CEC Article : How Many Calories? and why people's fitbit/Heart rate monitors get it w r o n g.
By C. H. Krafft

Understanding how many calories are burned in a water aerobics class can be difficult being put forth and the use of the water properties. You can burn up to 750-850 calories in an hour (high intensity water running or swimming) or you can burn as little as 150 calories in an hour (Water Yoga or bobbling on a noodle in place with gentle movements.)

First—Why the fitbits/heart rate monitors and research done with heart rate get it all wrong.

Heart rate is affected by how much of the body is submerged vertically in the water.
Standing in the shallow end to navel level reduces the heart rate by 6 bpm.
Standing in the shallow end at shoulder level reduces the heart rate by 15 bpm.
Swimming horizontally barely affects the heart rate at all. (Only 6-8 inches of vertical submersion).
In addition, the blood pressure is also reduced by amount of vertical submersion.

It is all due to the buoyancy affect of the water.
Buoyancy: The upward force/lift exerted by the water, when a body is submerged. There must be sufficient displacement of water to buoy up the body. Ideally we associate this with deep water training, but the effects of buoyancy can be felt in shallow water training as well.

INDUSTRY NEWS

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Examining Deep Water Research

By Carol Kennedy, MS

If you teach water exercise, you probably know that deep water training is effective, but the following research will lend scientific credibility to your anecdotal experiences. We'll look at three different areas and explore what the results mean in the context of your classes and personal training sessions.

Does working out in the water improve function on land?

Study: Michaud, Brennan et al. (1995) did a deep water interval training study with 10 healthy, sedentary subjects. Before beginning the training, the subjects participated in VO_2 max testing during treadmill running (TR) and deep water running (DWR). Then the subjects participated in a deep water interval training program three times a week wearing buoyant belts. After eight weeks of training, all subjects had their VO_2 max retested in both environments.

Results: Deep water interval training produced gains in VO_2 max of 10.6 percent for TR and 20.1 percent for DWR. Although the training produced greater improvements for DWR, the subjects also improved their treadmill time *on land*.

Application: This study is one of the first to suggest that water exercise training does improve function on land.

What are the different physiological responses to water versus land exercise?

Study: Wilbur et al. (1995) compared how land-trained subjects who were *not* water trained responded physiologically to TR versus DWR. Wilbur matched runners by VO_2 max and assigned them to either a DWR or a TR group. Both groups were tested during a 60-minute run at 70 to 75 percent of VO_2 max. Deep water runners wore buoyant belts, and land runners were tested on a land

Results: At the same VO_2, heart rate response was 14 percent lower for DWR than for treadmill exercise. Blood lactate levels were 31 percent higher for water exercise. These data suggest that submaximal DWR and TR of equivalent intensity and duration elicit different cardiovascular and metabolic responses.

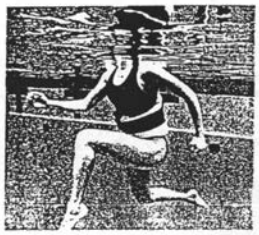
Michaud, Rodriguez-Zayas et al. (1995) did a similar study with eight well-trained male runners performing peak DWR and TR tests and participating in three 15-minute steady-state submaximal exercise trials. The results were similar to those found by Wilbur et al.

Application: We cannot use "land" heart rates to measure exercise intensity in deep water. Using ratings of perceived exertion (RPE) and/or talk tests is more appropriate. The greater anaerobic demand of supported DWR led the authors to recommend interval workouts with short rest periods rather than continuous runs, because of the high lactate response to the latter. It is important to note that even participants who are highly trained on land will take some time to adapt to the muscular demands of deep water exercise.

What about speed of movement and the physiological responses among trained deep water runners?

Study: In a very well controlled study, Frangolias (1995) compared metabolic responses to both TR *and* DWR in 13 endurance runners who had already trained in deep water for at least six months.

Results: When comparing DWR with TR at the same VO_2 max, the researchers found that heart rates were approximately 15 beats lower in the water, blood lactate levels and RPE were the same for both environments, and stride frequency was 39 percent slower in the water



to move more slowly in water while expending the same energy as on land. This is due to the resistance of the water. Once participants are trained in the water, blood lactate levels are the same in deep water and on land, meaning deep water exercise is not more anaerobic in a participant who is water trained. As participants become more adapted to water exercise, we need to challenge them by increasing resistance much as we do in a weight room setting. We can do this by adding equipment that increases surface area, having students travel against resistance, or increasing the speed of a movement.

References

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Photographs: Travis Trenkel

The preceding article was published in 1996. Nearly 20 years ago. It was done correctly by measuring the oxygen uptake in addition to the heart rate.

Research Summary and Implications

Study 1:VO2 Max test on treadmill and deep water on 10 healthy sedentary people. They were trained for 3 times and week for 8 weeks in deep water interval training only.

Result: Average increase of 10.6 % on VO2 max on treadmill and 20.1% for deep water.

Implication: Cardiovascular training in deep water will benefit land performance.

Precaution: It will not properly train connective tissue for impact on land.

Study 2: Runner (land only) were matched by VO2 max tests and split into 2 groups both were tested for 60 min at 70-75% of the VO2max one group on treadmill and the other deep water.

Result: At the same VO2 heart rate was 14% lower in the water, but the blood lactate levels were 31% higher. I.e. there were different cardiovascular and metabolic responses at the same intensity level. Hydrostatic water press would lower the heart rate and decrease the amount of energy needed to return blood to the heart. The viscosity of the water is higher so more of the body is working under higher resistance.

Implication: You can work out harder and keep your heart rate lower than on land at the same O2 uptake. This allows for greater workloads or less stress on the heart at equivalent workloads. Also the muscular demands in the water are greater than land and participants need adaptation time.

Study 3: 13 endurance runners (who had trained in water for 6 months) had their metabolic responses tested with treadmill and deep water running.

Result: At the same VO2 Max the heart rates were 15 bpm lower and the RPE and blood lactate level were similar but the stride was 39 % slower in the water due to the resistance of the water.

Implication: Once adapted at the same VO2max the heart rate is slower with the same blood lactate level again putting less strain on the heart at equivalent work loads.

So, if heart rate monitors and fitbits rely on measuring heart rate to determine the number of calories burned they will never work correctly in the water. The more submerged the participant the lower the heart rate and the lower the calculated calorie burn.

What other things can affect heart rate in the water that do not affect the exercise intensity. —-

Holding your arms out of the water especially shoulder height and above increases the heart rate. This creates a backpressure of blood on the heart from the amount of blood held above the heart. This falsely elevates the heart rate by back pressure on the heart which is not recommended. Holding your breath also increases your heart rate without increasing intensity, but that is not recommended either. Therefore the arms should be kept in the water and used for resistance to increase the exercise intensity by actual work.

Now how many calories do you burn with different types of water exercise…..
It depends on the workout.

Because it takes more muscle energy to push your body through water then through air, walking in thigh-deep water or in deep water with an exercise flotation device can give you a significantly higher workload of walking on land. Your energy utilization system works harder, too. You can burn up to 528 calories per hour of water walking (compared to 280 calories on land) without getting hot and with less risk of injury.

Calorie Burning Statistics—July/ August 1998 Fitness Magazine; Cardio H20 by Liz Neporent

Aquatic Strength Training with Equipment	342-390 cal/hour
Land Strength Training with the Same Equipment	306-366 cal/hour
Deep Water Walking (with travel)	528 cal/hour
Land Walking	282 cal/hour
Deep Water Running (with travel)	690 cal/hour
Land Running (11 min. mile)	480 cal/hour

Conclusion:

Using the water resistance in place adds only 20-40 calories per hour over the equivalent land exercise.

Using significant travel adds 200-250 calories per hour. The surface area of the body pushing through the water continuously is the key.

Now if you can add more resistance through drag devices, resisting arms, leaping and bounding while traveling, you can add another 200 calories per hour.

What about Stationary Arthritis, Water Yoga and Tai Chi? Well they only burn about 180-220 calories per hour. They are slow moving and don't take much use of the resistance of the water. Also the water helps support the limbs so you don't use the energy to hold the arms or legs up against gravity. There purpose is joint mobility and stretching not calorie consumption. The same is true for stationary workouts that are too deep and bobbing around with little effort from the arms and legs.

Review of water dynamics to increase intensity and muscular work/calorie burn.
1. Use of significant travel through the water.
2. Use of arms for pushing and pulling in the water and to add surface area resistance.
3. Use of arms for resistance against the direction of travel or to counter balance a leg movement and help the legs move bigger and faster.
4. Use of drag equipment against the direction of travel.
5. Directional force against the water. (Water step exercise, jump up and pull down, rebounding, leaping, propulsion...)
6. Lengthen levers against the direction of travel. Long arms and legs not short and bent. (Cross Country with STRAIGHT arms and legs uses more calories then jogging with bent arms and knees.)
7. Speed in a controlled fashion. Not so fast that you can't get full range of movement and use good form, but not so slow that you can't feel the resistance of the water.
8. Suspended with travel. As long as the participant can do this in good form. If they are not good swimmers and have trouble floating this may be a safety issue and an ineffective method of increasing intensity. If they float easily, then without travel they are just bobbing around.

Submit answers with $15. Passing score is 80%.
Checks payable to A-PAI, 547
WCR 18, Longmont, CO 80504.
1. What is the only good way of measuring exercise intensity?

2. Why don't heart rate monitors work in the water?

3. T or F Swimming heart rates are as affected by the water as water aerobics.

4. T or F Water aerobics or water training will not increase VO2 max for land exercises.

5. How much is the heart rate reduced in the water for shallow and deep water?

6. What are inappropriate ways of increasing heart rate in the water?

7. How many calories per hour does travel add to your workout?

8. How many calories per hour does stationary resistance add to your workout?

9. How many calories per hour does water yoga, tai chi, or bobbing stationary burn?

10.List 8 ways to increase calorie burn.