



# The Effects of Resistance and Aerobic Exercise Sequence on Energy Expenditure



Jessica Haller, Brittany LaRocque, & Keisha Schoenike

Faculty Mentor: Gary P. Van Guilder, PhD

Department of Kinesiology, University of Wisconsin-Eau Claire, Eau Claire, WI

## ABSTRACT

**Purpose:** There has been little research to determine the optimal order of aerobic and resistance exercise with respect to the amount of calories expended, which may provide a rationale for considering the sequence of exercise when designing exercise programs. Our experiment was designed to examine the effects of exercise sequence on energy expenditure during a single exercise bout.

**Methods:** Four physically active young adults (age: 20.75±2.2 years; 2 male, 2 female) participated in this study. Participants were randomized to perform two, 1-hour exercise sessions separated by 7 days consisting of 30 minutes of resistance exercise (8 whole body exercises; 2 sets @ 10 repetitions; 90 sec rest period) followed by 30 min of aerobic exercise (70% VO<sub>2</sub> reserve; sequence 1), or aerobic exercise followed by resistance exercise (sequence 2). Portable oxygen consumption was measured throughout each exercise bout to determine energy expenditure between exercise sequences.

**Results:** Total energy expenditure for sequence 2 (540.8±96.3 kcals) was higher compared with sequence 1 (527.7±123.3 kcals). There were no differences in energy consumption during the aerobic exercise that was performed in sequence 1 (394 kcals) compared with sequence 2 (394 kcals). Energy expenditure for resistance exercise in sequence 2 (146.8±13.4 kcals) was higher than that of sequence 1 (133.5±15.6 kcals). EPOC energy expenditure after sequence 1 (70.6 ±6.9 kcals) was higher than after sequence 2 (63±12.5 kcals).

**Conclusion:** Based on this data, it appears that performing aerobic exercise prior to resistance (sequence 2) yields greater energy expenditure while performing the activity. However, it also appears that performing resistance prior to aerobic (sequence 1) yields higher EPOC values. Due to a limited number of subjects, more research is needed to determine the optimal exercise order with respect to caloric expenditure.

## INTRODUCTION

- It is common practice for people to do both resistance and aerobic exercise in one single session due to time constraints and convenience, however there are no current guidelines for exercise order.
- Performing high intensity resistance exercise promotes greater energy expenditure during a subsequent aerobic session; however it is still unclear as to how performing aerobic exercise first may affect energy expenditure.
- During a resistance training session, accumulated fatigue has been shown to induce greater oxygen consumption during and after exercise because of increased anaerobic metabolism from set to set.
- Excess post-exercise oxygen consumption (EPOC) refers to the energy expenditure during a period of time post exercise in which the body's metabolic rate remains elevated.
- The number of calories a person expends during EPOC depends upon the length and type of physical activity performed; whether the sequence of exercise influences EPOC is not clear.
- The findings of the present study will benefit individuals who closely monitor the number of calories expended for exercise, especially individuals striving for weight loss.

## EXPERIMENTAL AIM

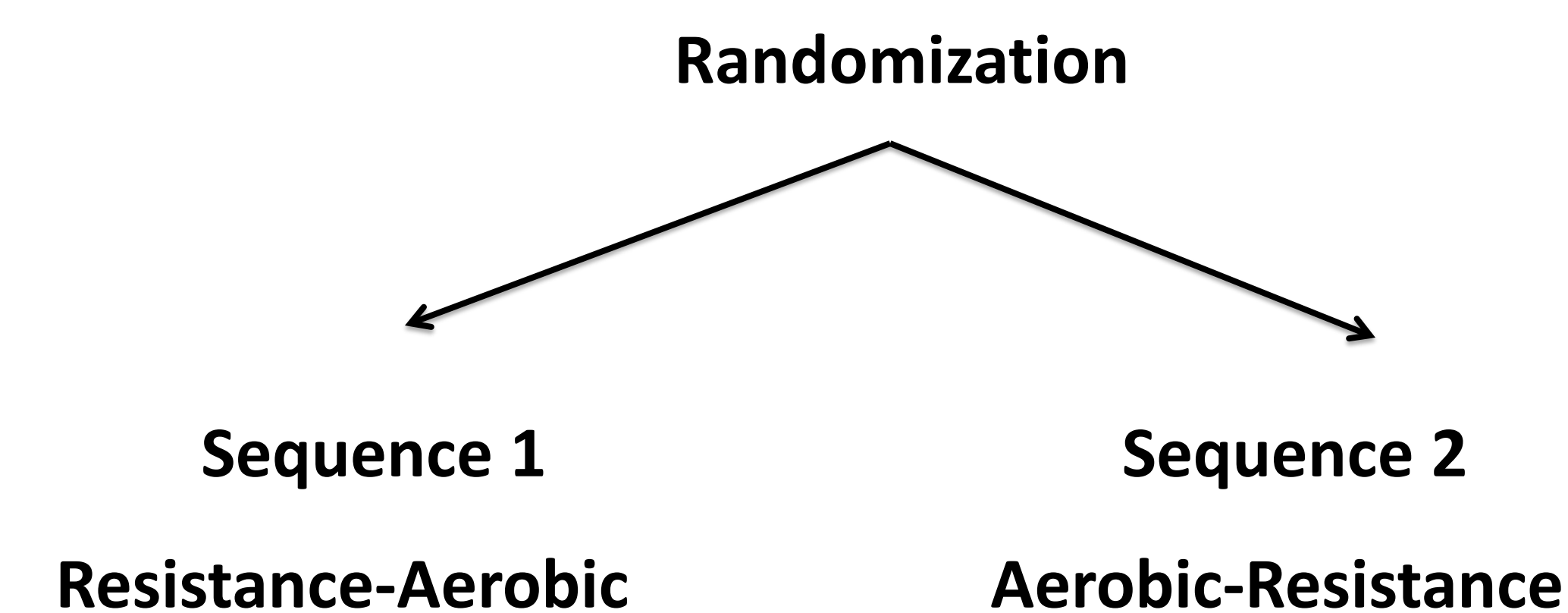
To better understand energy expenditure during and after exercise by manipulating the order of aerobic and resistance training. We hypothesized that the increase in energy expenditure seen when completing resistance training before aerobic will continue in to post-exercise state, yielding higher EPOC values when this order is performed.

## METHODS

### Subjects

- 4 healthy and physically active subjects participated in this study.
    - 2 Females (18-22 years)
    - 2 Males (20-23 years)
  - Volunteers were recruited from the University of Wisconsin- Eau Claire and surrounding community via word of mouth and online bulletins.
  - All subjects provided written informed consent according to the guidelines of the University of Wisconsin – Eau Claire.
- Screening and Testing Procedures**
- Height, weight and Body Mass Index (BMI) were measured.
  - Resting heart rate and blood pressure were measured
  - George Jog Treadmill Test and George 1-Mile Run Test were performed to assess cardiovascular fitness.
  - A 5-10 repetition maximum was recorded for the bench press and leg press to assess muscular strength.

### Randomized Experimental Protocol



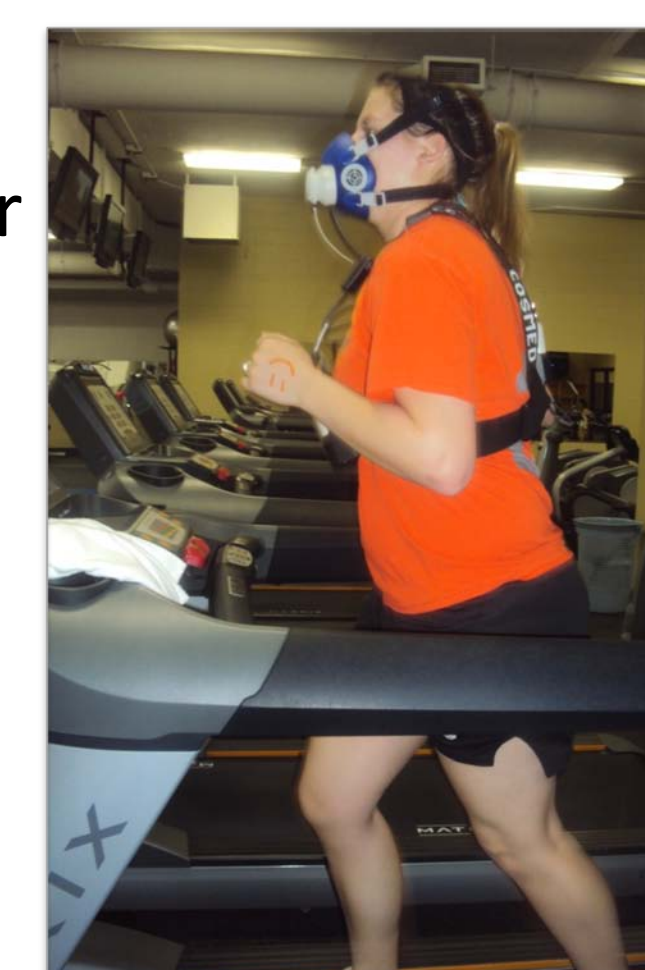
All participants performed the alternate sequence on their second session.

### Warm up

- 5 minute treadmill walk at 3.2 miles per hour

### Aerobic Exercise Protocol

- 30 minutes performed on a treadmill
  - 70% of VO<sub>2</sub> Reserve



### Resistance Exercise Protocol

- 8 resistance exercises
  - Performed at 70% of 1 RM
  - 10 repetitions
  - 2 sets
  - Timed 90 second rest periods between sets



### Cool Down

- 3 minute treadmill walk at 3.2 miles per hour

## STATISTICAL ANALYSIS

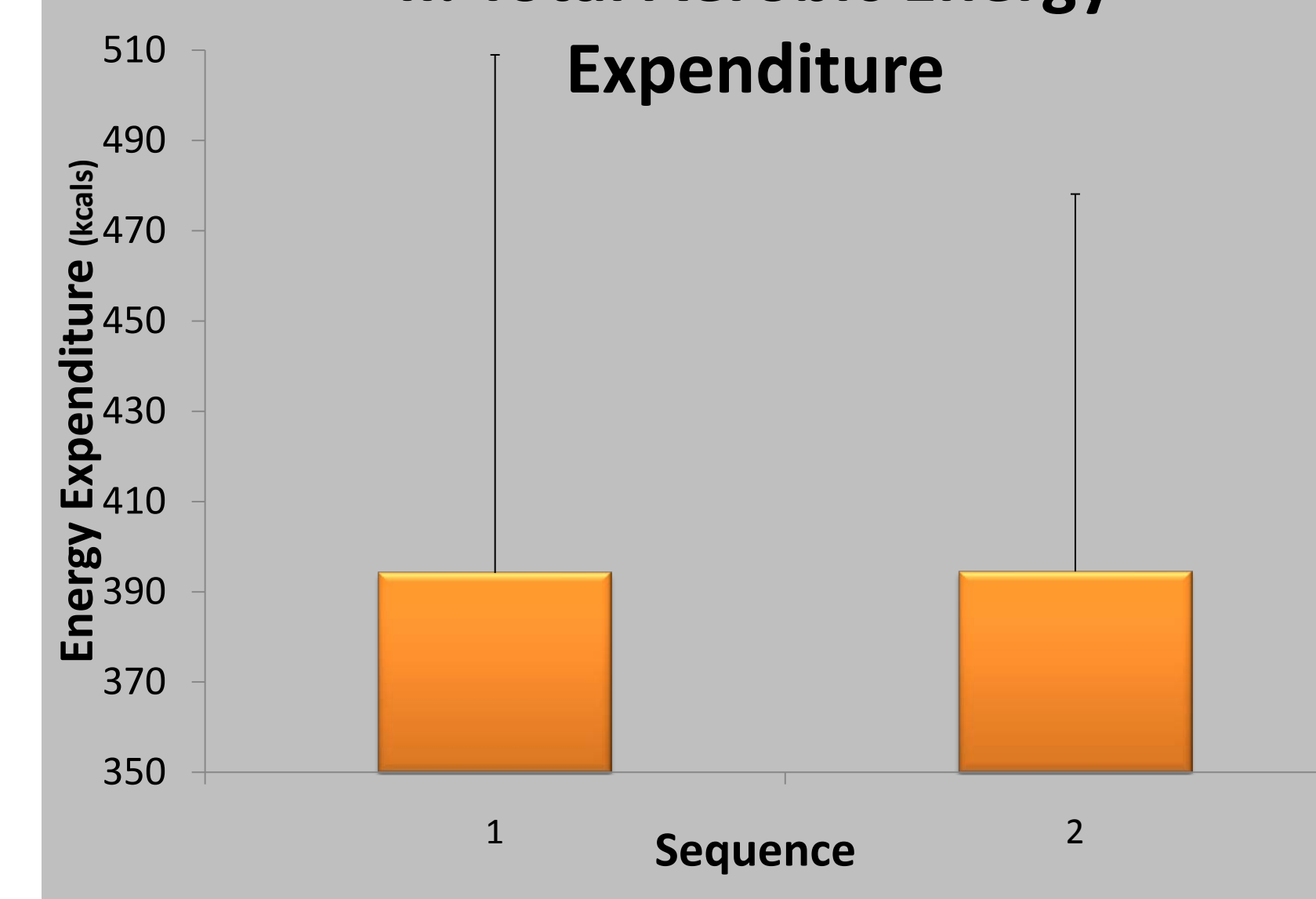
Energy expenditure between the two exercise sequences were analyzed using a Paired T test and Repeated Measures Analysis of Variance. Data are presented as mean ± SD. Statistical significance was set at  $P < 0.05$ . Statistical analyses were performed using SPSS software version 17.0 (SPSS Inc).

## RESULTS

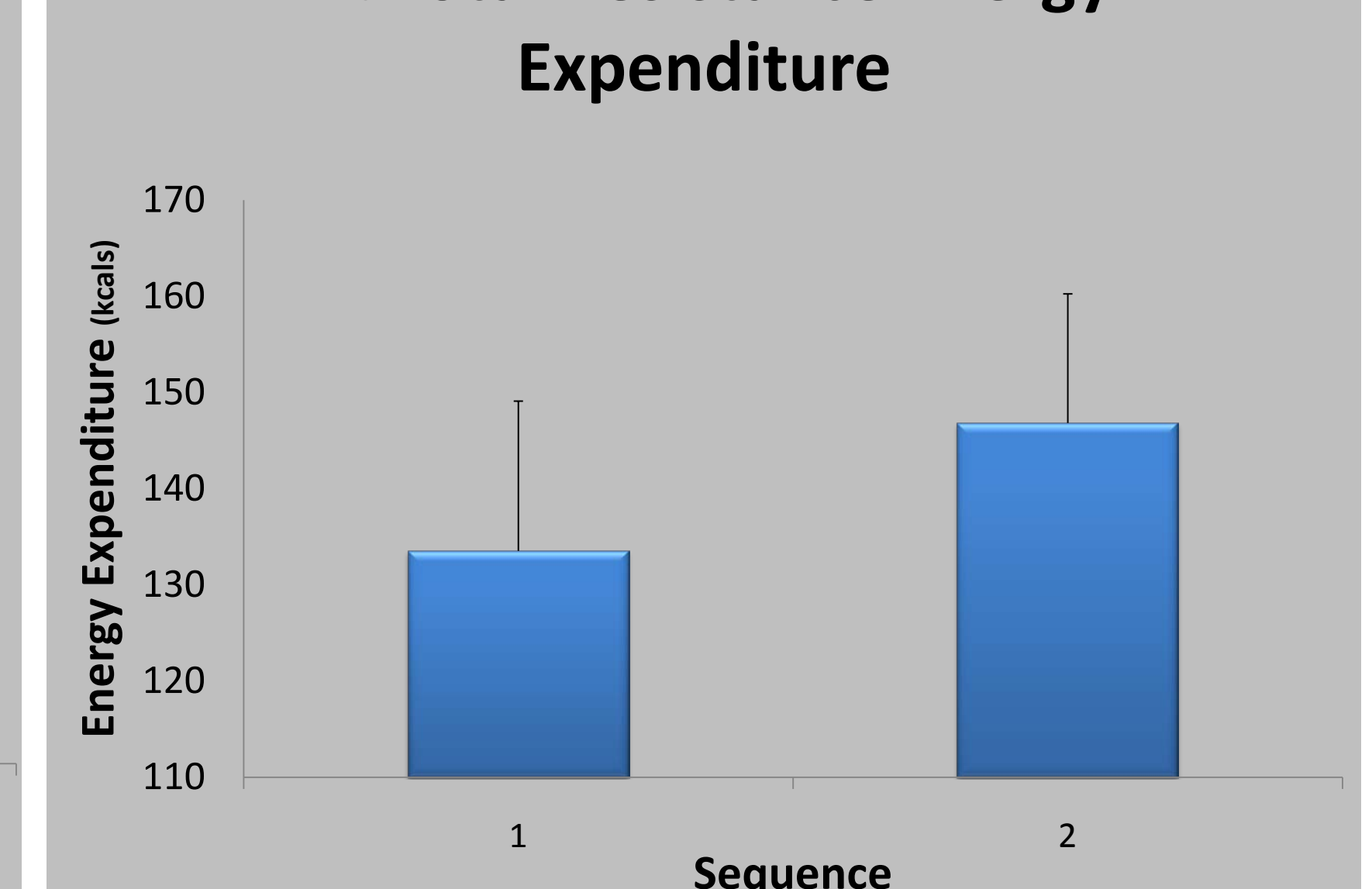
### I. Subject Characteristics

Variable	Total Group (N=4)
Age (Years)	20.8 ± 2.2
Resting Heart Rate (BPM)	70 ± 10
Systolic Blood Pressure (mmHg)	118 ± 3.2
Diastolic Blood Pressure (mmHg)	77.3 ± 5.3
Height (cm)	173.6 ± 13.4
Weight (kg)	73.3 ± 4.6
BMI (kg/m <sup>2</sup> )	24.6 ± 3.9
VO <sub>2</sub> max (ml/kg/min)	48.4 ± 6.3

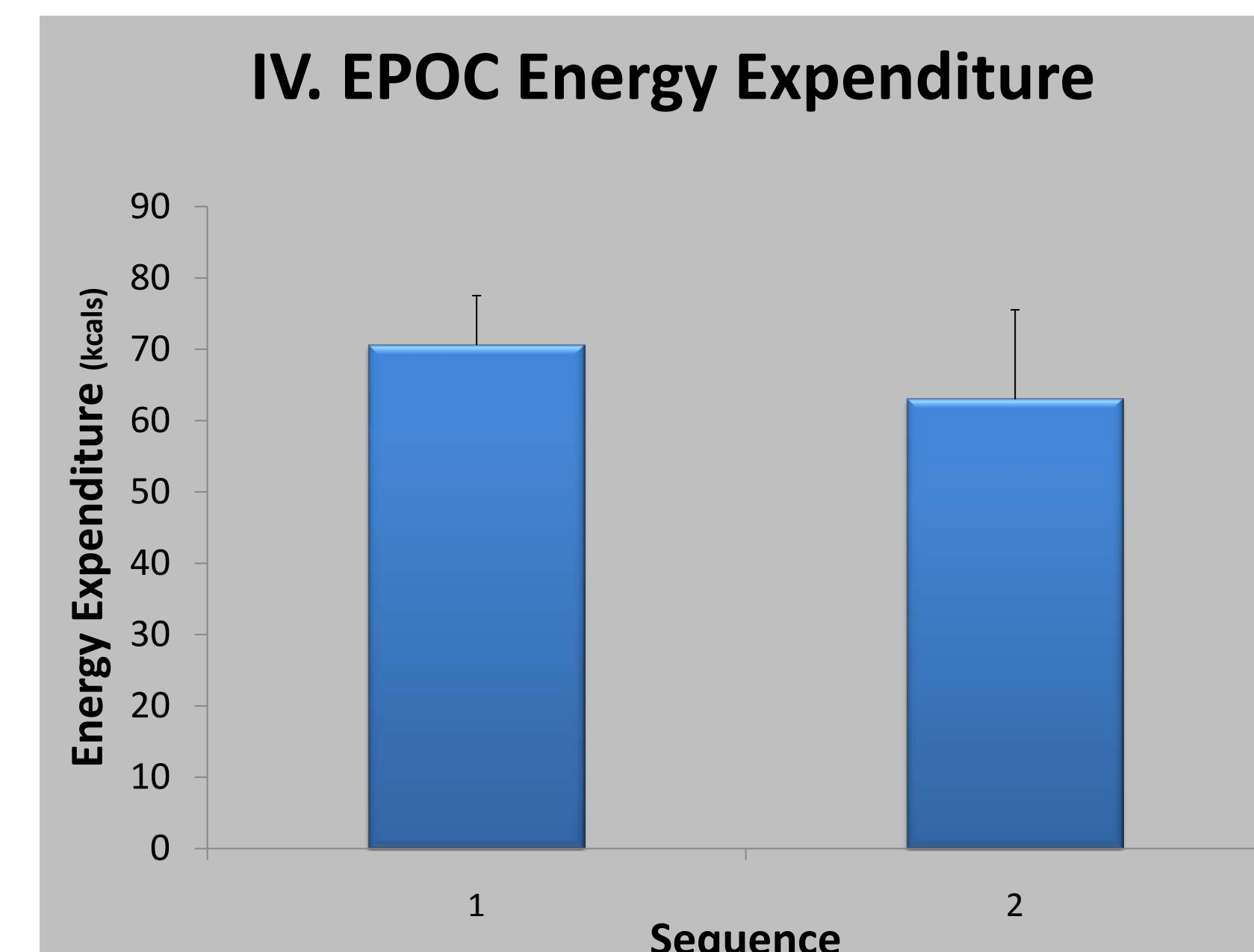
### II. Total Aerobic Energy Expenditure



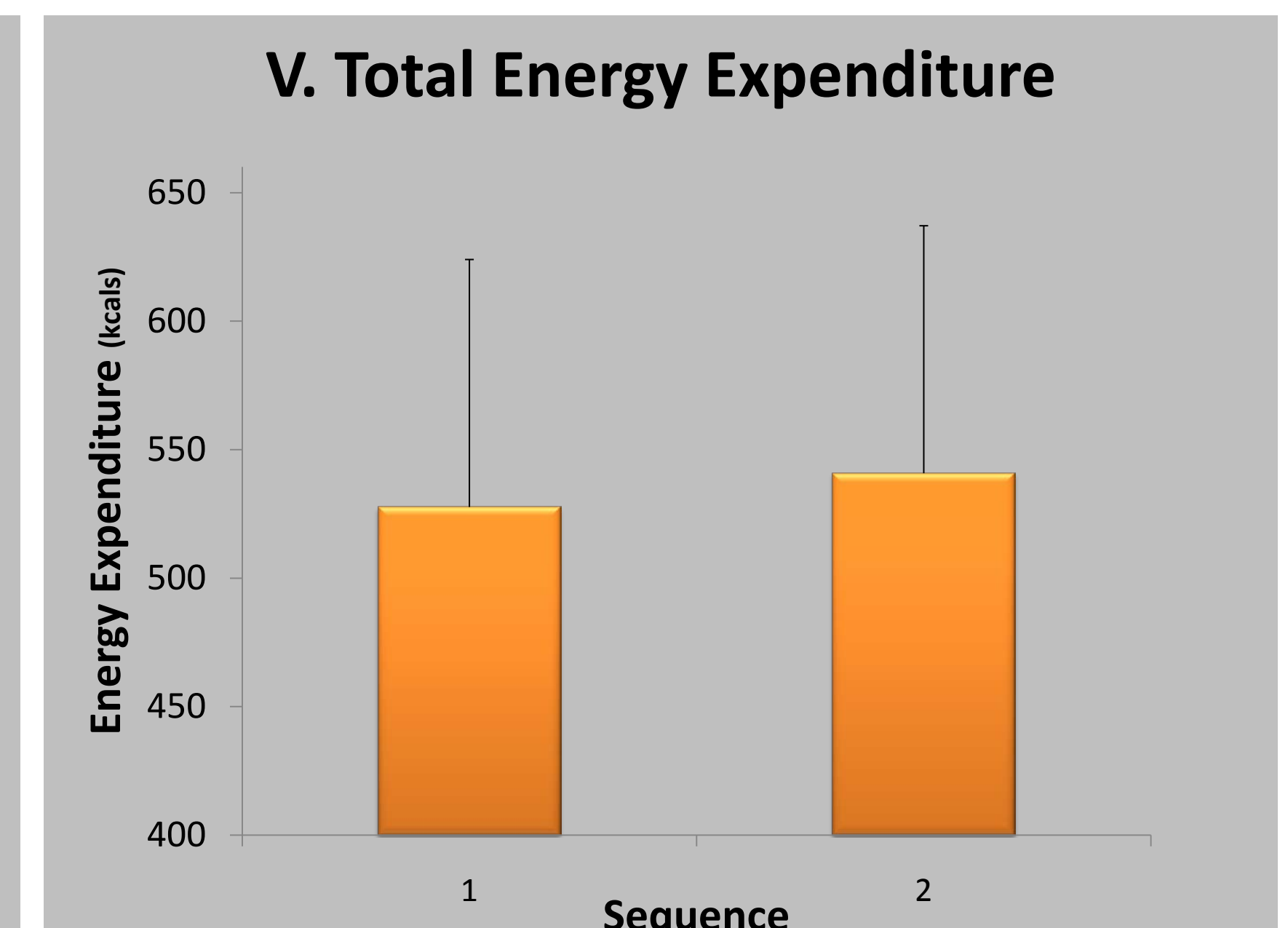
### III. Total Resistance Energy Expenditure



### IV. EPOC Energy Expenditure



### V. Total Energy Expenditure



## SUMMARY AND CONCLUSIONS

- Our study provides data suggesting that performing aerobic exercise before resistance exercise (sequence 2) yields higher energy expenditure values during the activity, shown in Figures II and III. Our study also provides data that suggests performing resistance exercise prior to aerobic exercise (sequence 1) yields higher energy expenditure during EPOC, shown in Figure IV.
- Further research is needed to determine the sequence of exercise that elicits the highest amount of energy expenditure overall. The overall energy expenditure value is key because it includes all of the calories burned during both exercise and recovery.
- Our study is important because expending greater amounts of calories will lead to a reduction in overall risk for mortality.

## ACKNOWLEDGMENTS

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