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PROJECT TITLE:
**Assessment of Mitochondrial Function via Blood Lactate
Response to Exercise**

Assessment of Mitochondrial Function via Blood Lactate Response to Exercise



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ABSTRACT

Exercise has been shown to increase the size, quantity and efficiency of mitochondria [3]. Aerobically fit populations display high mitochondrial efficiency, where unfit populations tend to show mitochondrial dysfunction. Lactate is a by-product of exercise which can be used as an energy substrate for several target organs including the heart, brain, liver, kidneys, and skeletal muscle. Those with mitochondrial dysfunction tend to have high circulating lactate levels, indicating that their mitochondria are not efficiently using lactate as an energy substrate [1]. Lactate can accumulate quickly in the circulation during moderate- to high-intensity exercise. Fit populations clear lactate quickly, where those with metabolic disease do not clear the excess lactate efficiently. Previous studies have examined the effect of maximal intensity exercise on lactate production and clearance to evaluate mitochondrial function in fit and unfit populations[6]. Previous protocols [6] did not normalize intensity to body composition, so fit populations may find the protocol too long and unfit populations may find the protocol too difficult. The present study aims to determine if a short, modified graded exercise protocol provokes a similar lactate response as the original (i.e. longer) protocol. Establishing a short, modified protocol may enhance future applications for diagnostic and clinical assessment of lactate to evaluate mitochondrial function. Results showed promise but could not be completed due to university closure surrounding the emergence of the novel coronavirus.

METHODS

Two graded exercise protocols were compared to evaluate lactate response to exercise. Subjects were drawn from the student population at Colorado Mesa University. Subjects were screened using the PAR-Q+ and ACSM risk stratification survey and completed an informed consent prior to exercise. Fat mass and fat free mass were determined using the BodPod. Resting lactate was measured just after body composition measurement, where a small blood sample was analyzed using a lactate meter.

Subjects were randomized to complete either a modified protocol or the long protocol [6]. Following volitional fatigue and termination of the graded exercise test, subjects completed two minutes of cool down at a self-selected resistance. Recovery lactate was measured at rest 5 and 10 minutes after cooldown completion. Subjects returned to complete the next protocol approximately a week after completion of the first randomized protocol. The screening and experimental protocol were reviewed and approved by the Institutional Review Board at Colorado Mesa University.

Modified Protocol

Initial resistance was set at 1.5x the subject's body weight in kg. Resistance increase between stages was determined by increasing the wattage at each stage by .5 watts per kg of fat free mass. Subjects completed a 10-minute warmup, followed by 5-minute stages, where resistance was increased at the end of each stage. Exercise lactate measurements were taken during last minute of each stage.

Long Protocol

Subjects were allowed to warm up for 15 minutes at a self-selected pace under 100w, which served as the starting resistance. The graded exercise test consisted of 10 minute stages, with resistance increasing by 35 watts at each stage. Blood lactate measurements were taken in the final minute of each stage, followed by a rating of perceived exertion.

DISCUSSION

- Lactate is used as energy substrate for the brain, skeletal muscles, liver, heart and kidneys via cell to cell shuttling [1].
- Lactate measurements can be used in the clinical setting to assess mitochondrial function as a response to exercise or prolonged stress on the body [2].
- In response to exercise, mitochondria increase in number, size, and efficiency. Mitochondria become dense, which improves oxidative capacity [3].

- In those with mitochondrial disease, lactate utilization as a fuel source is diminished due to mitochondrial insufficiency, so resting and exercise lactate levels are elevated [4],[5]

CONCLUSION

Blood lactate can be used to assess mitochondrial function in response to exercise. Mitochondrial insufficiency diminishes the ability for the body to utilize lactate as a fuel substrate. Exercise upregulates mitochondrial function by improving mitochondrial density, efficiency, and size. Lactate collection has clinical applications for predicting mitochondrial diseases by assessing cellular metabolic function in a cost-effective, non-invasive manner.

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