



The Effects of Resistance and Aerobic Exercise Sequence on Energy Expenditure



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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:** Ten physically active young adults (age: 21.4 ± 1.5 years; 5 male, 5 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_2 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 1 (599.2 ± 204.9 kcals) was significantly higher ($P=0.04$) compared with sequence 2 (572.6 ± 185.0 kcals). Energy expenditure increased ~35 kilocalories during the aerobic exercise session that was performed in sequence 1 compared with sequence 2. There were no differences in resistance exercise energy expenditure between sequence 1 (189.2 ± 106.1 kcals) and sequence 2 (181.5 ± 71.2 kcals). **Conclusion:** Energy expenditure is higher when aerobic exercise is performed after a sequence of whole body resistance exercise. These findings may be due to poor mechanics in running economy from the preceding resistance exercise session. This is important, because expending greater amounts of calories will lead to a reduction in overall risk for mortality.

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 may induce a greater oxygen consumption because of increased anaerobic metabolism from set to set; regardless of exercise order.

Caloric expenditure during resistance exercise is lower than continuous aerobic exercise when matched for time and relative intensity

Expending 1,000 calories weekly from physical activity is associated with a 20%-30% reduction in the risk of all-cause mortality.

This study can help to provide insight into whether energy expenditure can be enhanced by performing aerobic before resistance training or resistance before aerobic training.

EXPERIMENTAL AIM

To determine if varying the order of resistance training and aerobic training in a single exercise bout influences total energy expenditure. We hypothesize that during a single exercise bout participants will burn more calories when performing resistance before aerobic exercise.

METHODS

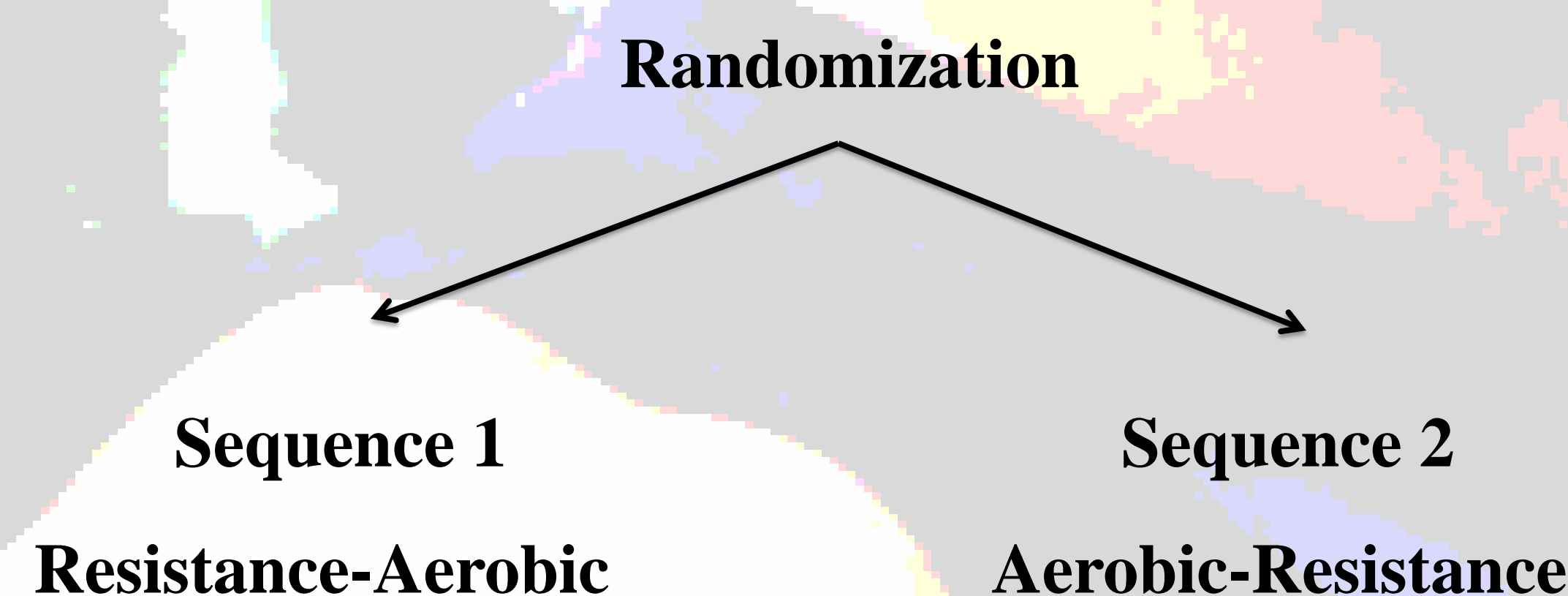
Subjects

- 10 healthy and physically active subjects participated in this study.
 - 5 Females (20-22 years)
 - 5 Males (20-24 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_2 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

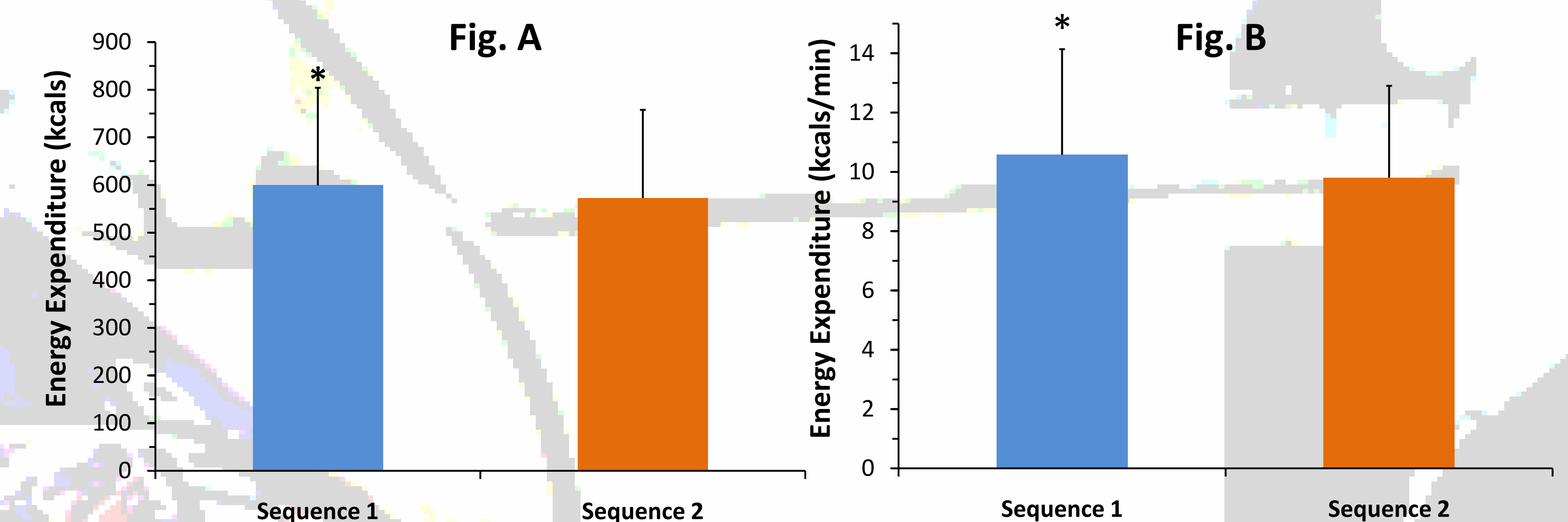
Differences in baseline characteristics between male and female subjects were determined using independent sample T tests. Energy expenditure between the two exercise sequences were analyzed using a Paired T test and Repeated Measures Analysis of Variance. Data are presented as mean \pm SD. Statistical significance was set at $P<0.05$. Statistical analyses were performed using SPSS software version 17.0 (SPSS Inc).

RESULTS

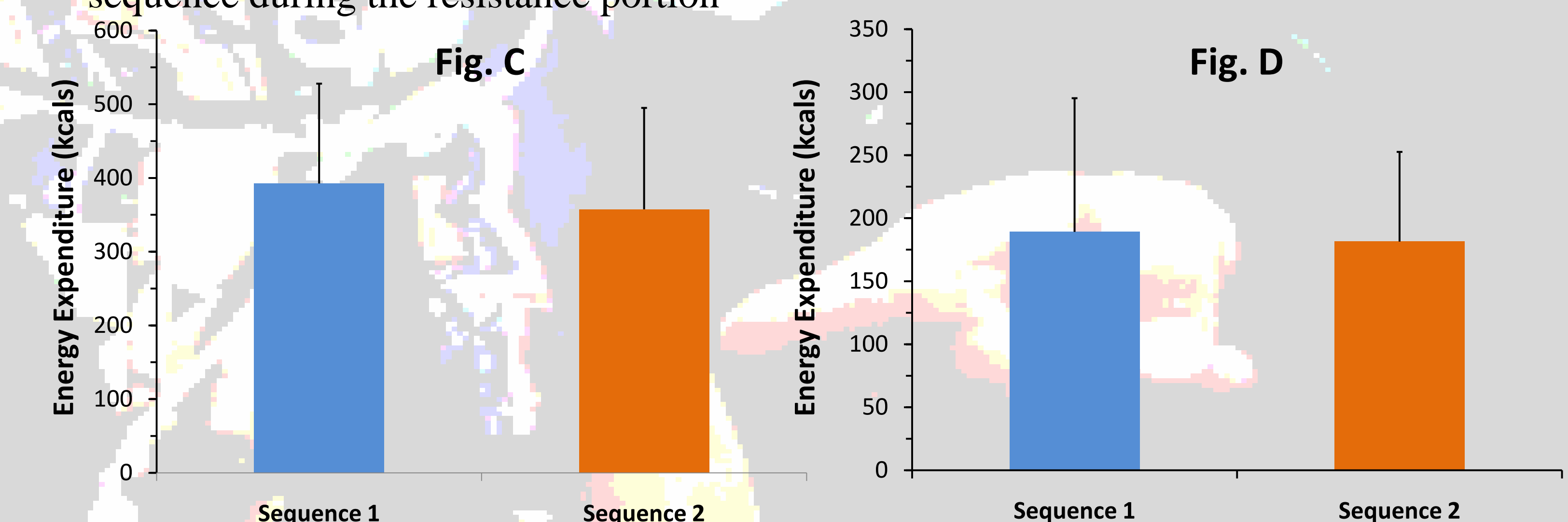
I. Subject Characteristics

Variable	Total Group (N=10)	Females (n=5)	Males (n=5)
Age (Years)	21.4 ± 1.5	20.4 ± 0.5	22.4 ± 1.4
Resting Heart Rate (BPM)	66 ± 9	72 ± 6	59 ± 6
Systolic Blood Pressure (mmHg)	121 ± 8	121 ± 12	122 ± 4
Diastolic Blood Pressure (mmHg)	73 ± 5.0	75 ± 5	70 ± 3.6
Height (cm)	175.0 ± 7.8	168.3 ± 2.8	182.0 ± 3.9
Weight (kg)	74.2 ± 16.0	59.8 ± 2.0	88.6 ± 8.7
BMI (kg/m^2)	24.1 ± 3.3	21.2 ± 0.8	27.0 ± 1.7
VO_2 max (ml/kg/min)	49.9 ± 5.0	46.0 ± 2.6	53.7 ± 3.7

II. Total energy expenditure (A) was significantly greater (27 calories) when resistance exercise was performed before aerobic exercise. Similarly, the amount of calories burned per minute (B) was significantly higher (7.3% kcals/minute) when performing exercise in the same order.



III. Aerobic energy expenditure (C) participants expended ~35 more calories during the aerobic portion in sequence 1 when compared to sequence 2. Resistance energy expenditure (D) participants expended nearly the same amount of calories regardless of sequence during the resistance portion



SUMMARY AND CONCLUSIONS

Our study provides data that suggests that performing resistance before aerobic exercise results in greater energy expenditure.

The main reason for the difference in caloric expenditure between orders is due to the aerobic exercise component. One potential explanation for this finding lies within poor mechanics in running economy from the preceding resistance exercise session.

Our study is important because expending greater amounts of calories will lead to a reduction in overall risk for mortality.

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