Blood Lactate Response to Active Recovery in Athletes *vs.* Non-Athletes

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INTRODUCTION

- Blood lactate is a by-product of anaerobic energy production and with accumulation, can lead to reduced rates of energy production and fatigue.[1]
- Active recovery following high intensity activity can help remove lactate, preparing the individual for repetitive bouts of activity.[2]
- Previous research has indicated an optimal intensity for active recovery following a bout of exercise for the removal of blood lactate to be at 80% of the individual's lactate threshold.[3]
- However, previous research studies have relied primarily on highly trained athletes.[3,4]
- The 80% of lactate threshold might not be the optimal intensity for non-athlete populations attempting to recover from lactate producing exercise.

PURPOSE

To investigate the lactate response in athletes *vs*. non-athletes during an active recovery protocol.

METHODS

IRB Approval.
The study was approved by the Institutional Review Board at Texas A&M University-Kingsville (protocol #: 2019-030 / 12306).

Study Design.
All subjects visited the lab on two separate occasions separated by a minimum of three days. For each visit, subjects abstained from exercise, nicotine, and alcohol for at least 48 hr.

Subjects.
All subjects provided informed written consent prior to testing. 16 subjects (8 athletes, 8 non-athletes) were recruited from the student population at Texas A&M University-Kingsville. Both males and females were recruited.
Athletes were defined as: NCAA division two athletes (all sports).
Non-Athletes were defined as: Recreational athletes (ACSM recommended physical activity to categorize someone as physically active).
Eligibility/ineligibility criteria included:
- Must be between ages 18-40 yr.
- Cleared to engage in vigorous exercise through ACSM guidelines.
- Cannot be diagnosed with a chronic condition restricting exercise.
- Currently not pregnant/plan on becoming pregnant during study.
- Cannot be suffering from a current musculoskeletal injury.

Equipment.
Resting blood pressure and heart rate: Omron HEM-705 automated BP device.

Exercising heart rate: Polar heart rate monitors.

Blood lactate: Nova biomedical lactate plus meter.

Exercise treadmill: A Quinton Q-stress exercise system with a paired TM65 treadmill was used for both VO_{2max} and exercise sessions.

Study Day One
Day one for all subjects followed this order:
- Informed written consent.
- Screening for study eligibility including health history and participant characteristics.
- Measurement of height, weight, and BMI as well as resting blood pressure, heart rate, and blood lactate.
- Bruce Protocol VO_{2max} test on treadmill.

Pre-participation Screening/Testing.
All subjects underwent health screening according to the American College of Sport Medicine's guidelines for exercise testing and prescription. Only subjects cleared to engage in moderate-to-vigorous intensity exercise based on these guidelines were allowed to participate.

Baseline VO_{2max} Test.
- Subjects began with a 5-min warmup at 3 mph and 0% incline.
- Following warmup, subjects began Bruce protocol at stage 1.7 mph and 10% incline for 3-min stages of increasing intensity.
- Subjects were instructed to step off at 2:15 of each stage to have blood lactate measures taken. Subjects returned to treadmill within 30-45 sec.
- Once the lactate threshold was obtained, blood lactate measures ceased and subjects continued the Bruce protocol until maximal exhaustion. Speed and incline of last stage was recorded as well as at the stage that lactate threshold occurred.

METHODS, cont.

Calculations for Day Two Exercise Sessions.
- Using recorded speed and incline, ACSM's running prediction equations was used to determine VO_{2max}.
- Using the predicted VO_{2max}, 90% of max was calculated and the appropriate speed and incline was determined to elicit 90% of VO_{2max}.
- Using the lactate threshold intensity, 80% of lactate threshold was calculated and the appropriate speed and incline was determined.

Study Day Two
Day two for all subjects followed this order:
- Resting values for blood pressure, heart rate, and blood lactate.
- Exercise Session (warm up, stimulus, active recovery).
  - Warm up at 5 mph and 0% incline.
  - Exercise stimulus at 90% of VO_{2max} for 5 min.
  - Active recovery at 80% of lactate threshold for 32 min or until baseline lactate levels were achieved.
  - Measurements of lactate and heart rate were measured at baseline, post-warm up, immediately after the exercise stimulus, and every 4 min during active recovery.

Statistical Analysis. Baseline characteristics between groups were compared using *t*-tests. Area Under the Curve (AUC) was calculated for blood lactate in athletes and non-athletes. ANOVA was used to compare AUC lactate and heart rate for athletes *vs*. non-athletes with *post hoc* Bonferroni-adjusted *t*-tests for time point comparisons.

RESULTS

Table 1. Subject Characteristics*

Characteristic	Athlete	Non-Athlete
Age, years	20.6±0.7	21.6±1.4
Height, cm	174.2±12.2	167.9±7.5
Weight, kg	78.1±16.2	77.6±14.8
BMI, $kg \cdot m^{-2}$	25.6±4.4	27.3±2.7
Resting lactate, $mmol \cdot L^{-1}$	1.7±0.9	1.5±0.7
VO2max, $ml \cdot kg^{-1} \cdot min^{-1}$	49.6±4.5	52.9±2.7
Heart rate, bpm	66.3±12.3	69.3±15.4
Systolic blood pressure, mmHg	121.0±12.1	123.6±14.9
Diastolic blood pressure, mmHg	70.5±6.9	71.1±10.2

*No statistical difference between athletes *vs*. non-athletes for all.

Table 2. Blood Lactate Responses

Outcome	Beta Coefficient	*p* value	Cohen's *d*
Overall Lactate, $mmol \cdot L^{-1}$	β= -109.8	$p < 0.001$	d= 2.32
Time point 0 lactate, $mmol \cdot L^{-1}$	β= 0.220	$p = 0.472$	d= 0.005
Time point 1 lactate, $mmol \cdot L^{-1}$	β= 0.326	$p = 0.482$	d= 0.007
Time point 2 lactate, $mmol \cdot L^{-1}$	β= -1.939	$p = 0.091$	d= 0.041
Time point 3 lactate, $mmol \cdot L^{-1}$	β= -4.510	$p < 0.001$	d= 0.095
Time point 4 lactate, $mmol \cdot L^{-1}$	β= -4.586	$p < 0.001$	d= 0.097
Time point 5 lactate, $mmol \cdot L^{-1}$	β= -4.003	$p < 0.001$	d= 0.085
Time point 6 lactate, $mmol \cdot L^{-1}$	β= -3.404	$p < 0.001$	d= 0.072
Time point 7 lactate, $mmol \cdot L^{-1}$	β= -2.619	$p = 0.003$	d= 0.055
Time point 8 lactate, $mmol \cdot L^{-1}$	β= -2.504	$p < 0.001$	d= 0.053
Time point 9 lactate, $mmol \cdot L^{-1}$	β= -1.812	$p < 0.001$	d= 0.038
Time point 10 lactate, $mmol \cdot L^{-1}$	β= -2.298	$p < 0.001$	d= 0.049

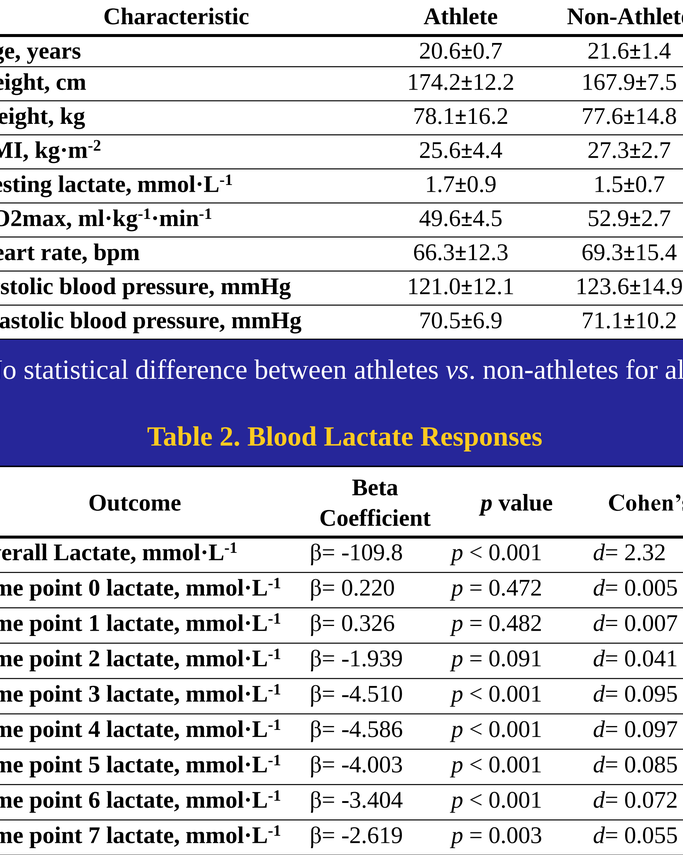

Figure 2: Blood Lactate Response During Active Recovery
*Significant difference for athletes *vs*. non-athletes at $p \leq 0.005$

RESULTS, cont.

Table 3. Heart Rate Responses

Outcome	Beta Coefficient	*P* value	Cohen's *d*
Overall HR (bpm)	β= -14.027	$p = 0.003$	d= 0.164
Time point 0 HR (bpm)	β= -0.624	$p = 0.877$	d= 0.070
Time point 1 HR (bpm)	β= 1.450	$p = 0.810$	d= 0.163
Time point 2 HR (bpm)	β= 0.416	$p = 0.920$	d= 0.047
Time point 3 HR (bpm)	β= -19.174	$p = 0.029$	d= 2.152
Time point 4 HR (bpm)	β= -22.816	$p = 0.011$	d= 2.561
Time point 5 HR (bpm)	β= -18.922	$p = 0.007$	d= 2.124
Time point 6 HR (bpm)	β= -17.541	$p = 0.017$	d= 1.969
Time point 7 HR (bpm)	β= -19.981	$p = 0.002$	d= 2.243
Time point 8 HR (bpm)	β= -20.534	$p = 0.002$	d= 2.305
Time point 9 HR (bpm)	β= -18.038	$p = 0.008$	d= 2.025
Time point 10 HR (bpm)	β= -18.533	$p = 0.001$	d= 2.080

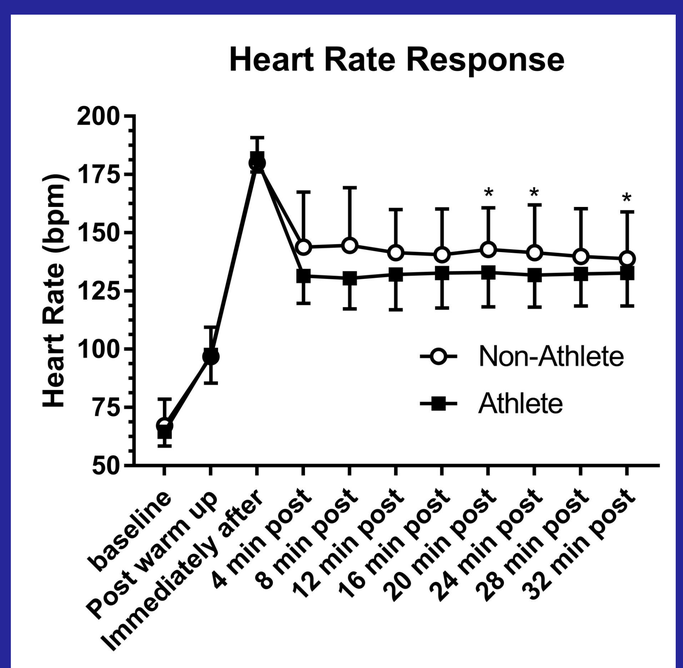

Figure 2: Heart Rate Response During Active Recovery
*Significant difference for athletes *vs*. non-athletes at $p \leq 0.005$

CONCLUSIONS

- Active Recovery at 80% of lactate threshold demonstrated a significant statistical difference in lactate removal for athletes compared to non-athletes.
- 80% of lactate threshold elicits a significant difference (higher) in heart rate response during active recovery for non-athletes and could contribute to the difference in lactate removal.
- Future research should investigate the most efficient workload for the removal of blood lactate in non-athletes, potentially an intensity that lowers non-athletes heart rates more than the intensity used in this study.

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REFERENCES

1. Powers, S. K., & Howley, E. T. (2007). *Exercise physiology: Theory and application to fitness and performance* (pp. 303-308). New York, NY: McGraw-Hill.
2. Monedero, J., & Donne, B. (2000). Effect of recovery interventions on lactate removal and subsequent performance. *Int J Sports Med*, 21(08), 593-597.
3. Menzies, P., Menzies, C., McIntyre, L., Paterson, P., Wilson, J., & Kemi, O. J. (2010). Blood lactate clearance during active recovery after an intense running bout depends on the intensity of the active recovery. *J Sports Sci*, 28(9), 975-982.
4. Baldari, C., Videira, M., Madeira, F., Sergio, J., & Guidetti, L. (2005). Blood lactate removal during recovery at various intensities below the individual anaerobic threshold in triathletes. *J Sports Med Phys Fit*, 45(4), 460.