How Many Calories?

By: June M. Chewning, M.A. (Updated 9-2016)

The question still lingers. Is vertical, water exercise a good form of exercise for weight reduction? How many calories are expended in a water exercise session?.

One of your students comes to class and asks you about an article or news clip. The article says that water is not a good exercise medium to burn calories and lose weight. How do you address this comment? You have seen several students successfully lose weight in your water exercise classes, and perhaps you have lost weight yourself. How can you reassure your students that the water does work before half your class leaves your program?

First and foremost, you as an exercise professional want to have a firm understanding of how calorie consumption works in the human body. The number of calories burned when you exercise is dependent upon several variables. When you hop on a treadmill, you plug in your weight in order to get a calorie read out. The number of calories you burn when you walk or run is dependent primarily on your weight (the more weight you "bear," the more calories you burn), how fast you go, and your elevation (whether you go up hill or not). Environmental factors (air temperature, humidity, what you wear, etc.) and individual characteristics (age, fitness level, gender, weight, etc.) play a role in calorie consumption as well. Determining caloric consumption during exercise is not a straightforward simple calculation.
When you hop on a stationary bike, the caloric expenditure formula changes because you are not "bearing" weight since you are sitting on the bike. The number of calories you expend now depends on the speed at which you are pedaling, the amount of resistance, as well as environmental and individual factors. Your weight is supported by the bike and is not as much of a factor.

If you are not on a piece of electronic equipment that can calculate your caloric expenditure, how do you know how many calories you are burning? First, it is important to realize that caloric expenditure in humans is most accurately measured through "direct calorimetry," which requires a large airtight chamber with rigid engineering requirements. In this process, the amount of heat the body produces is measured.
Measuring heat production in exercising humans is even more difficult because of sweating, evaporation, heat given off by electronic exercise equipment, and other factors difficult to control. So for these reasons, energy expenditure during exercise is usually measured through "indirect calorimetry" or by measuring oxygen consumption (VO2). This is done with a mouthpiece and tube connected to a computer that measures the composition of the air you breathe in and the composition of the air you breathe out. The difference between the oxygen breathed in and the oxygen breathed out is the oxygen used by your muscles (and other processes) for metabolism. When you exhale there will be less oxygen breathed out because your muscles have used (or consumed) this oxygen during exercise. It is safe to assume that if oxygen uptake (or usage) is elevated during exercise, that energy expenditure is increased, and calories are burned. With oxygen consumption you can also estimate the primary fuel being used (glucose or fatty acids), and the amount of calories being burned per minute.

Experts believe, based on scientific research that anyone would say that oxygen and caloric consumption are definitely elevated during water exercise. Therefore, it is very clear that water exercisers burn calories in aquatic fitness classes.

The three issues that continue to challenge the fact that exercise in water does burn calories include:
1.Lower exercise heart rates that occur during aerobic exercise in the water,

2. Faster recovery after water exercise and the concern that post exercise caloric expenditure does not remain elevated for as long a period of time after aqua fitness, and

3. Buoyancy lowers your weight bearing capacity and therefore lowers your caloric consumption in a water exercise program.

It is important to remember that heart rate is used to estimate oxygen consumption during exercise. Since both heart rate and oxygen consumption have a linear relationship with increased workload, heart rate seems a viable alternative to measuring oxygen consumption. It would be impossible for everyone to hook up to a computer and measure oxygen consumption during exercise sessions. So, heart rate is used to estimate intensity or oxygen consumption. Caffeine, medication, stress, temperature, and humidity, to name just a few, can all alter heart rate responses during exercise. If heart rate response is altered, then it does not become as true a predictor of oxygen consumption.
In the water, heart rate is affected by the water's cooling effect on the body, hydrostatic pressure, partial pressure, and the dive reflex. Although there is evidence that this response may be individual, it is clear that heart rates are lower in the water at rest and submaximal exercise for most people. (Kravitz 1997, Baretta 1996, Darby 2000) Research has shown that water exercise heart rates tend to underestimate oxygen consumption and therefore aquatic target heart rates need to be adjusted or lowered. For the most part, this is old news.

The issue of post exercise caloric expenditure after water exercise is less clear. From a physiological standpoint, it would be reasonable to assume that recovery in the water would facilitate venous return, lactate removal, and heart rate recovery. (Nakamura 1996, Viitasalo 1995) Water temperature, length of time spent in the water after exercise, environmental and individual factors would all contribute to post exercise energy expenditure. In essence, the jury is still out as far as how post exercise calorie consumption in the water compares to post exercise calorie consumption on land. There is not enough research at this point to draw any conclusions.

When submerged to the armpits as in most shallow water exercise, buoyancy does indeed reduce impact stress and weight bearing. The reduced compression and joint load makes the water a great place for participants with musculoskeletal disorders to exercise comfortably. It would be natural to assume that because load is reduced in the water, caloric consumption would be reduced as well. Research indicates otherwise.

One study (Cassedy 1992) indicated different MET (metabolic equivalent) levels for upper and lower extremity exercises done in the water vs. out of the water. The upper extremity exercise consisted of raising the arms to the sides, pulling them in to the center of the chest at shoulder height, pulling them back out to the sides again, and then down to starting position at the sides. The lower extremity exercise consisted of an alternating front kick. On land, the upper extremity exercise expended 2-3.5 mets, as compared to the water at 3-6 mets. The lower extremity exercise expended 4-6.5 mets on land, as compared to 4-9 mets in the water. It is interesting to consider that the water's resistance can create workload and caloric consumption for the body. On land, weight bearing is a primary factor for increasing caloric consumption, but in the water it appears that using the water's resistance is more of a

factor. If these two movements were combined in the water, it could be estimated that the exerciser would be expending somewhere between 7-15 mets. It therefore appears that water exercise that combines leg and arm movements is equivalent once again to running or walking at 10-11 minutes / mile, which could be translated to a caloric expenditure estimation of 400 to 500 calories for one hour of exercise.

A more recent study (Darby 2000) produced similar results. The participants performed leg only and arm/leg exercises on land and in chest deep water at various intensities. Even when water pace adjustments were made, kcal expenditure in the water was 1-2 kcal/min more depending on the intensity. This would indicate the possibility of burning 60 to 120 more calories in the water. Interestingly, the researchers concluded that their results indicate that the water may be a good place to exercise for those trying to lose weight. Caloric expenditure per unit of time was higher in the water due to the water's resistance. "Even though the landing or loading forces due to gravity were reduced because the participants were exercising in the water, energy expenditure per unit of time was increased."

It appears water temperature plays a role in oxygen consumption and caloric expenditure as well. In a study conducted in 1988 (Pendergast) it was suggested that exercisers who have reduced core temperature may have reduced oxygen consumption capabilities. It was SUGGESTED that water temperature may affect VO2, and a water temperature at around 84 degrees was recommended. This is reflected in WATERinMOTION's recommendation of a water temperature of 83 to 86 degrees F for cardiorespiratory exercise.

A deep-water study (Baretta 1993) showed an average of 9.8 Kcal/ minute being consumed during deep water exercise, which is equivalent to a 10-11 minute/ mile walk or run. Students worked at a music cadence between 100 and 130 BPM with flotation belts and hand buoys. This would translate to roughly 343 calories for 35 minutes of cardio work in class, not including the calories burned during the warm-up, cool down, and toning portions of class. This could indicate approximately 400 to 500 calories being burned during a one hour deep water class. Not bad for a "non weight bearing" activity.

Just as on land, there are several variables that affect caloric consumption during vertical water exercise. Variables include:
Water depth (which affects weight bearing, control of movement and the amount of water resistance)
Speed of movement (which affects the amount of drag and resistance)
The amount of force applied against the water's resistance
The length of the person's limbs
Environmental factors such as water temperature, air temperature, humidity, chemicals etc.
Obviously, the student that "works the water" by applying more force is going to expend more energy, have a higher VO2, and therefore expend more calories. The harder you work in properly controlled aquatic environmental conditions, the more calories you burn.

In a qualitative review conducted in 2009 (Barbosa), several water research studies were analyzed to evaluate acute responses (during the exercise session) and chronic adaptations (change over time). This pivotal review yielded the following 3 key points:
"Several papers reported consistent and significant improvement in physical fitness (e.g., aerobic capacity, muscular strength, flexibility and body composition) after a program of head-out aquatic exercise with at least eight weeks.

Chronic adaptations to head-out aquatic exercise programs are the cumulative result of appropriate acute responses during the exercise session. Appropriate acute adaptations can be obtained taking into account the water temperature, water depth, type of exercise and its variants, the equipment used and the segmental cadence according to the subjects' profile."
Just as with any kind of exercise, if the type of exercise is performed at the proper intensity, duration, and frequency required to produce acute and chronic responses in the body, these responses occur in the water, too. However exercise in the water environment is a little more complicated than exercise on land with additional variables that need to be considered and controlled. This review basically establishes the point that when you exercise in the water at the correct intensity, duration, and frequency with aquatic variables accounted for, you achieve the same chronic adaptations as when you exercise on land. This makes perfect physiological sense and therefore comes as no big surprise. If you exercise in the water at an intensity and duration that facilitates weight loss at a frequency of 3-5 times per week for at least 8 weeks or longer, you will lose weight just as you would in any other exercise program.

The key to weight loss in the water is understanding how to properly control the acute responses to facilitate the chronic adaptations by properly monitoring intensity and the water variables to create caloric consumption for weight loss. It is imperative to understand how the heart and perceived exertion responds in water exercise, and use methods like the Kruel Aquatic Heart Rate Formula to prescribe a program that is conducive to weight loss. This requires substantial knowledge of how the water works and skill acquired through experience.
Do you burn calories in a vertical water exercise class? Absolutely! How many calories do you burn? In the proper conditions, with proper motivation to work, it looks like an estimate of approximately 400 to 500 calories per one-hour class is still a reasonable estimate. It appears that the water's resistance makes up for the loss of workload due to reduced weight bearing from the water's buoyancy. We know our students burn calories and we see them lose weight and dress sizes. We all know that water works!

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