

# UTILIZING LACTATE THRESHOLD TO INVESTIGATE THE EFFECT OF HEAT ON LUNG DIFFUSING CAPACITY DURING EXERCISE

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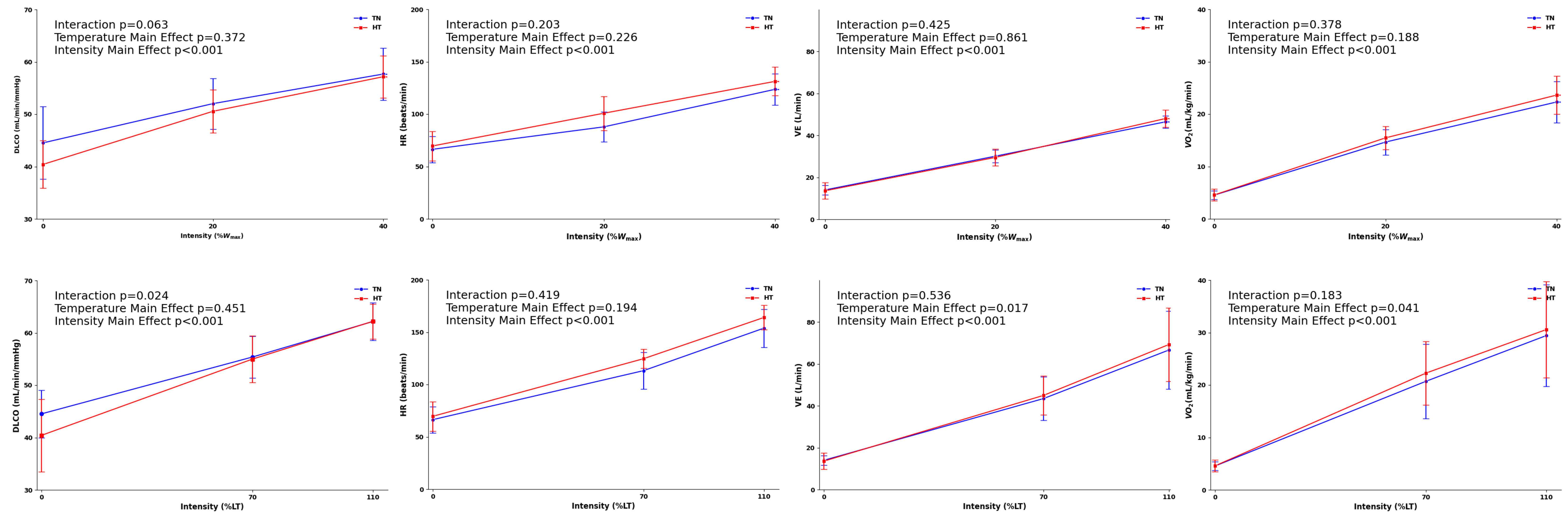
## Introduction

- Combined heat and exercise have been shown to alter the cardiovascular system's hemodynamic response, which is determined by factors such as the magnitude of the environmental (heat or cold) load, duration, intensity, and type of exercise (Gonzalez-Alonso, 2012, Chou et al. 2023, Rowell, 1974).
- Lung diffusing capacity for carbon monoxide (DLCO) has been used to objectively assess the efficiency of gas exchange in the human respiratory system. DLCO quantifies the capacity of the lungs to facilitate the transfer of gases from the alveoli into the pulmonary capillary blood (Blakemore et al. 1957).
- Previous work showed that DLCO is higher in the heat versus thermoneutral conditions during exercise at 40%, but not 20%, of maximum workload ( $W_{max}$ ) (Schoeberlein et al. 2023).

## Aims and Hypotheses

- AIMS:** To extend previous work by 1) using a lower heat stress to allow for completion of a higher workload and 2) prescribing workloads as a function of lactate threshold (LT), in addition to  $W_{max}$ , to better control for subjects of varying aerobic fitness.
- HYPOTHESES:** We hypothesize that 1) This protocol will allow for investigation of DLCO in heat versus thermoneutral conditions at a high-intensity exercise stage; 2) At rest, DLCO will be similar in the heat versus thermoneutral conditions; and 3) DLCO will be higher in the heat versus thermoneutral conditions during moderate-high intensity exercise.

## Results



## Methods

- Five male (Table 1) recreationally active, non-smoking adults with no history of cardiorespiratory diseases participated in 3 visits.
- Visit 1: Incremental exercise test to determine cycling  $W_{max}$  and LT, quantified using the Log-Log method in the R package lactater.
- Visits 2 and 3: Cycling at rest, 20 and 40%  $W_{max}$  and 70 and 110% LT in a hot (HT; 35°C) or thermoneutral (TN; 20°C) chamber.
- Parameters measured during exercise included DLCO, heart rate (HR), minute ventilation ( $V_E$ ), and oxygen consumption ( $VO_2$ ).
- Statistics: Two-way repeated measures ANOVA (temperature x intensity) in terms of both  $\%W_{max}$  (0, 20, 40) and  $\%LT$  (0, 70, 110). Significance was set at  $P < 0.05$ .



Chamber Set-Up: Upright cycle ergometer and metabolic cart. Subject completing ventilation and gas exchange measurements.



Measuring blood pressure during exercise.

Table 1. Characteristics of subjects.

| Demographics                   |             |
|--------------------------------|-------------|
| N (M/F)                        | 5 (5/0)     |
| Age (y)                        | 23 ± 7      |
| Height (cm)                    | 184 ± 5     |
| Weight (kg)                    | 85.4 ± 7    |
| BMI (kg/m <sup>2</sup> )       | 25.3 ± 3.1  |
| Lung Function                  |             |
| FVC (L)                        | 6.9 ± 0.5   |
| FVC, % predicted               | 115 ± 11    |
| FEV <sub>1</sub> (L)           | 5.1 ± 0.3   |
| FEV <sub>1</sub> , % predicted | 103 ± 9     |
| Exercise Performance           |             |
| $W_{max}$ (W)                  | 291 ± 60    |
| W at LT (W)                    | 153 ± 62    |
| LT as % of $W_{max}$           | 51 ± 9      |
| $VO_{2peak}$ (ml/kg/min)       | 50.8 ± 11.3 |

BMI (body mass index); FVC (forced vital capacity); FEV<sub>1</sub> (forced expiratory volume in 1 s);  $W_{max}$  (maximum workload); LT (lactate threshold);  $VO_{2peak}$  (peak oxygen consumption).

## Discussion

- Conventional thought suggests that exposure to heat triggers increased cardiac output (Q). This may augment blood volume in the pulmonary vasculature, thereby enhancing lung surface area for gas exchange (Coffman et al. 2018).
- Unexpectedly, there was no effect of heat on DLCO during exercise when assessed in terms of  $W_{max}$ , even with the inclusion of a high-intensity workload, suggesting that the heat stress was inadequate to increase lung surface area.
- While we observed a significant interaction of temperature and intensity when analyzing DLCO as a function of LT, these findings are inconclusive as we could not statistically identify any simple main effects.
- Nevertheless, the significant interaction in DLCO when analyzed as a function of LT suggests that controlling for aerobic fitness may be important for detecting physiological effects of heat on lung surface area during exercise.

## Conclusions

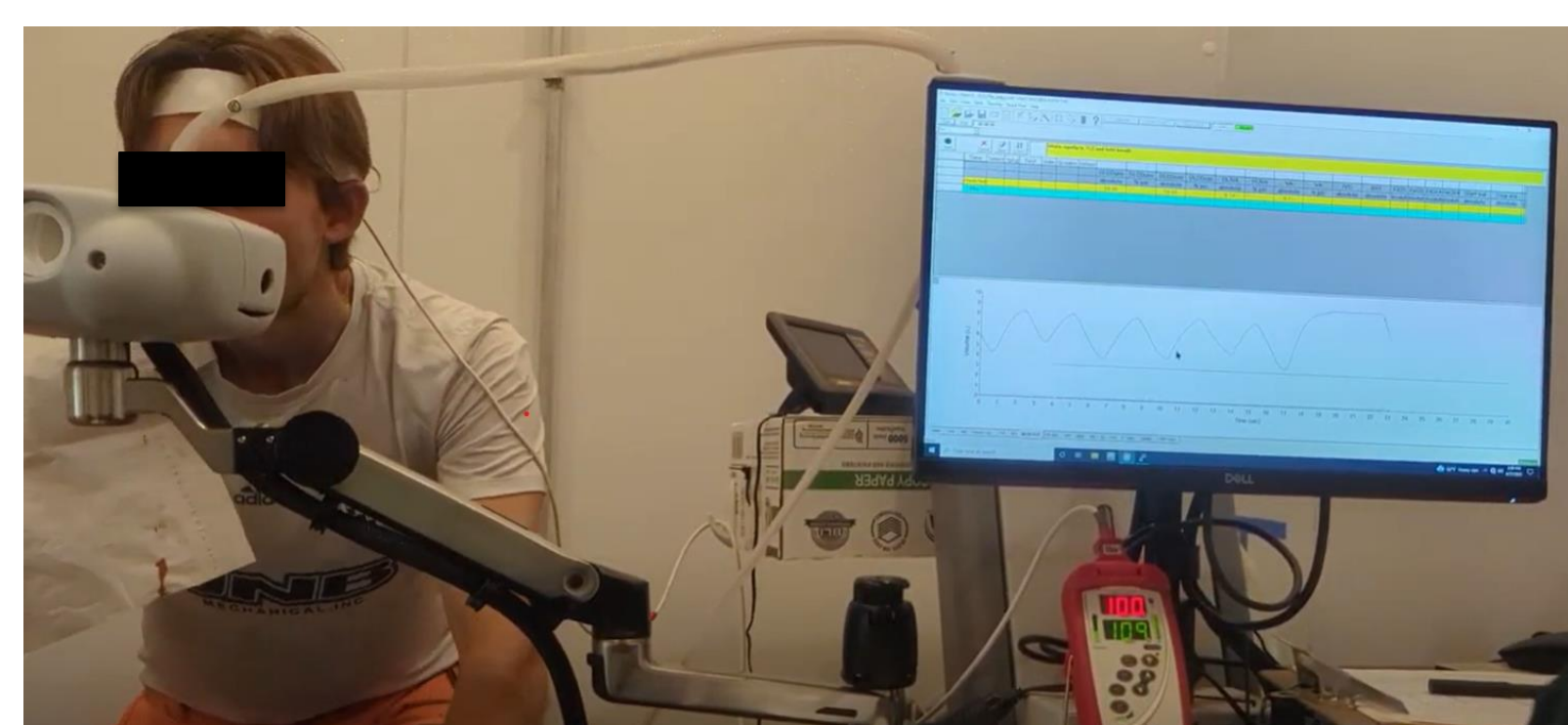
- Ultimately, this research calls for a more comprehensive investigation into the complex physiological mechanisms governing pulmonary vascular hemodynamics under heat stress during physical exertion.
- Studies incorporating various levels of heat stress and subject fitness, alongside measurement of skin blood flow and sympathetic drive, are needed to better understand the impact of heat exposure on DLCO during exercise.

## References

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Subject performing DLCO maneuvers during exercise.