



### ABSTRACT

**BACKGROUND:** Mitochondria are highly concentrated in skeletal muscle tissue, and undergo damage from ROS during metabolic processes. This damage is often left unrepaired and leads to mitochondrial dysfunction, which has been linked to many common diseases. Exercise training increases mitochondrial development within skeletal muscle tissue and thus may be protective. Environmental temperature, when paired with exercise may provide an even greater effect than exercise alone. **PURPOSE:** The purpose of this study is to analyze the effects of three weeks of exercise training with various environmental temperature conditions on mitochondrial quantity and quality. **METHODS:** Thirty-six male subjects performed one hour of cycling five days/week for three weeks in either a hot (33° C), cold (7° C), or neutral (20° C) condition. Biopsies were taken from the *vastus lateralis* muscle for analysis of mitochondrial quantity and quality on the first and last day of training (pre, post, and 4-hrs post exercise). Thus, we can calculate mitochondrial copy number and deletion ratio. **RESULTS:** mtMinArc and mtMajArc copy number did not change within any temperature condition before or after 3 weeks training ( $p>0.05$ ). mtDNA deletion ratio was lower in the cold compared to both hot ( $p<0.001$ ) and neutral ( $p=0.006$ ) both before and after 3 weeks training. **CONCLUSIONS:** These data indicate that the adaptive effects of exercise in three weeks do not cause a change in mitochondrial quantity. However, in cold conditions the lower mtDNA deletion ratio implies mitochondrial remodeling, which results in higher mitochondrial quality.

### INTRODUCTION

- Mitochondrial dysfunction has been linked to many age-related diseases, as well as the aging process.
- Previous work from our lab indicates that exercise training may effect mitochondrial development and that environmental temperature may cause an even greater effect.

### AIMS

- To identify the effects of three weeks of training paired with environmental temperature on mitochondrial quantity and quality.

### METHODS

- Twelve subjects performed one hour of cycling five days/week for three weeks and muscle biopsies were taken from their *vastus lateralis* muscle on the first and last day of training.
- DNA was isolated from muscle tissue and analyzed using qRT-PCR
- mtMinArc and mtMajArc were the mtDNA targets used, and B2M was the nuclear housekeeping gene.
- The mtMinArc copies and mtMajArc copies were determined using the  $2^{-2\Delta\Delta Ct}$  equation in order to determine number of mtDNA copies per nuclear DNA copies (Quiros, Goyal, Jha, and Auwerx, 2018).
- Mitochondrial quality was determined by the mtDNA deletion ratio.
- A two way ANOVA analyzed differences between temperature and time points.

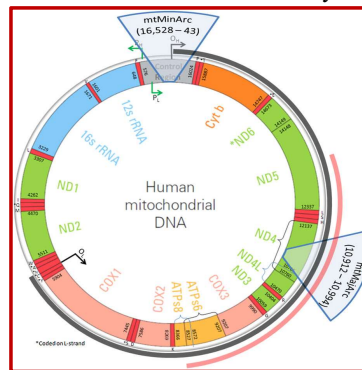


Table 1. Participant Descriptives

	Hot (n = 12)	RT (n = 12)	Cold (n = 12)
Age (y)	25 ± 1	23 ± 1	26 ± 2
Height (cm)	178.6 ± 1.8	177.2 ± 2.0	181.0 ± 2.1
Pre Weight (kg)	86.5 ± 5.4	85.3 ± 7.5	87.0 ± 6.0
Post Weight (kg)	86.1 ± 5.2	85.9 ± 7.7	86.5 ± 5.8
Pre VO2 (ml · kg <sup>-1</sup> · min <sup>-1</sup> )	37.4 ± 1.5	39.3 ± 2.8	40.8 ± 1.7
Post VO2 (ml · kg <sup>-1</sup> · min <sup>-1</sup> )	39.2 ± 1.8	44.2 ± 2.5	45.4 ± 2.2
Pre Max WL (W)	215 ± 9	215 ± 14	234 ± 10
Post Max WL (W)	256 ± 10	254 ± 14	263.8 ± 11

Data are mean ± SE.

### CONCLUSIONS

- The increase in mtMajArc relative amount post training post-exercise may indicate an improved acute response to exercise with three weeks training.
- There is a lower mtDNA deletion ratio decreases with four hours of recovery from exercise, both before and after three weeks of training.

### RESULTS

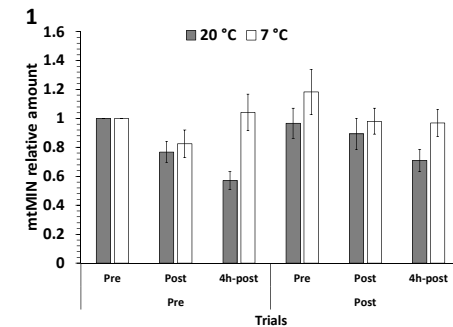


Figure 1: There were no significant differences between time, temperature, or time\*temperature in mtMinArc relative amount ( $p>0.05$ ).

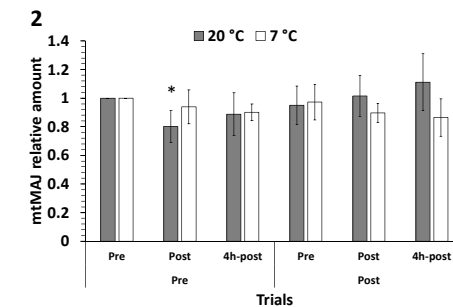


Figure 2: In Neutral conditions, mtMajArc relative amount was lower pre-training post-exercise compared to post-training post-exercise ( $*p=0.038$ ).

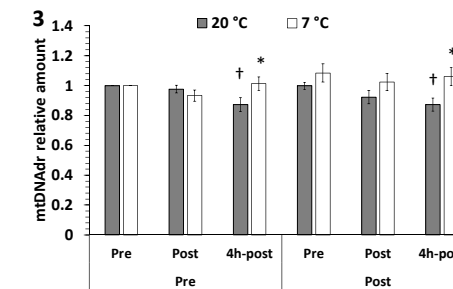


Figure 3: mtDNA deletion ratio was higher in the cold at both pre and post-training 4h-post ( $*p=0.04$ ,  $p=0.021$ ). It was also lower at both 4h-post time points compared to pre-training pre in the neutral condition ( $†p=0.012$ ,  $p=0.030$ ).

### ACKNOWLEDGMENTS

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