A Study to Determine the Difference in Energy Expenditure Between Continuous and Intermittent Bouts of Exercise
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ABSTRACT

Intermittent exercise, performed in short 10-15 minute bouts, and continuous bouts of physical activity of at least 30 minutes may produce similar benefits on body weight regulation and blood pressure in sedentary adults, suggesting that total energy expenditure is similar. Purpose: To determine if there is a difference in energy expenditure between continuous exercise and intermittent exercise at a moderate intensity. Methods: Eight apparently healthy adults (2 male, 6 female) between the ages of 20-25 years participated in this study. We employed a counterbalance design in which subjects performed one 60 minute exercise and recovery session consisting of one intermittent and one continuous exercise treadmill protocol separated by one week. The intermittent exercise test consisted of two, 15 minute bouts of moderate intensity (70% predicted VO₂max) treadmill running that was separated by a 3.5 hour interval. The second exercise session consisted of a continuous 30 minute treadmill test at the same intensity. Results: The total amount of energy expended during the 60 minute exercise session (3619.9 ± 341.3 kcals; P<0.05) and the rate of energy expenditure (12.1 vs. 11.3 kcals/min; P = 0.05) was higher when exercise was performed for 30 minutes continuously compared with short intermittent exercise. Similarly, during the exercise testing period only, energy expenditure was significantly higher for the 30 minute bout (294.7 kcals) compared with the two intermittent bouts (277.5 kcals). Conclusions: Moderate intensity exercise performed continuously for at least 30 minutes elicits greater energy expenditure than 30 minutes of exercise that is split into two shorter duration 15 minute exercise bouts. These findings appear to be due to a greater rate of energy expended per minute secondary to higher exercise heart rates during continuous exercise.

BACKGROUND

Increased physical activity is one of the best ways to reduce chronic disease risk, including the risk of cardiovascular disease and diabetes.

The American College of Sports Medicine (ACSM) recommends an individual to perform at least 30 minutes of physical activity at moderate intensity aerobic exercise 5 days per week or at least 20 minutes of vigorous intensity exercise 3 days per week.

To obtain the health benefits from physical activity, maximizing energy expenditure is essential. Increased volume of exercise that maximizes energy expenditure is associated with greater improvements in insulin sensitivity, body composition, and plasma cholesterol.

Intermittent exercise, performed in short 10-15 minute bouts, and continuous bouts of physical activity of at least 30 minutes may produce similar benefits on body weight regulation and blood pressure in sedentary adults, suggesting that total energy expenditure is similar.

Performing short 10-15 minute intermittent bouts of aerobic exercise throughout the day may be beneficial for populations that are unable to participate in a longer continuous exercise bouts because of existing physical limitations/disability or chronic disease.

For these individuals, an exercise program that involves frequent intermittent bouts of physical activity, separated by several hours of recovery, may be a more reasonable approach to elicit the same health benefits as continuous, longer duration exercise.

EXPERIMENTAL AIM AND HYPOTHESIS

To determine if there is a difference in energy expenditure between continuous exercise and intermittent exercise at a moderate intensity. We hypothesized that there will be no difference in energy expenditure between continuous and intermittent bouts of exercise.

METHODS

Subjects

Eight apparently healthy adults (2 male, 6 female) between the ages of 20-25 years participated in the study.

Volunteers were recruited from the University of Wisconsin- Eau Claire by promotional flyers and personal contact.

All subjects provided written informed consent according to the guidelines of the University of Wisconsin – Eau Claire.

Screening and Testing Procedures

Body composition including height and weight.

Auscultatory resting systolic and diastolic blood pressure.

Sub-maximal testing to predict VO₂ Max.

Completed Physical Activity Readiness Questionnaire and Health History

Experimental Protocol

To obtain the appropriate speed for the intermittent and continuous exercise bouts, we used the George 1 mile run sub-maximal test to predict a VO₂ max.

The resulting measurements were obtained from the following equation: VO₂ max = 100.5 + 8.344 x Gender (0 = female, 1 = male) – 0.1636 x body mass (kg) – 1.438 x Jog time (min/mile) – 0.1928 x Heart Rate.

We used the following ACSM running/jogging formula to calculate the appropriate speed: VO₂ = Resting Component + Horizontal Component + Vertical Component; R = 3.5 ml.kg.min, H = speed (m/min) X 0.2, V = grade (decimal) X m/min X 0.9 (VO₂ = (0.2 x S) + (0.9 x S x G) + 3.5).

We employed a counterbalance design in which each subject performed one 60 minute exercise and recovery session consisting of one continuous longer duration bout of exercise, and two short intermittent bouts of exercise on treadmill separated by one week.

60 Minute Continuous Exercise Protocol

Prior to each testing session each individual warmed up at 3.0 MPH, followed by a 30 minute exercise bout at 70% of their VO₂ max.

Oxygen consumption was measured using open circuit indirect calorimetry (Medgraphics) for 3 minutes prior to exercise, 5 minutes during warm-up, 30 minutes of exercise, 5 minutes of cool-down and for 30 minutes post-exercise.

60 Minute Intermittent Exercise Protocol

Prior to each testing session each individual warmed up at 3.0 MPH, followed by two 15 minute exercise bouts at 70% of their VO₂ max separated by a 3.5 hour rest period.

Oxygen consumption was measured using open circuit indirect calorimetry (Medgraphics) for 1.5 minutes prior to exercise, 2.5 minutes during warm-up, 15 minutes of exercise, 2.5 minutes of cool-down and for 15 minutes post-exercise.

STATISTICAL ANALYSIS

Differences in baseline characteristics between male and female subjects were determined using independent sample T tests. Energy expenditure between the two exercise sessions (continuous versus intermittent) 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

<table>
<thead>
<tr>
<th>Variable</th>
<th>Total Group</th>
<th>Males</th>
<th>Females</th>
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<tbody>
<tr>
<td>Age (yrs)</td>
<td>21.5±1.6</td>
<td>22.5±2.7</td>
<td>22.0±0.9</td>
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<tr>
<td>Height (inches)</td>
<td>66.62±4.4</td>
<td>70.1±3.8</td>
<td>65.3±1.5</td>
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<tr>
<td>Weight (lbs)</td>
<td>160.9±27.1</td>
<td>204.5±24.3</td>
<td>146.3±6.2</td>
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<td>BMI (kg/m²)</td>
<td>25.5±3.0</td>
<td>29.4±2.1</td>
<td>24.2±2.1</td>
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<tr>
<td>Systolic blood pressure (mmHg)</td>
<td>125±10</td>
<td>129±10</td>
<td>124±11</td>
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<tr>
<td>Diastolic blood pressure (mmHg)</td>
<td>77±7</td>
<td>75±6</td>
<td>78±7</td>
</tr>
<tr>
<td>Predicted VO₂ Max (ml/kg/min)</td>
<td>47.7±4.0</td>
<td>52.5±6.0</td>
<td>46.2±3.5</td>
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<tr>
<td>Resting Heart Rate (bpm)</td>
<td>71±12</td>
<td>64±2</td>
<td>73±13</td>
</tr>
</tbody>
</table>

II. The total amount of energy expended (A) during the 60 minute exercise session and the rate of energy expenditure (B) was higher when exercise was performed for 30 minutes continuously compared with short intermittent exercise. *P<0.05

III. The amount of energy expended during exercise per se was significantly higher when subjects performed continuous exercise compared with two intermittent bouts of exercise (C). There was no difference in energy expenditure in the recovery period between exercise bouts (D). *P<0.05

SUMMARY AND CONCLUSIONS

Continuous moderate intensity exercise for 30 minutes results in greater energy expenditure compared with two, short 15 minute bouts of exercise of the same intensity. Our data suggest that this finding is attributable to an increased rate of energy expenditure secondary to increased heart rate during the 30 minute exercise session.

Due to minimal differences in total caloric expenditure, shorter bouts of 10-15 minutes of moderate intensity exercise remains an efficient way to elicit similar health benefits as longer, continuous bouts of moderate intensity exercise. This is important for those individuals who are unable to perform longer durations of continuous exercise.

ACKNOWLEDGMENTS

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