles) for power output performed during the constant heart rate (HR) trials at 77% (HR_L), 86% (HR_M), and 95% (HR_H) of HR_{max} trials. * Significantly different than all other trials.

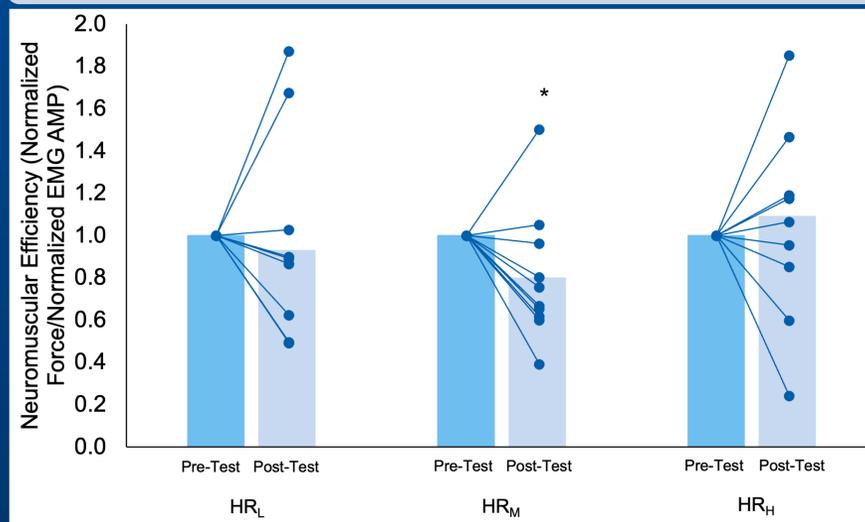


Figure 3. Individual changes (lines) in neuromuscular efficiency (NME) from the pre-test to the post-test maximal voluntary isometric contraction (MVIC) upon completion of the HR-clamp trials, in addition to the mean NME (bars) pre-test and post-test for all three trials. *Significant difference from pre-test.

RESULTS

- There was significantly less TW performed for the HR_H (109 ± 72 kJ) compared to HR_L (475 ± 81 kJ) and HR_M (460 ± 162 kJ) trials (all $p < 0.001$), but there was no difference between HR_L and HR_M ($p = 1.000$).
- There were significant differences among all HR-clamp trials for average PO ($p < 0.001$, $HR_L: 135.47 \pm 21.23$ W, $HR_M: 159.78 \pm 23.40$ W, $HR_H: 209.69 \pm 26.13$ W).
- There were no significant differences in NME at post-test compared to pre-test (NME=1.0) for HR_L ($p = 0.339$, NME= 0.93 ± 0.49) or HR_H ($p = 0.283$, NME= 1.09 ± 0.46). NME was significantly reduced for the HR_M trial ($p = 0.036$, NME= 0.80 ± 0.31).

CONCLUSIONS

- Only the HR_M trial demonstrated a reduction in NME, despite similar TW between the HR_L and HR_M trials.
- This may have been driven by the location of the trials relative to the moderate, heavy, and severe exercise intensity domains.
- Specifically, the greater the average PO for the HR_M trials compared to the HR_L may have placed subjects in the heavy domain for a longer duration of the trial, resulting in greater metabolic byproduct accumulation and driving peripheral and central factors of fatigue.
- In contrast, the greater PO but shorter T_{Lim} and less accumulated work at HR_H trial may have limited the influence of accumulation on peripheral and central factors of fatigue.

PRACTICAL APPLICATIONS

- Coaches and practitioners may consider the middle of the recommended intensity range to elicit a neuromuscular stimulus when utilizing HR-clamp exercise.
- The lower end of the range will allow for similar TW compared to the middle HR range but may avoid the accumulation of neuromuscular fatigue.
- The higher end of the HR range may be used for intervals, but a single session does not meet the recommended accumulated time for exercise prescription to improve endurance performance

ACKNOWLEDGMENTS

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