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ENERGY EXPENDITURE OF RECREATIONAL KAYAKING

Anne Hoffman[1], Kyle Garner[1], Mandy Krings[1], Dan Ottney[1], Rachel Becker[1]

[1]Department of Kinesiology/ University of Wisconsin – Eau Claire, Eau Claire, WI, USA

ABSTRACT

Hoffman, AC, Garner, KJ, Krings, AR, Becker, RR, Ottney, DC. Energy Expenditure of Recreational Kayaking. *Journal of Undergraduate Kinesiology Research*. 2006; 2(1):26-31. Kayaking is a form of exercise that has not been researched extensively as an alternative to traditional cardiovascular activities. **Purpose:** The purpose of this experiment is to determine the physiological effects of recreational kayaking. **Methods:** This study involved ten subjects (six male and four female), with mean age of 31.9 ± 14.5, height 175 ± 11.8 cm, weight 77.7 ± 16.6 kg, VO_2max of 54.2 ± 13.1 ml/kg/min, with all participants having at least a recreational level of physical activity. Most of the participants had some prior knowledge of the mechanics of kayaking. Each of the ten subjects was required to perform a VO_2 max test using the Modified Balke protocol, which was conducted in the UWEC exercise physiology laboratory. Each participant was required to kayak a 1.5 mile designated course at an RPE of 3-4 (1-10 scale). Heart rate was measured during each session and RPE was reported at the conclusion of the trip. **Results:** After completing all testing, our results indicated that recreational kayaking can be used as a viable mode of exercise to fulfill ACSM exercise recommendations. While kayaking participants burned approximately 339 kcals in 19.5 minutes, and had a heart rate reserve of 40%. **Conclusion:** These findings are important because recreational kayaking can be used as a healthy alternative to traditional cardiovascular exercise training. Our study found that recreational kayaking exhibits outstanding physiological benefits.

Key Words: Heart Rate, RPE, Kayak, VO_2 max, energy expenditure, body composition

INTRODUCTION

The United States Surgeon General states that a person should participate in 30 minutes of moderate intensity exercise on all or most days of the week to achieve positive health benefits (1,2). Today, 40% of Americans do not even participate in any type of leisure activity (3). A moderate intensity exercise has been known to improve insulin sensitivity, dyslipidemia, obesity, and lower the risk for cardiovascular disease according to the Studies of the Targeted Risk Reduction Intervention through Defined Exercise study (STRRIDE) (4). Moderate intensity is defined by 40-60 % of VO_2

reserve and/or heart rate reserve (5). The American College of Sports Medicine (ACSM) recommends 30 minutes of physical activity, 3-5 days per week, at a moderate intensity and to expend 150-400 kilocalories per day.

Historically the most common mode of physical activity has been walking. Sixty-seven million men and women are walking regularly and walking has surpassed swimming as the exercise activity of adults over 50 (6).

Interest in snowshoeing, rock climbing and other outdoor and non-traditional activities has increased in recent years, however research on the physiological responses of these activities is not well defined (2,7,8). Recent studies have been done on the physiological responses of snowshoers, rock climbers, walking, and running (7,8,9). One snowshoeing study reported that men expended approximately 500 kilocalories during a 30 minute session while females burned approximately 375 kilocalories per session (8). Another study on walking and running reported that men expended approximately 88.6 kilocalories walking one mile at an RPE of about 4 or 5 one a scale of 1-10, and 124.5 kilocalories running compared to women expending approximately 74.1 kilocalories walking and 105.5 kilocalories running (9). This caloric expenditure shows that this activity meets the ACSM recommendation. In a rock climbing study, climbers were instructed to climb at their own pace. There were technically "harder" climbing routes and technically "easier" climbing routes. The subjects who climbed on the harder route were at 46% of their VO_2 max and the subjects who climbed the easier route were at 40% of their VO_2 max while climbing. Percentage of VO_2 max is not as accurate as % VO_2 reserve however they are slightly related to the same intensity. In 1997, American Sports Data reported that regular snowshoers totaled 1.2 million; a figure which was up over 300% from 1994 (8). Very limited research has been done on the physiological responses of recreational kayaking. A study was done on the physiological effects of recreational kayaking and they determined that their subjects burned between 714-895 kilocalories during a 120 minute work-out, which exceeds the recommended values (2). Studies have been performed on elite kayakers however the benefits of kayaking as a fun physical activity have yet to be completely described.

The purpose of this experiment is to determine the physiological effects of kayaking. It is hypothesized that kayaking will show health benefits similar to other outdoor aerobic activities and traditional modes of exercise.

METHODS

Subjects

Six male and four female recreationally active, healthy subjects between the ages of 20and 57 were selected from the faculty and undergraduate student populations at the University. The mean age, height, weight and body composition are reported in Table 1. Prior to collecting the data, the study was approved by the University's Human Subjects Institutional Review Board. All subjects signed a written informed consent before volunteering for the study. Kayaking skills of the subjects ranged from novice to recreational, but all subjects have a basic understanding of the sport and skills required.

Table 1. Subject Demographics

Variable	Mean ± SD
Age (years)	31.9 ± 14.5
Height (cm)	175 ± 11.8
Weight (kg)	77.7 ± 16.6
VO_2max (ml/kg/min)	54.2 ± 13.1

Instruments

Two Perception America 11.0 kayaks, manufactured in Easley South Carolina were used, a life vest, an optional helmet, paddles, polar HR monitors, and a treadmill.

Maximal Session

Each subject performed a VO_2 max test using a Sensor Medics Metabolic Analyzer on a treadmill with the exception of one subject performing his test on a Nu-Step. Each individual was instructed to continue exercising until they were physically unable to continue. The Modified Balke protocol was used to elicit the VO_2 max and was reliable in obtaining a VO_2 plateau in approximately 8-12 minutes. The Modified Balke protocol involved selecting an appropriate speed on the treadmill for the subject that was to be maintained throughout the test. After each minute the grade of the treadmill was increased by one percent each minute. Along with the grade of the treadmill elevated, the subject was asked to state their rate of perceived exertion on a scale of 1-10 (1=not tired, 10=can't go any more.) We were confident that the Polar Tech heart monitor was accurate because of the reliability of the Polar Tech watch matching the heart rate displayed on the treadmill and the Sensor Medics Metabolic Analyzer. The subjects also wore a Polar Tech heart rate monitor which was accurate for each of the tests. The VO_2 max was completed when the subject reached exhaustion and could no longer continue on the treadmill. At this particular time we printed out charts of the subject's respiratory exchange ratio (RER) (VCO_2/VO_2), maximum heart rate, oxygen uptake, and rate of perceived exertion (RPE). Each individual's VO_2 max was confirmed because we observed a plateau by showing that no increase in VO_2 with an increase in workload, on the graph once their maximum oxygen uptake had been reached. Also, each individual had a respiratory exchange rate (RER) greater than 1.1. Lastly, we were confident that each person had reached exhaustion because their rate of perceived exertion (RPE) was a 9 or a 10. The researchers all had a working knowledge of the equipment and testing procedures being used.

Kayaking Session

While the participants kayaked, their heart rate was monitored. The initial run will also allow the researchers to become familiar with the equipment and procedures. The actual run will last approximately 20-30 minutes and starts at Owen Park and ends at Hobbs Ice Arena boat landing. The subjects were instructed to kayak this stretch at a moderate intensity of a 3 or a 4 on the rate of perceived exertion (RPE) 0-10 scale. The subjects were instructed to begin their kayaking session when they felt comfortable with the kayak. At this time, they were also told to start their watch to keep time, and to frequently check their watch to be sure their heart rate was being recorded.

Procedures

Subject data was collected in two separate sessions. The first involved a VO_2 max test in the laboratory and the second was a 30 minute kayaking trip. The route chosen for kayaking was one and a half miles long and went through the UW-Eau Claire campus on the Chippewa River. Prior to testing each subject was taken on a familiarization run on the course and instructed to dress appropriately for the environmental conditions. We measured the different environmental conditions because they may play a role in the different physiological responses. The temperature on October 26th was 40 degrees, the humidity was at 64 percent, and the wind was moving at 8 mph east to northeast. Our second kayaking session was on November 9th. The temperature was 42 degrees, the humidity was at 65 percent, and the wind was moving at 12 mph west to northwest. Our third kayaking session was on November 14th. The temperature was 33 degrees, the humidity was at 84 percent, and the wind was moving at 7 mph east to southeast. No specific limitations were given to the subjects prior to their testing.

Design and Analysis

The independent variable is the kayaking intensity. The dependent variables are heart rate (%HRR), rate of perceived exertion (RPE), blood pressure, and VO_2 (%VO2R).

Statistical Analysis

Mean and standard deviations (SD) for all data was calculated.

RESULTS

Table 2 shows the mean subject data information which we are using to compare to the results from the other studies. Table 3 shows the comparison of kilocalories burned between kayaking, snow shoeing, running, walking and weight training sessions of a representative male.

Table 2. Mean Subject Data.

Variable	VO_2 (ml/kg/min)	RPE	Time (min)	HR (bpm)	RHR (bpm)	MHR (bpm)	HRR (%)	kcals/min
Mean	54.2	4.3	20.8	118.9	64.2	191	40	9.9

Table 3. Activity Comparison.

Activities	Kayaking	Snowshoeing	Running	Walking	Weight Training
Kcals	339	500	124.5	88.6	135.2
Duration	1.5 miles (19.5 min.)	30 min.	1 mile	1 mile	1 set/8-10 exercises

DISCUSSION

Research needed to be done on the physiological effects of recreational kayaking due to the lack of previous research done on this same topic. Similar studies have been done on the physiological effects of indoor rock climbing, walking, running, and outdoor snowshoeing. In all of these studies the participants showed an increased number of kilocalories burned, increased heart rate, and an increased RPE while taking part in the activities. However, the previous kayaking study averaged 178.5 – 224 kcals in a 30 minute session and outdoor snowshoeing averaged 500 kcals in a 30 minute session which shows a higher energy expenditure than walking (88.6 kcals in 1 mile) and running (124.5 kcals in 1 mile). Although the previous study done on the physiological effects of recreational kayaking used only three subjects.

The subject's heart rate increased with the onset of exercise. The mean of their heart rate was also significantly higher then their resting heart rate. In our directions to them we wanted them to keep intensity at an RPE of a 3 or a 4. ACSM suggests a heart rate percentage between 40-59% is moderate (5). During our study the average heart rate reserve was 40%. Our subject's heart rates remained within their ranges for the entire portion of the kayaking session.

The ACSM recommends that the average individual expend 150-400 kcals per day (5). By putting our subject's weight (in kg) into an equation, we determined that our subjects burned between 100-339 kcals during our 20-30 minute session. This exceeds the recommended ACSM values.

VO_2 max is considered the best cardio-respiratory, endurance, and fitness measurement (3). We compared our findings to the participants baseline VO_2 max. Therefore, the Modified Balke Protocol confirmed that our subjects were in good health and physical conditions. They were able to successfully participate in our experiment.

Rate of Perceived Exertion scale (1-10) was used to monitor the subject's intensity levels. A 1 on the scale indicates no workload, a 5 indicates moderate to hard intensity, and a 10 indicates exhaustion. Our subjects were to perform their kayaking session at a rate of 3 or 4. RPE is an accepted method by the ACSM to monitor progress toward maximal exertion during exercise testing. Our results showed that all subjects, regardless of sex performed at an intensity level of a 3 or 4 during the 20-30 minute kayaking session. Polar heart rate monitors were also used to time each 20-30 minute session and to monitor there average heart rate.

Assumptions and Limitations

There were a few assumptions with our experiment. One being that all the participants were in good physical health. Another assumption was that the participants would perform at an RPE of 3 or 4. We did not have an RPE scale in front of the participants during the kayaking session so they had to access that on their own. Subjects were told to express their RPE out loud at the end of the session, and could have worked at a higher RPE than 3 or 4. However, our subjects were familiar with the RPE scale so this was not considered a limitation.

One of the limitations of our study is that we had to hold the kayaking sessions on three different days. The weather including temperature, humidity, and wind direction was different for each day, which could have had an effect on performance. Also the conditions of the Chippewa River since it is not a whitewater river, we were testing on calmer water.

Another limitation was not being able to use the portable metabolic analyzer. We had planned on using the analyzer in our study, this was a limitation because you had to estimate energy expenditure. We used polar heart rate monitors instead.

CONCLUSIONS

Our study found that recreational kayaking exhibits outstanding physiological benefits. Our subject's heart rates exceeded or remained in the ACSM recommended range for our level of exertion performed (3 or 4). Recreational kayaking fulfills the ACSM energy expenditure recommendation for exercising 20-30 minutes. This showed that recreational kayaking has similar health benefits to other outdoor activities and could replace other traditional modes of exercise. This is a great way to mix up your exercise program to add more variety, and still get the same if not better results of other activities.

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Address for correspondence: Hoffman, AC, University of Wisconsin-Eau Claire, Eau Claire, Wisconsin, 54701. 715-579-6524 hoffmaac@uwec.edu.

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