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Measuring Physiological Changes in Response to a Division III Collegiate Cross-Country Season

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The goal of cross-country training regimens is to maximize oxygen consumption, increase metabolic efficiency of skeletal muscle, and delay the onset of fatigue. 1  
Performance can be predicted from variables such as maximal oxygen uptake (VO2 Max), lactate threshold (LT), and running economy (RE). 3,4  
VO2 Max measures oxygen consumption and it represents a maximal aerobic capacity. 3,4  
LT is the point at which blood lactate accumulates. 3,4,5  
RE reflects the energy demand for a given velocity of running and reflects overall running efficiency. 3  
After a cross-country season, we expect to see an increase in VO2 Max, improved LT, and an improved RE to indicate efficacy of a training program. 2  
Ideally, successful training programs include high mileage with a variation of long runs, interval training at or below race pace, and moderate sprint work. 1

### Purpose
To assess how physiological variables change over a competitive cross-country season in Division III female athletes.

### Materials and Methods

#### Subjects
- 11 female Division III cross-country athletes (20.18 ± 2.5 years, 162.89 ± 7.46 cm, 58.22 ± 8.91 kg, 21.5 ± 1.65 % body fat) were recruited to participate.

#### Procedure
- Subjects came to the lab on two occasions 10-12 weeks apart, pre and post season, and followed an identical procedure:  
  - Height, weight, and body composition measurements were taken.  
  - Three trials of a maximal vertical jump were performed.  
  - A 3 minute treadmill warm up was completed.  
  - A staged VO2 Max treadmill test was performed, with the grade increasing 2% every three minutes at a steady pace between 6.5-7.5 mph.  
  - Blood lactate, VO2 heart rate, and RPE readings were taken every 3 minutes.  
  - After a rest period, a RE treadmill test was completed by measuring oxygen consumption while running 4 minutes at a 'steady' pace and 4 minutes at a 'race' pace.  
  - Performance was analyzed by comparing average seconds per mile in the first and last race of the season.

#### Data Analysis
- Paired-samples t-tests were used to compare the pre and post season physiological data.

### Results

**Figure 1.** Mean vertical jump (cm) pre and post season.

**Figure 2.** Mean VO2 Max (ml/kg/min) pre and post season.

**Figure 3.** Mean lactate threshold (mmol/L) pre and post season.

**Figure 4.** Mean lactate threshold as a percentage of VO2 Max pre and post season. *indicates p < 0.05

**Figure 5.** Mean running economy (ml/kg/min) at a slow, steady pace and a faster, race pace pre and post season.

**Figure 6.** Mean race pace (seconds/mile) pre and post season.

### Discussion
- The principle of Specific Adaptations to Imposed Demands (SAID) indicates a training program which transitions from high mileage and moderate intensity to lower mileage and high intensity is designed to increase the demand placed on the anaerobic system. 1,3  
- An increase in anaerobic capacity is consistent with a decrease in LT along with a significant decrease in LT as a percentage of VO2 Max. 3  
- No significant changes observed in vertical jump, VO2 Max, or RE are consistent with previous research among trained distance runners over the course of a cross-country season. 2,6  
- Despite a lack of a statistically significant difference in average seconds per mile, an increase of 10 seconds per mile is considerable across a 3.75 mile race. 3  
- At the start of the competitive season, athletes were already well trained, likely accounting for the lack of significant changes. 3,4  
- Beneficial future research could include a variable of anaerobic capacity such as a Wingate test. 2,4

### Conclusion
A 10-12 week collegiate cross-country season does not significantly influence physiological variables likely due to the training demands which stressed the anaerobic system and therefore lead to specific adaptations in the anaerobic system.

### Literature Cited