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Original Research Article

Cardiorespiratory Responses during an Aqua Cycling Class

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Abstract

Introduction: A relatively new group fitness class which is growing in popularity is aqua cycling. Aqua cycling is essentially a "spinning" class performed while partially immersed in water. Cycling underwater provides a low impact environment and the resistance provided by the water purportedly allows for high levels of energy expenditure (EE) with little musculoskeletal strain on the body. **Purpose:** To determine the relative exercise intensity and EE during an aqua cycling class and determine if aqua cycling meets ACSM guidelines for exercise prescription. **Methods:** Eight males (age 22.3 ± 1.75 years) and 8 females (age 21.1 ± 1.46 years) completed an aqua cycling workout by following along to a pre-recorded DVD. The total class was 50 minutes in length, including a 5-minute warm-up and a 5-minute cool-down. Heart rate and VO_2 were monitored every minute throughout the workout and perceived exertion (RPE) was recorded at the end of each segment of the workout using the 6-20 Borg scale. **Results:** Average HR and %HRR were 115 ± 13.7 bpm and 49 ± 9.8 %HRR, and average VO_2 and $\%VO_2R$ were 20.3 ± 3.15 ml/kg/min and 47 ± 5.3 $\%VO_2R$, respectively. The VO_2 corresponded to an average of 5.8 ± .90 METs. The average energy expenditure for the class was 363 ± 65.5 kcals, which corresponded to 7.3 ± 1.31 kcal/min. Average RPE for the 40-minute workout portion of the class, excluding the warm-up and cool-down, was 12.2 ± .95. **Conclusion:** Based upon the HR, VO_2, and RPE responses, aqua cycling provides a moderate intensity workout that meets ACSM guidelines for improving cardiovascular endurance and positively influencing body weight. Consequently, aqua cycling also provides a low impact exercise alternative for those individuals for whom weight-bearing exercise may be problematic.

Key Words: Aqua Cycling, Energy Expenditure, Relative Exercise Intensity

Introduction

It is well known that exercise is important for overall health and disease prevention[1-2]. According to the current American College of Sports Medicine (ACSM) guidelines, it is recommended that individuals perform 30 minutes of moderate intensity aerobic exercise at least 5 days/week or 20 minutes

of vigorous intensity aerobic exercise at least 3 days/week in order to achieve the health/fitness benefits of exercise[2]. As stated above, the intensity of exercise should be moderate to vigorous, which ACSM defines as 64-95% of maximal heart rate (HR), 46-90% of maximal oxygen consumption (VO_2max), and 40-89% of heart rate reserve (HRR) or oxygen uptake reserve (VO_2R)[2]. However, many people do not meet these recommendations because they find exercise boring or claim exercise is not "fun." As a result, group exercise classes such has spinning, boot camp, Zumba, and Pound® have been developed, which provide a fun and social environment, in attempts to increase exercise compliance.

A relatively new group fitness class is aqua cycling. Aqua cycling is essentially a "spinning" class performed while immersed in water, typically up to the xiphoid process. Cycling in the water provides a low impact environment and the resistance provided by the water allows for high levels of energy expenditure with little musculoskeletal strain on the body[3]. Aqua cycling was originally used for the purpose of rehabilitation[4], but has now emerged as a unique fitness trend, appearing in fitness studios all over Europe and most recently in the United States. To date, studies have reported no adverse events related to aquatic cycling[5].

When comparing cardiorespiratory responses between land and water-based exercise, research findings are inconsistent. There is a tendency for studies to find lower submaximal and maximal heart rates during water-based exercise compared to land-based exercise [3-8]. Studies have generally found that submaximal and maximal VO_2 are similar during water and land-based exercises at the same power output [4-5,9-11]. However, Garzon et al.[12] and Kanitz et al.[8] found that VO_2 was lower during water-based exercises and attributed this finding to the fact that the increased buoyancy when exercising in the water required less muscle recruitment to execute the exercise.

When comparing the overall training effects of land-based exercise to water-based exercise, the benefits have been shown to be greater in water than on land[13]. They found that women in a water-based walking group were able to exercise at a higher metabolic rate compared to on land and attributed the differences to improved subjective feelings which resulted in greater gains in physical fitness.

Rating of perceived exertion (RPE) is another way to quantify exercise intensity. Research supports the use of RPE as an effective indicator of intensity during land-based exercise and Alberton et al.[14] found a similar relationship between RPE and underwater exercise intensity. Brubaker et al.[9] also found similar RPE values during aquatic exercise compared to land-based exercise at the same exercise intensity. Conversely, Barbosa et al.[7] observed higher RPE during water vs. land-based exercise. According to ACSM[2], RPE should be between 12-17 on the 6-20 Borg Scale in order to elicit cardiorespiratory benefits.

To our knowledge, there are no data evaluating the physiological responses to an aqua cycling class. The purpose of this study was to assess HR, VO_2, RPE, and EE during an aqua cycling class and determine whether aqua cycling meets ACSM guidelines for exercise prescription. This investigation was part of a companion study[15] which compared submaximal and maximal HR and VO_2 responses during increment land-based and water-based cycling tests. Data from that study (i.e., the water-based test) allowed the data from this study to be converted to relative exercise intensity (e.g., %HRR and % VO_2R).

Methods

Participants

Sixteen apparently healthy volunteers participated in this study. Subjects ranged in age from 19-24 years and had no musculoskeletal or cardiovascular problems that would have been exacerbated while immersed in water or prevent them from exercising at various intensities. All subjects had basic familiarity with riding a stationary bike. Approval from the University of Wisconsin – La Crosse Institutional Review Board for the Protection of Human Subjects was obtained and written informed consent was provided by each subject prior to data collection.

Procedures

Subjects practiced cycling and performing various exercises using the Hydrorider Professional Bike (Biscayne Park, FL) to familiarize themselves with the activity of underwater cycling. Subjects practiced until deemed proficient by the principle investigator and then completed an aqua cycling workout by following along to a pre-recorded DVD of an aqua cycling class edge of the pool deck. The aqua cycling DVD was created by the investigators of this study and was based on workouts performed at aqua cycling studios around the country. The total class was 50 minutes in length, including a 5-minute warm-up and a 5-minute cool-down. The 40-minute workout portion of the class consisted of 4 sections: 1) Interval 1, 2) Arm, 3) Interval 2, and 4) Leg. There was a 2-minute recovery period (cycling against light resistance) after Interval 1 and after the Arm section. Interval 1 was 10 minutes in duration and was similar to a high intensity interval training pattern of 1 minute “on” or exercising at a high intensity, with 1 minute “off” or a recovery period. The Arm section was 6 minutes in duration and consisted of various arm strokes and movements in the water performed simultaneously with a comfortable baseline pedaling rate of 70 rpms. Interval 2 was a repeat of Interval 1. The Leg section was 10 minutes in duration and was a mixture of higher intensity pedaling and leg exercises that were done without the feet secured on the pedals.

All sessions took place in a university swimming pool. The seat height was adjusted so that each subject was submerged to their xiphoid process. Prior to the test, each subject sat quietly on the bike in the water for 10 minutes to determine resting HR. Upbeat music, similar to that played in typical land-based spinning

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classes, was played throughout the entire workout and the subjects were given encouragement periodically, especially during the more difficult portions of the workout, similar to what an instructor would give during a typical spinning class. Heart rate and VO_2 were measured continuously during the entire workout. Heart rate was recorded with a Polar HR monitor (Bethpage, NY) and VO_2 was measured using a Parvo Medics metabolic cart (Sandy, UT). Prior to each test, the metabolic system was calibrated with gases of known concentrations (15.98% O_2, 4.12% CO_2) and with room air (20.94% O_2 and 0.03% CO_2) as per manufacture guidelines. Calibration of the pneumotachometer was done via a 3 Litre calibration syringe. Rating of perceived exertion was assessed at the end of each section of the workout using the 6-20 Borg Scale[16]. Energy expenditure was calculated from the VO_2 data assuming a constant of 5 kcal per liter of oxygen consumed. Percentage of HRR was calculated using the subject's resting HR that was determined in the water. Percentage of VO_2R was calculated using a resting VO_2 of 3.5 ml/kg/min for all subjects.

Statistical analyses

Standard descriptive statistics were used to characterize the subject population (age, height, weight, HRmax, VO_2max). Differences in demographic characteristics between males and females were compared using independent t-tests. Standard descriptive statistics were used to summarize the responses to the aqua cycling workout (HR, VO_2, EE, RPE). All data are represented as mean $\pm$ standard deviation. Alpha was set at .05 to achieve statistical significance. Data were analyzed using SPSS version 25.0 (Chicago, IL).

Results

Descriptive characteristics of the subjects who participated in the study are presented in Table 1.

Table 1. Descriptive characteristics of the subjects (N= 16).

	Males (n=8)	Females (n=8)
Age (yrs)	22.0 $\pm$ 1.70	21.0 $\pm$ 1.50
Height (cm)	176.8 $\pm$ 1.88	168.9 $\pm$ 6.17
Weight (kg)	78.6 $\pm$ 8.24	65.4 $\pm$ 9.53

Absolute and relative HR responses during the 50-minute aqua cycling class are presented in Figure 1 and 2, respectively. The average HR and %HRR were 115 $\pm$ 13.7 bpm and 49 $\pm$ 9.8 %HRR, respectively. Average and relative VO_2 responses during the aqua cycling class are presented in Figure 3 and 4, respectively. The average VO_2 and $\%VO_2R$ were 20.3 $\pm$ 3.15 ml/kg/min and 47 $\pm$ 5.3%, respectively. The VO_2 corresponded to an average of 5.8 $\pm$ .90 metabolic equivalent units (METs).

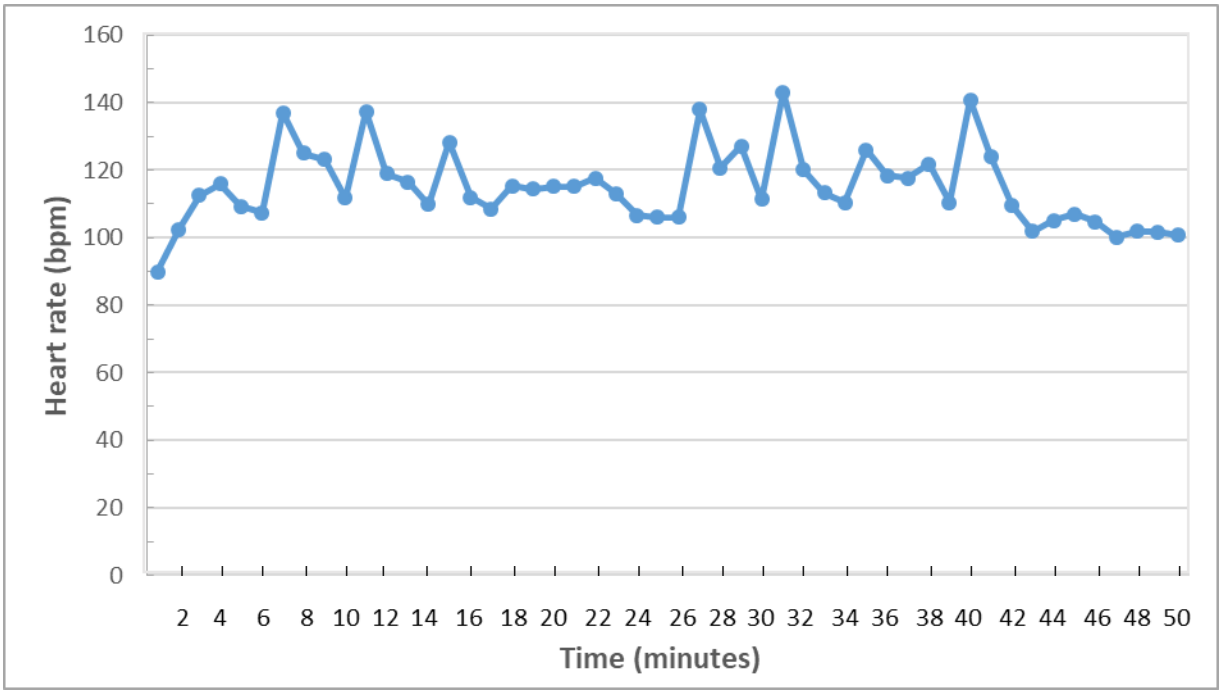

Figure 1. Average heart rate during the aqua cycling class.

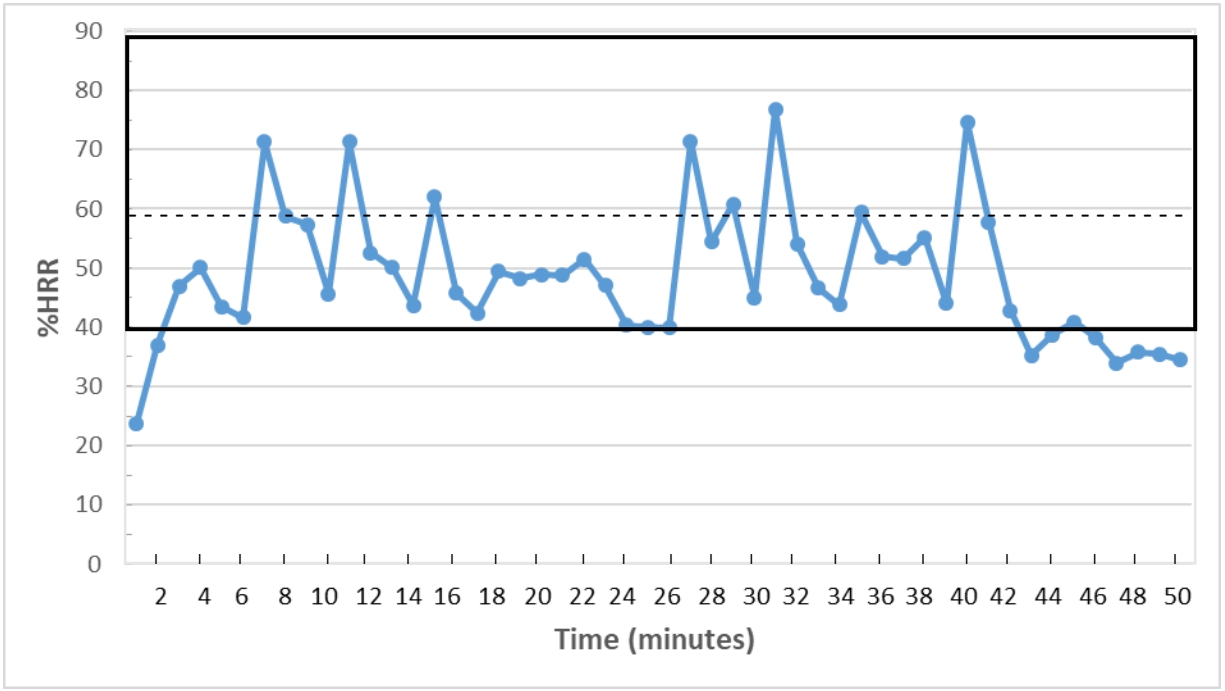

Figure 2. Average %HRR during the aqua cycling class. ACSM guidelines recommend exercising between 40-89% of HRR which is represented by the boxed area on the graph. The separation between moderate and vigorous intensity ranges within the guidelines is represented by the dotted line.

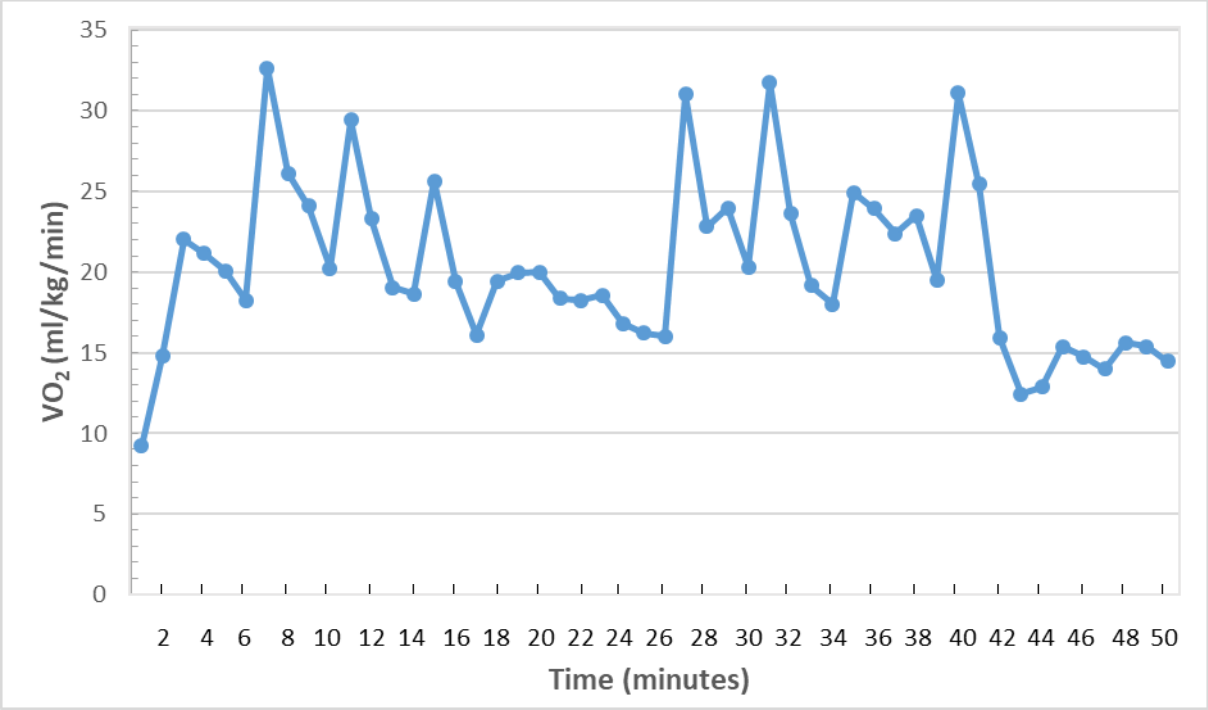

Figure 3. Average VO_2 during the aqua cycling class.

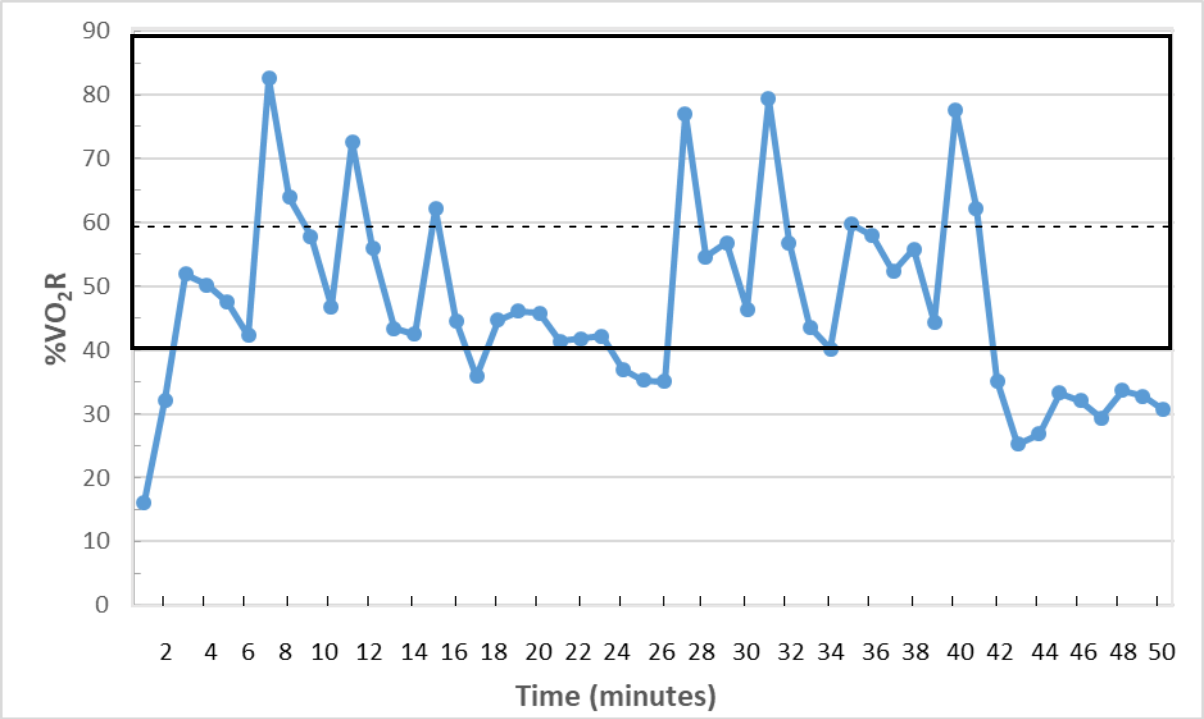

Figure 4. Average %VO_2R during the aqua cycling class. ACSM guidelines recommend exercising between 40-89% of VO_2R, which is represented by the boxed area on the graph. The separation between moderate and vigorous intensity ranges within the guidelines is represented by the dotted line.

Energy expenditure (kcal/min) data for the aqua cycling class are presented in Figure 5. The average energy expenditure was 7.3 ± 1.31 kcal/min. The number of calories expended during the entire workout averaged 363 ± 65.5 kcals. Average RPE values at the end of each segment of the aqua cycling class are presented in Figure 6. The average RPE for the entire aqua cycling class was 11.0 ± .79. Excluding the warm-up and cool-down, the average RPE for just the 40-minute workout portion of the class was 12.2 ± .95.

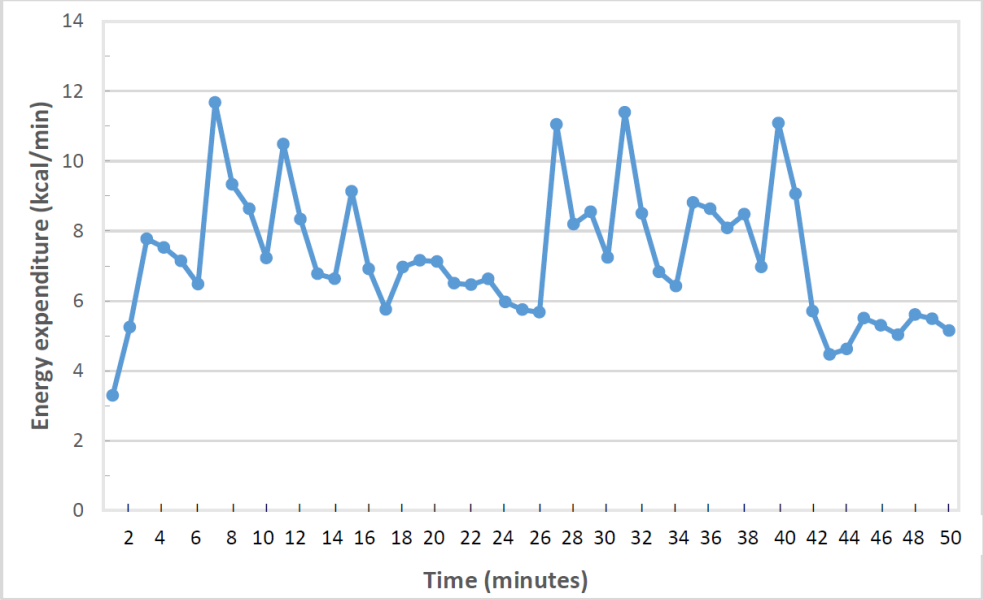

Figure 5. Average by-minute energy expenditure (kcal/min) during the aqua cycling class.

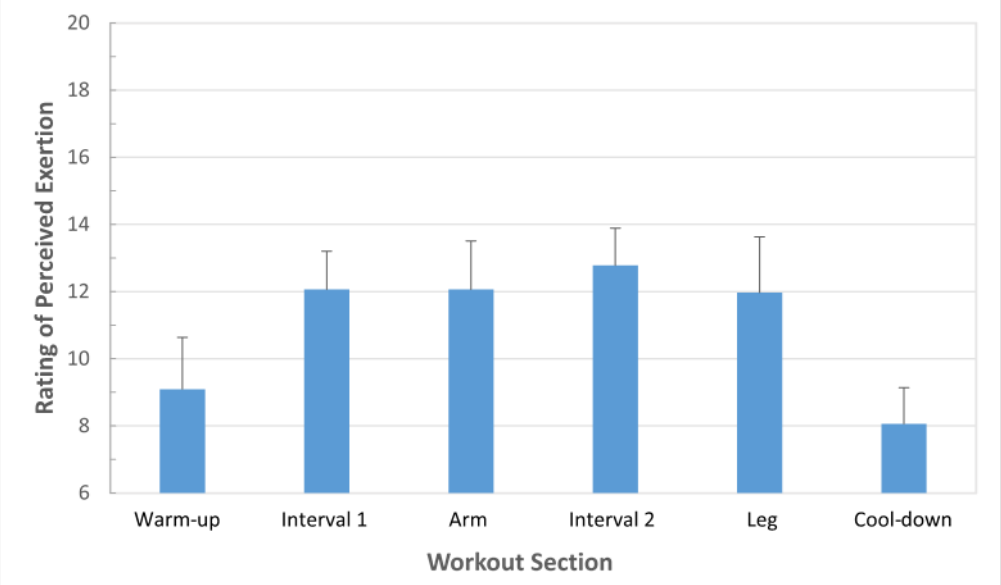

Figure 6. Average RPE at end of each segment of the aqua cycling class.

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Discussion

The purpose of this study was to determine the relative exercise intensity and EE during an aqua cycling class and determine if aqua cycling meets ACSM guidelines for exercise prescription. ACSM guidelines recommend that an individual should exercise between 40-89% HRR and VO_2R in order to achieve cardiorespiratory benefit[2]. The current study found that subjects were exercising at an average of 49% of HRR and 47% of VO_2R during the aqua cycling class, which is within ACSM guidelines for improving cardiorespiratory endurance. These averages would be considered in the moderate intensity range (40-59% of HRR or VO_2R), but as can be seen in Figures 2 and 4, some portions of the workout were in the vigorous intensity range (60-89% HRR or VO_2R). This variation in exercise intensity is typical of the general choreographic plan common in cycling classes[17].

A key point is whether or not the percentage of HRR and VO_2R when exercising in the water provide a similar intensity as during land-based exercise. Garzon, Gayda, Nigam, Comtois and Juneau[18] compared two maximal incremental exercise tests, one performed on the Hydrorider aquabike immersed in water up to the xiphoid process and one on a dryland ergocycle. Both exercise tests were performed at similar external power outputs. There was no significant difference between the average values of %HRR and $\%VO_2R$ for the same external power output during exercise on the immersible ergocycle and the dryland ergocycle. In other words, the relative intensity of aqua cycling and dryland cycling elicited similar %HRR and $\%VO_2R$ responses at similar external workloads. Therefore, ACSM guidelines for exercise prescription are accurate for exercise modalities in the water.

ACSM[2] recommends exercising between 12-17 on the 6-20 Borg scale in order to reap cardiorespiratory benefits. During the 50-minute class, which included the warm-up and cool-down, the overall intensity was rated as 11.0, which would be classified as "fairly light" exercise, according to the verbal anchors on the Borg scale. However, when looking just at the 40-minute workout portion of the aqua cycling class, the average RPE was 12.2, which would be considered "light-moderate" exercise and falls within ACSM guidelines.

Donnelly et al.[19] recommends that individuals expend 1200-2000 kcal per week (240-400 kcal/workout) in order to lose or manage body weight. Subjects in the current study expended an average of 363 kcal during the 50-minute class. This indicates that aqua cycling could be used as an effective workout for weight management. This is especially important for elderly or overweight individuals, or those who have musculoskeletal or orthopedic conditions, who cannot tolerate land-based exercise long enough or cannot exercise at a high enough intensity to expend the recommended number of calories. Our findings are consistent with

those of Rebold et al.[3], who noted that cycling underwater provides a low impact environment, and the resistance provided by the water allows for high levels of EE with little musculoskeletal strain on the body.

An obvious question is how does an aqua cycling class compare to a land-based cycling class. Battista et al.[16] found the average intensity of a 45-minute conventional indoor cycling class and a 35-minute indoor cycling class with four variations in choreography to be 74% and 66% of VO_2max, respectively. While there was significant variation in momentary exercise intensity due to the stochastic nature of indoor cycling classes, the intensity during the majority of both classes was within 75% to 80% of VO_2max, which is within the high-intensity range based on ACSM guidelines for improving cardiorespiratory endurance. Piacentini, Gianfelici, Faina, Figura, and Capranica[20] evaluated an indoor cycling class that was specifically designed to improve cycling performance and promote weight loss. They found that subjects exercised at an average of 79% of VO_2max and 86% of HRmax, which also falls into the high-intensity range based on ACSM guidelines. Therefore, the researchers suggested that indoor cycling should be an activity for healthy, active individuals, and should be avoided by sedentary and older populations or those with health problems. In the current study, subjects were exercising at 49% HRR and 47% VO_2R, which corresponded to 69% of HRmax and 51% of VO_2max. Thus, the overall intensity was in the moderate range, which would be ideal for an older or more sedentary population.

Comparisons between different workouts can be made using metabolic equivalents (METs). Intensity is often classified based on METs because individuals have different VO_2max values, which would affect the calculated relative exercise intensity. Light-intensity physical activity is defined as 2.0-2.9 METs, moderate-intensity ranges from 3.0-5.9 METs, and activities $\geq$ 6.0 METs are considered vigorous physical activity[2]. In the current study, the average MET requirement was 5.8 $\pm$ .90 METs, which falls within the moderate-intensity category. Other activities that are of similar intensity include walking at 4.0 mph on level ground (5.0 METs)[21], hula-hooping (5.9 METs)[22], TRX Suspension Training (5.8 METs)[23], stand-up paddle boarding at an easy pace (6.3 METs)[24], and Pound® (5.1 METs)[25].

Possible limitations of the current study include the fact that subjects performed this workout without other class members present and without a live instructor. Therefore, the observed responses could possibly represent a conservative estimate of the exercise intensity of a typical aqua cycling class. Another limitation was that the subjects in this study were healthy, young adults. Responses in an older or more sedentary population could be somewhat different. Further research could be conducted to evaluate the cardiorespiratory response and

relative exercise intensity of an aqua cycling class in other populations.

Conclusions

In summary, aqua cycling meets ACSM intensity guidelines for improving cardiovascular endurance and energy expenditure guidelines for maintaining and improving body composition. Additionally, it could be an enjoyable low impact alternative for those with orthopedic issues that make weight bearing exercise problematic.

Disclosures

This study was funded by the American Council on Exercise (ACE). However, ACE was not involved in the design of this study, collection or analysis of the data, or the preparation of this manuscript.

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