How Many Calories?
June M. Chewning, M.A.

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? This is an update of an article from a previous AKWA. The question and the answer are still basically the same, but we now have even more scientific evidence to support the answer.

It can be very frustrating. 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 you lose your whole class?

First and foremost, you as an exercise professional want to have a firm basis 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 straight-forward simple calculation.

When you hop on a stationary bike, the calorie formula changes because you are not "bearing" weight because 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 mouth-piece and tube connected to a computer that measures the composition of the air you breath in and the composition of the air you breath out. The difference between the oxygen breathed in and the oxygen breathed out is the oxygen used by your muscles for metabolism. It is safe to assume that if oxygen uptake 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.

I do not feel, based on scientific research, that anyone would say that oxygen and caloric consumption are NOT elevated during water exercise. It is very clear that you burn

calories in water exercise. The three issues that do continue to plague water exercise's contention to burn calories are:

1. lower exercise heart rates during aerobic exercise in the water,
2. faster recovery after exercise and the concern that post exercise caloric expenditure does not remain elevated for as long a period of time after water exercise,
3. and the fact that buoyancy lowers your weight bearing capacity and therefore your caloric consumption in the water.

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 evident 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 work load 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. This 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 the AEA'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: 1) water depth (which affects weight bearing, control of movement and the amount of water resistance), 2) speed of movement (which affects the amount of drag and resistance), 3) the amount of force applied against the water's resistance, 4) the length of the person's limbs, and 5) 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, the more calories you burn.

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 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 the water works!

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