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Water Physiological Benefits During Exercise
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Although much of the research on the physiological impact of exercising in water was done in the 1990's, a layman's interpretation that you can give to your classes (and or management) on the real impact, implications and benefits of water exercise for special populations and performance athletes was not concisely done. It also explains why some participants complain about not "feeling" like they are getting as hard of a workout as they get on land. This article is intended to help with being able to address questions and give information on the remarkable benefits of water.

First, we will examine the properties of water and the direct implication of just being in water.

Archimedes principle: When a body at rest is immersed in water, either completely or partially, it experiences an upward force equivalent to the weight of the fluid it displaces. A body will float if it displaces water weighing more than its own weight and will sink if it displaces water weighing less than its own weight.

Affects – Participants with more lean body mass will sink and need more floatation to work comfortable and in proper alignment unless they are very good swimmers. It also means they have to work harder in suspended without flotation equipment positions. Participants with less lean body mass will float and suspended without flotation equipment positions are easier than impact or travel. Be aware that if you are trying it increase intensity you may have to split your options for "floaters" and "sinker" or some of the participants will lose the benefit of your programming. Make them aware of the difference and pick the option that is harder to try and keep your training benefit. Otherwise interval training becoming ineffective and will not produce the caloric burn and anaerobic training responses. This would include breaking the plateau effect, increasing the anaerobic threshold and fast twitch muscle fiber training.

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 when using loping types of movement.

Affects– Because of the buoyant and hydrostatic pressure of the water, the resting and exercise heart rates and blood pressures are lower than on land at the same O₂ uptake. The more of the body that is submerged the greater the affect. In navel deep water the heart rate is roughly 6 PBM less than land and in shoulder deep it is roughly 15 BPM less. This means for people with high blood pressure, cardiac or circulatory problems the deeper the water the safer for them to workout as long as they are comfortable in the water and the risk of drowning is low.

Secondly – This buoyant and hydrostatic effect helps with circulation and the return of blood and fluids from the lower extremities. This means for Pre/post natal, seniors and

those with blood vessel valve problems, endemia is reduced, and circulation is improved while in the water.

Thirdly – This buoyant effect helps with gastrointestinal problems by lifting the bowels and allowing better digestion. This can help seniors, pre/post natal and participants with gastrointestinal disorders.

Fourthly – For prenatal participants it helps support the abdomen and fetus and gets the pressure off of the back and hips.

Fifthly – This buoyant affect combined with water temperature helps with flexibility work for participants. The limbs weigh less in the water and the joints are more open in the anti-gravity environment. For participants need to work on flexibility for injury prevention or rehab 86-90 degree water will work better than land based flexibility exercises. Precaution - prenatal participants are over flexible because of the hormones in their bodies. Overstretching during this time can cause destabilized joints later since tendons and ligaments don't return to their normal length like muscle tissue if over stretched.

Sixthly – The buoyant affect helps with balance. For weak participants or participants with bad or changing balance conditions (prenatal). The water buoyancy supports the body's weight and prevents falls and injuries while working on balance. Participants for whom any land based balance exercises are too strenuous or difficult because of their own body weight can develop better balance in the water where they weight less and can relax without the fear of falling and injuring themselves. They can develop the balance skills and strength to allow the to transition to the gravity based exercises with a better progression.

Viscosity: The internal friction of the water that tends to resist motion. Water is more resistant than air, most sources agree it is 12x more resistant, thus acts as a resistance/drag to movement.

Affects – A more balance workout is attainable with using both the upper and lower body effectively and working out the opposing muscle groups synergistically. Without equipment deep water is double concentric. If you add buoys, noodles, bands, balls, or resistance equipment other than neutral devices like gloves, you will have eccentric contractions and can work the muscles in an unbalanced manner unless the instructor programs accordingly.

Secondly – This drag produces an overload for all bones and muscles at a higher degree than air. For osteoporosis, the tendons and ligaments need to pull on the bones at a higher level than they are used to for the bones to increase in density. A leg workout (like land walking or low impact aerobics) will only affect the bone density of the legs; it will not increase the bone density of the upper body. In water aerobics, viscosity affects all the body parts that are being moved against the water. Therefore, there is more benefit to the upper body, back and hips than land workouts unless they are strength training the entire body. Remember the astronauts have to train with the bands everyday in space to maintain bone density. Impact is not the only way to increase bone density. Resistance is just as viable.

Thirdly – Speed/jump enhancement. By practicing exercises like running, kickboxing, jumping and tennis like (speed based sports) in the water (which has a much higher

resistance and drag), a performance athlete can increase their land-based speed significantly. It is similar to training with parachutes for running and bats with fins for drag for tennis and baseball.

Fourthly – This is an advantage and a disadvantage. For healthy joints, movement through the water does far more than land to strengthen the stabilizers around the joints, especially, lateral movement. This builds stronger more stable joints. However, if a participant has a joint injury the viscosity and drag may be too much and cause further damage because of the higher load.

Hydrostatic Pressure- The water exerts a force against the body is all over the body. Similar to atmospheric pressure, water pressure changes with depth as air pressure changes with height. For a 1-mile increase in elevation the atmospheric pressure on your body decreases by 30%. For a 22-foot submersion in water the pressure on your body doubles. The water effect is approximately 250x that of air for depth changes.

Affect-This also helps with circulation and lessens the occurrence of varicose veins. It helps with endemia and circulatory problems.

Secondly – It helps stabilize the joints in their movements. It is like have a lightweight ace bandage all over your body. Therefore for pre/post natal, arthritis, seniors and rehab patients it adds some extra stability during joint movement.

Thirdly – This is more of the current area of study. This pressure and somewhat of a sensory deprivation aspect of the water has some neurological benefits. Stroke victims seem to be able to focus and regain movement function faster in the water. Autism and other disorders where pressure is key as a calming effect are also being studied in the water. Recall autism is like a sensory overload disorder and there is several related disorder where pressure helps to calm or stop an episode. Water therapy is being investigated for use with these disorders and other neurological problems. Water temperature may also be important.

Thermal Conductivity-The water has a much higher thermal conductivity than air. That means that if you are warmer than water, water has several orders of magnitude better ability to pull heat from you by conduction (it is physically in contact with you at a high enough density) than air. If also means that if it is warmer than you it delivers heat to you more effectively. Air uses evaporation of our sweat and radiation (it is physically in contact with you but at a low density) to cool us.

Affect- You will never feel as overheated working out in 83 degree and cooler water as you do on land even at the same intensity. The water cools you off more efficiently and faster than air. If a person has a disorder where they cannot sweat effectively and overheats easily, the water is safer for them to workout in than on land. Pre-menopausal and menopausal women with hot flashes will find the water more comfortable to perform higher intensity exercise. Prenatal can keep their core temperatures lower and it is safer for the fetus especially in the 1st trimester.

Secondly-Temperature gradients can be used to help joints. Studies have shown that 85-88 degree water helps the joints be more mobile and the synovial fluid flow increase to the joints. With buoyancy and the correct water temperature joint mobility and flexibility

are greater. Even performance athletes who need to work on flexibility can make better gains in the appropriate water. Note that water under 83 has the opposite affect and tightens the muscles and restricts the joints.

Thirdly – Other disorders are temperature dependent. Fibromyalgia needs temperature of 90 for a comfortable workout where multiple sclerosis needs cold water (82 or lower) or the condition is aggravated instead of helped. Higher temperatures slow the messages due to the loss of myelin (the nerve sheaths). Symptoms like blurry vision, tingling and numbness can return as their body temperature rises. New wellness centers associated with hospitals that have 3 good-sized pools.

-A workout/MS pool from 3.5 to 12 feet at 82.

-A medium sized arthritis pool at 3.5 to 5 feet deep at 86 and

-A therapy pool at 3.5 to 5 feet at 90 degrees.

These 3 pools accommodate most of the height of participants with any special need they may have or allow workout or flexibility training.

We have now covered some of the more important water effects on physiology that are true whether someone is exercising in the water or just standing in the water. We will now explore the exercise specific research and its implications.

Research Summary and Implications

Study 1:

VO2 Max tests on treadmill and in deep water was performed on 10 healthy sedentary people. They were trained for 3 times a week for 8 weeks with deep-water interval training only.

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

Implication: Cardio vascular training in deep water will benefit land performance.

Precaution: It will not properly train connective tissue for impact on land. I.e. ligaments and tendons for impact to prevent “shin splints”

Study 2:

Runners (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 in 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 pressure 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.

Precaution: Even though it is safer for someone with cardiac problems to workout in the water since the heart is working less at the same intensity; the perceived exertion is also different. They still need to monitor their condition. If they have high blood pressure (which is also lower in the water and lower during exercise in the water) they still need to adhere to the 140 rule. So don't let them over exert just because it is a safer environment. They are still high-risk participants.

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 the body has adapted, exercising at the same VO₂ uptake as land (same intensity) will show slower heart rates, but the blood lactate levels are similar. Again water exercise puts less strain on the heart at equivalent workloads. Also speed perception is different in the water. To run at the same speed in the water as on land would require a much higher intensity.

These were studies that looked at forcing the same intensity or workload to compare the physiological responses. We will now look at the comparison of attempting to do the same activities in the water as on land and the caloric burn.

Because it takes more muscle energy to push your body through water than through air, walking in thigh-deep water or in deep water with an exercise flotation device can give you almost double the workload of walking on land. Your energy utilization system works harder, too. You can burn up to 525 calories per hour of water walking (compared to 280 calories on land) without getting hot and with less risk of injury. However, this does not mean that all exercises are double.

For deep water running you burn 690 calories per hour compare to 480 calories per hour for an 11 min land mile pace. This is not a doubling, but a 30 % increase, but each activity was between 210 and 240 calories per hour more in the water. It would make sense that because of the viscosity and drag we see approximately a constant increase in water training.

Finally, we examine water circuit and land circuit training. Both of these use equipment that provides the resistance as opposed to either air or water. Approximately 366 calories per hour are burned in aquatic circuits and 336 calories per hour are burned on land. This

makes sense because there is more drag caused by the water in the water circuit, but the equipment is providing the majority of the resistance in both cases. However, remember the exercise heart rate and blood pressure are lower for the aquatic case at the same workload.

My goal here was to give you some summaries and studies to help you answer questions and be aware of the benefits, but using those benefits in balance. Water has some great properties for exercise, but we live in a gravity-based world.

Performance athletes and special populations still have to live in this world 99% of the time and need to be able to function there as well. For certain groups, water may be there only option for exercise.

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1. In what decade was most of the research done on the water's effect on exercise?

2. What is the Archimedes principle?

3. How does the Archimedes principle affect suspended exercises without flotation?

4. What must the instructor be aware of when trying to do effective interval training on a class of many people?

5. What is Buoyancy?

6. How does buoyancy affect both resting and exercise heart rates and blood pressure?

7. Name a special population that can benefit from this effect?

8. Name and explain four other affects buoyancy has that benefit pre/post natal, seniors and arthritis populations.

9. For arthritis and rehab patients working on flexibility and joint range of motion, what other factor besides buoyancy must be taken into account for proper programming.

10. Why is balance training in the water a benefit and who (name 2) is it most beneficial for?

11. What is viscosity?

12. For which group is the viscosity affect a possible problem for?

13. How can performance athletes use viscosity for training and what does it improve?

14. How can viscosity have an effect on bone density?

15. If you don't use your arms in the water will the bone density of the upper body be affected by the viscosity of the water?

16. Would the answer be the same if you were using your arms with bands above the water?

17. What is hydrostatic pressure?

18. How does this pressure help joints?

19. What is a current area of study on hydrostatic pressure and whom can it help?

20. What is thermal conductivity?

21. What three groups will feel better and be safer in working out in 83 degree that may not be able to exercise safely in 83 degree air?

22. What temperature is best for arthritis?
23. What temperature is best for MS?
24. Why is it not good for someone with MS to exercise in warmer water?

25. What temperature is best for fibromyalgia?
26. Is there a single pool for everyone?
27. Study 1 showed the cardiovascular improvements gained in the water transfer to land. What is the caution?

28. Study 2 and 3 showed one similarity in results. What was it?

29. Why did Study 2 show higher lactic acid levels at the same intensity and Study 3 did not?

30. For most cardiovascular activities in the water, what differences were seen in the caloric burn?

32. Why weren't the same differences seen for resistance/strength training in the water?

33. If this is the case, are there any benefits to strength training in the water?

34. Summarize 4 benefits for senior of water workouts?

35. Summarize 4 benefits for pre/post natal of water workouts?

36. Summarize 4 benefits for arthritis and rehab of water workouts?

37. Summarize 4 benefits for athletes of water workouts?

38. Can all training be done in the water? If not why?

39. Who might have to exercise in the water only?