

Caloric expenditure: does water exercise make the grade?

THE AMERICAN COLLEGE OF SPORTS MEDICINE (ACSM) recommends a caloric expenditure of 150 to 400 calories per day just to maintain physical function. It recommends that previously sedentary individuals may benefit initially from a minimum expenditure of 1000 calories per week. They further recommend that to achieve weight loss, overweight adults expend 2000 calories per week.

What does this mean for two different women? If previously sedentary Betty has a simple goal of improving her health and fitness levels she needs to participate in a program that elicits a minimum calorie expenditure of 1000 calories per week. On the other hand, Sally, who wants to lose weight, would require a caloric expenditure of 2000 per week from her exercise program.

Can water exercise help Betty and Sally?

The Aquatic Exercise Association in the US reported that in normal conditions, where the water temperature is 28 to 30 degrees Celsius, performing a combination of exercises that involve the upper and lower body at armpit depth water would result in a caloric expenditure of approximately 400 to 500 calories per hour. So if Betty participated in a 60 minute aqua exercise class, two or three times a week, she would satisfy the minimal requirements established by ACSM. If she was not able to tolerate 60 minutes of continuous exercise, she may benefit initially from 30 minutes of water exercise, four to five days per week. Sally, on the other hand, would benefit from attending a 60 minute aqua exercise class a minimum of four times a week.

This may seem like a lot of exercise for the previously sedentary Betty, but research has also shown that both she and Sally would have to exercise longer to achieve the same caloric expenditure on land. A study reported on by J Lindle^{1,2} that compared upper and lower body exercises performed on land to the same upper and lower body exercises performed in chest-depth water resulted in a greater caloric expenditure when performing the exercises in the water. The water exercises resulted in a caloric expenditure that was 1 to 2 calories per minute more than the exercises performed on land. This suggests that both Sally and Betty could possibly expend 60 to 120 more calories per hour if they exercise in the water, than if they participate in a land-based exercise class.

How can that happen?

An understanding of the factors that contribute to caloric expenditure could make this information difficult to believe. Firstly, the number of calories used during exercise is directly related to the weight of the body – the heavier the body, the more work required to move it. For example, if Sally and Betty were walking together (on land) at the same pace and Betty weighed 64 kilos and Sally weighed 80 kilos, it is likely that Sally would be expending more calories due to her body weight.

The buoyancy of the water decreases body weight so the actual weight of the body does not increase caloric expenditure with water exercise. Many researchers have concluded that the increase in energy cost of water exercise is due to the resistive

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forces of the water. One study compared the MET values (energy expended during exercise) of upper body and lower body exercises performed in the water to the MET values of the same motions performed on land. The MET values for the upper body exercises were between 3 and 6 in the water and between 2 and 3.5 on land. The MET values for the lower body exercises were between 4 and 9 in the water and 4 and 6.5 on land. The author concluded that the resistance of the water represents a greater factor in caloric expenditure than does the weight bearing status of the exercises performed on land. As a reference 3.3 METs would be similar to walking 4.8 kmph on a treadmill and 9 METs would be similar to jogging 8 kmph.

Who creates more resistance in the water, Betty or Sally?

The resistance of the water is a major factor in determining caloric expenditure, however, there are several factors that require consideration when discussing resistance in the water. For example, in water the resistance can be altered by the speed of the movements that affect drag and resistance, the limb length and surface area, and the amount of force applied against the water's resistance.

An evaluation of the upper and lower body exercises that were performed provide an illustration of the possibilities for altering caloric expenditure during water exercise. The upper body exercises involved a movement pattern that included shoulder abduction, horizontal adduction and shoulder flexion. The lower body movements included hip flexion and extension. The energy cost of these motions performed on land will be relative to gravity and the individual performing the movement. The energy cost in the water will be relative to the amount of force that is applied with the movements, the drag forces created by the movement, the limb length of the individual performing the movements and the water depth. So if we assume that Sally's overall body mass is greater than Betty's, when they perform these movements on land Sally may be expending more energy to move her limbs against gravity.

Now, Sally and Betty are walking in the water but Betty, who weighs less, could actually be expending more calories. Betty still weighs 64 kilos and Sally still weighs 80 kilos. We can assume that Sally may have a larger body mass and, due to greater surface area, may also expend more energy to move her limbs against the resistance of the water. However, Betty could apply more force and create more drag forces, thus creating a greater caloric expenditure.

Sally floats while Betty works

Water depth is another factor to consider when discussing caloric expenditure and water exercise. AEA recommends exercising at chest depth for efficiency and safety (if performing shallow water exercise). Higher water depths affect buoyancy, resistance and control of movement, all of which can influence caloric expenditure. Sally and Betty are walking in the water, Betty at chest depth and Sally at neck depth. Betty is stable enough to apply a greater force against the water. She is also able to apply greater force off of the pool floor to propel her forward. Sally, due to buoyancy, is unstable and has a very difficult time applying force against the water and against the pool floor to travel forward. Betty, in this case, is most likely experiencing a greater caloric expenditure.

Other factors that might affect Betty and Sally

Caloric expenditure is influenced by several other factors, some of which are environmental and some of which are attributable to individual characteristics. Environmental factors include water temperature, air temperature and humidity. AEA's recommendation for water temperature is between 28 and 30 degrees Celsius. Water temperatures below 28 and above 30 can actually alter the physiological response to exercise. Lower water temperatures can decrease the metabolic rate while higher temperatures can increase it. An increase in the metabolic rate as a result of water temperature can influence the body's ability to safely and efficiently perform the exercises.



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Individual characteristics that can affect caloric expenditure include age, fitness level and gender. Younger people typically have a higher metabolic rate than older people, so if Sally was older than Betty and all factors were equal (water depth, resistance, etc.), Betty may experience a greater caloric expenditure than Sally. However, if Sally has significant experience with exercise, specifically water exercise, and Betty was previously sedentary, Sally may experience a greater caloric expenditure. A study published that compared the effects of experienced deepwater runners with inexperienced deepwater runners showed that the experienced runners were able to obtain a higher workload and thus a greater caloric expenditure than the inexperienced runners.

Do we make the grade?

Research studies have concluded that participation in an appropriately designed water exercise program can result in a caloric expenditure that satisfies the ACSMs recommendations for maintaining physical fitness and for weight loss. This means that Betty could possibly achieve her initial goal of 1000 calories per week. Sally could possibly reach her weight loss goal of 2000 calories per week. However, their success will be dependent upon body position in the water, motivation, experience, initial fitness level, the temperature of the water and their willingness to work hard. ■

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REFERENCES

1. Lindle, J. *How Many Calories?* Nokomis, FL: Aquatic Exercise Association, 2002.
2. Lindle, J. *Aquatic Fitness Professional Manual.* Nokomis, FL: Aquatic Exercise Association, 2006.



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