Aquatic Cross Training for Athletes: Part II

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Column Editor

SUMMARY

THE CURRENT ROUNDTABLE IS THE SECOND PART OF A TWO PART SERIES WHICH EXPLORES THE USE OF AQUATIC TRAINING METHODS BY ATHLETES. WITH THE INCREASED RESEARCH FOCUS ON TRAINING IN AQUATIC ENVIRONMENTS THE CURRENT ROUNDTABLE IS DESIGNED TO EXPAND UPON THE INFORMATION PRESENTED IN THE FIRST ROUNDTABLE.

QUESTION 6: WHAT FREQUENCY, DURATION AND INTENSITY IS IDEAL FOR CROSS TRAINING PROGRAMS FOR ATHLETES?

Becker: High-level athletic performance is critically dependent upon fitness combined with motor skill performance. Repetitive training drives skill-specific performance so certainly the bulk of training needs to be performed in the environment that an athlete will compete in. But excessive repetitive activity can lead to injury, so a balance must be sought between training, over-training, and cross training. We have successfully used aquatic cross training in athletic activities that lead to frequent injury from over-training, such as distance run training. During the later stages of training, we often had the athletes train in water for 3 of 6 days training, with the seventh for rest. In general, 2 or 3 days per week of cross training will see a significant positive effect. Typically we trained athletes at the same intensity that they would use for their normal training level. Often, this was achieved through Borg scale techniques, as in-water heart rate measurement is both difficult and may be inconsistent with land rates. We have found training durations of 50 to 90 minutes to be sufficient.

Lindle-Chewning: This question is very difficult to generalize as individual athlete differences will result in differing training plans. In my opinion when working with athletes, the overall volume of training is a primary consideration when implementing aquatic cross training. Heart rate, perceived exertion, duration and frequency need to be closely monitored in order to evaluate the efficacy of the exercise prescription. In the aquatic environment intensity needs to be carefully monitored in order to insure an adequate training stimulus.

Another factor that affects performance success in the aquatic environment is proper form and technique. Vertical form, running technique, and familiarity with water exercise will ultimately affect exercise intensity and the overall oxygen consumption of the exercise bout (6). Research indicates that rating of perceived exertion (RPE) is higher in the water than at similar oxygen consumption on land (7). Greater involvement of the anaerobic system is also suggested due to the recruitment of smaller muscle groups (13) with reports of more muscle fatigue in the arms, shoulders, hips and legs during deep water run training.

Huff: Discussing frequency, duration and intensity of aquatic cross training can be challenging. The recommendations would have to be specific to the sport, the athlete and the program. The recommendations would also be based on the purpose of using aquatic cross training and the phase in the training cycle. Aquatic cross training could be implemented:

- As part of a rehab protocol following an injury. The frequency, duration and intensity, in this case would be dependent upon the athlete's tolerance level (3,6).
- To maintain cardiovascular fitness during an active rest phase (3). The frequency, duration and intensity, in this case would have to be comparable to land based activities that are included in that phase of training.
- To add variety to a training program. Frequency, duration and intensity, in this case would match that of the land based program.
- To assist an athlete that has reached a training plateau. Frequency, duration and intensity in this case would be dependent upon the goals.

Sherlock and Sherlock: The frequency, duration and intensity of the cross training programs should cater to the individual athletes needs, sport and goals of the training session. If the program is supplemental, twice a week for 30 to 90 minutes is sufficient to reap the benefits of the aquatic environment. If the training is in place of a majority of the training volume, the frequency, duration and intensity should be adjusted accordingly to meet the goals of the training session.

Stolt: This depends on the availability and scheduling of training that is permitted. Personally, I would not work longer than 60 minutes in a pool session with an athlete or a group of athletes. In this time frame, you can structure an intense and demanding workout to challenge the athlete both physically and mentally.

Intensity depends on the condition of the athlete and how you are using the training. Is this a preseason workout to aid in the overall conditioning of the athletes, or is the session used as a recovery workout post-game or training session.

Frequency again is determined by pool space availability and time permitted for training. It may be more ideal to use the pool in post or pre season as you may have more freedom in scheduling. Two to three times per week is sufficient (3).

QUESTION 7: IS THERE A DIFFERENCE IN DETERMINING INTENSITY IN AN AQUATIC ENVIRONMENT VERSUS THAT ON LAND?

Becker: It is common with land-based exercise to judge training intensity by measuring heart rate via carotid or radial pulse. While heart rate may be accurately measured in this manner, heart rate is a relatively poor proxy for aerobic fitness as it varies greatly between individuals. The effect of immersion upon heart rate is also a factor to consider as neck-depth immersion typically lowers heart rate by 10–15% at rest, and the enhanced cardiac filling pressure produced during immersion increases stroke volume and cardiac output (2). The variables that would really be desired are a measurement of oxygen consumption and a measure of cardiac output, neither of which can be easily measured by the individual. So athletes have grown accustomed to monitoring heart rate. There is a relationship between oxygen uptake and heart rate during deep water running, and it does appear to correlate with oxygen consumption on land, but there does seem to be a strong relationship with aqua-running skill (17). While various heart rate monitoring devices exist which may be used during immersion, we typically have encouraged the use of a Borg scale for assessment of exercise intensity (5,6). This scale has been modified by Wilder and Brennan for aqua running and has been useful in day to day training (16).

Lindle-Chewning: Both submersion research and training studies indicate a decreased heart rate response in the aquatic environment at rest and during submaximal exercise when compared to on land training (1,2,4,7–10,12,3). Theories explaining this lower heart rate response include temperature effects, reduced gravity, compression, partial pressure, the dive reflex, and reduced body mass (1,2,4,7–13). Although heart rate is suppressed in the water, oxygen consumption responses have been attained that meet ACSM recommendations for cardio respiratory exercise.

This heart rate response makes accurately measuring intensity with heart rate more difficult in the aquatic environment. When looking at measuring intensity in the aquatic environment with heart rate it may be recommended that a 13% or 17 beat per minute deduction should be taken from the minimum and maximum training intensities (2,3,8,10). It is important to note that these recommendations are only general guidelines and the heart response to the aquatic environment is often individual specific (11). Therefore it may be recommended that the determination of an individual heart rate deduction for use in aquatic exercise is necessary, especially with clients where precise measurement of intensity is desired.

Huff: The intensity of cardiovascular exercises performed on land is typically measured as a percent of maximum heart rate or heart rate reserve and/or rate of perceived exertion. The same factors are used to measure the intensity of cardiovascular exercises performed in the water however there are slight differences in the measurements (3). Research has shown that heart rates per given oxygen consumption level in the water are lower than those achieved on land and that the rating of perceived exertion (RPE) may be slightly higher due to the increased reliance on anaerobic energy systems when using the arms and legs against the water (5). These differences should be considered when recommending an appropriate method for measuring the intensity of cardiovascular exercise in the water.

The intensity of resistance training on land is typically measured as a percentage of a 1RM. Measuring the intensity of resistance exercises in the water is a difficult task. There are many more variables to consider when manipulating the intensity of exercises in the water. Intensity can be influenced by factors such as the size and shape of drag or buoyancy equipment. Larger equipment or equipment with irregular shapes will increase intensity. The amount of force that is applied and the speed and the velocity of the movement may also influence intensity. The amount of force is based on the athlete and may be difficult to consistently replicate with each repetition. The speed and velocity may be manipulated by maintaining a recommended cadence. Rating of perceived exertion may be an appropriate method for measuring the intensity of resistance training in an aquatic environment due to the difficulties with specific measurements.

Sherlock and Sherlock: The ideal means of determining intensity for any medium would be to conduct a graded exercise test and determine the individuals VO_2max, lactate threshold, heart rate response, and rating of perceived exertion (RPE). With this information the strength and conditioning professional would be better able to construct an aerobic exercise program. If the activity is going to be done in water, this testing should take place in the water because of the physiologic changes that occur with immersion (1,2,4–7,10,13,14). Utilizing a heart rate, VO_2max and lactate threshold gathered from an exercise test performed on land would not directly cross-over to the same activity done in the water. Heart rate responses in the water have been noted to be dramatically different (up to 20% lower) from that on land, thus, specificity of testing is imperative (8). It should also be noted that the aquatic effect on the heart rate seems to be very individual (8). If testing cannot be performed, the recommendation is to use a modified Karvonen equation: 220 – age – resting heart rate (RHR) = X → (X)(% max) + RHR – 17 bpm (approximately 13%) = aquatic target heart rate (3,8).

Stolt: As discussed in question number two addressing cardiovascular fitness, it is apparent that the athlete's body responds differently while training in the water than on land (1,3,6). How the athlete's body responds differently to intensity and exertion in the aquatic environment than on land is determined by the type of activity as well as the depth in which the exercise is performed (2). To review, heart rate is lower, blood pressure is different, perceived exertion may be higher in deep water (1,3). When working with athletes new to the water, I may use a heart rate monitor or a talk test. As the athletes, become familiar with their responses to the environment perceived exertion becomes a more viable means of determining intensity.

QUESTION 8: IS THERE A SPECIFIC AQUATIC ENVIRONMENT THAT WOULD BE MORE FAVORABLE FOR CROSS TRAINING ATHLETES?

Becker: For effective cross training to occur, the athlete must be able to move and exercise in a manner producing the desired cross training benefit. Thus an aquatic environment should not be too warm to allow active exercise, too shallow to allow appropriate movements, too constrained to move freely, or too cold to tolerate for the period of training. That said, we have trained elite athletes including very tall basketball players effectively in a deep-water tank that was only 5′ by 6′ by 6.5′ deep. Chest depth or even shallower environments may be used effectively, especially when used in conjunction with an underwater cycle or treadmill. Obviously, high standards of pool cleanliness are critical, as active exercisers dramatically alter pool chemistry, and the smaller the pool volume, the greater this impact. Surrounding air quality is also important, as dissolved ammonia and organic nitrogen from sweat combines with chlorine to produce chloramines, which are irritating and potentially injurious to lungs (12).

Lindle-Chewning: The aquatic environment chosen will be dependent upon the goal of cross training. Specificity is a consideration, so the environment should be chosen with specificity and training goals in mind. Shallow water, a transitional depth, or deep water can be used. For example, shallow water may be used for vertical jump training, transitional depths may be used for racquet sport training, and deep water may be used for long distance run training. Water temperature is also a consideration for the program format chosen. Access in to and out of the pool as well as equipment options will also determine the environment you choose.

Huff: Deep water provides a non impact environment for cross training. The nonimpact environment would be beneficial for the following reasons:

- Less stress on the body (3,4).
- Provides time for the body to recover from the stress of a previous training session (2,3,6).
- Movements can be performed that closely resemble those movements involved in land based training.
- Improves the recruitment of the core muscles to stabilize the body against the forces of the water.
- Cardiovascular benefits are similar to land based training (1,3).
- Allows the athlete to practice the movement pattern without being concerned about impact.
- Provides resistance in multiple planes of movement which allows the athlete to overload all phases of the movement.

However, deep water training does not allow for contact with the ground. The transfer of energy from the ground through the body is very important in many athletic events.

Shallow water provides a decreased impact environment for cross training. Shallow water training would be beneficial for the following reasons:

- Less stress on the body than land based training (3,4).
- Movements can be performed that closely resemble land based training with the inclusion of the reaction with the ground.
- Improves the recruitment of the core muscles to stabilize the body against the forces of the water.
- Cardiovascular benefits have been shown to be similar to land based training (5).
- Provides resistance in multiple planes of movement which allows the athlete to overload all phases of the movement.

The recommendation on a specific mode of aquatic cross training would be based on the sport, the athlete and the goal of the program. Deep water would be recommended for aquatic cross training when the goal is to reduce the impact and stress on the body (3). However, if the athlete's goal is to develop specific neuromuscular recruitment patterns, and the event requires the use of ground forces, then shallow water training may be a better option.

Consideration should also be given to the athlete when determining which mode of cross training would be the most appropriate. Deep water training would only be recommended to an athlete that is comfortable in deep water and able to maintain proper form while exercising. Non-swimmers or athletes that are not familiar with the aquatic environment may benefit more from initial participation in a shallow water program.

Sherlock and Sherlock: The Aquatic Exercise Association recommends

78–86 degrees Fahrenheit for activities such as lap swimming and resistance training (8). Cross training an athlete would fall within these guidelines. Generally one would like the aquatic environment to be at a temperature that the athlete can sustain the intensity of the exercise session without any thermal or hypothermal distress. If rehabilitation exercises and/or flexibility exercises are the focus of the session warmer water would be recommended (86°–92° Fahrenheit) (8). This higher temperature generally allows the person immersed to achieve a greater range of motion at the targeted joint and relaxes and warms the musculature to assist in producing these optimal effects. The depth of the aquatic facility would be dependant on the type of cross training to be performed and the goals being targeted.

Stolt: First and foremost the athlete should be comfortable. He or she need not be a swimmer, but need to be comfortable engaging in activity in the water. Nonswimmers should be comfortable enough in the water to move and run through the water. Before you place athletes in water over their head, you need to be certain of their abilities (4), and what work you are requiring from them.

Water temperature depends on the population with which you are working. Therapy should be conducted in warmer water, so the athlete will be warm (7). High intensity training/running should be in cooler water, as the athlete can get warm very quickly when asked to perform higher intensity activities.

QUESTION 9: WHAT ARE THE BENEFITS OF UTILIZING AQUATIC CROSS TRAINING WITH ATHLETES?

Becker: The physiologic effects of immersion and aquatic exercise are numerous and may be salutary in athletic training. Neck-depth immersion increases deep tissue circulation, with the result that muscle circulation is greatly enhanced by a factor of nearly 250% (4). Hydrostatic pressure significantly increases cardiac volume and cardiac output even at rest, and at lower heart rate levels (2,3,8). Immersion also increases renal circulation and urine output potentially assisting the elimination of metabolic waste products. At the same time, hydrostatic pressure is well in excess of venous and lymphatic pressures, so that resolution of edema is often enhanced (2). The combination of an increased central blood volume within the thoracic cavity combined with the hydrostatic pressure upon the chest wall produces an increase in the work of breathing, and potentially can create improvements in respiratory capacity, both with respect to enhanced inspiratory strength and endurance as well as overall efficiency of the respiratory system (1,7,10). Because fatigue in the muscles of respiration may produce shunting of blood from the lower extremities to enhance flow in the mission-critical respiratory musculature, an increase in endurance may enhance athletic performance and stamina (14). The buoyancy produced through immersion offloads the joints of the lower extremities and the spine, potentially facilitating recovery from injury (9). The studies mentioned above on aquatic plyometric training programs found that the aquatic program offered the same level of performance enhancement as the land program, but with significantly less muscle soreness (13). Most of these effects are unique to the aquatic environment, making aquatic cross training a very useful training mode, facilitating recovery from minor injury, while maintaining aerobic fitness and facilitating an increase in cardiopulmonary function.

Lindle-Chewning: The primary reason why athletes cross train in the water is reduced impact. It saves wear and tear on the musculoskeletal system and reduces the risk of overuse injury and muscle soreness as indicated in the plyometric jump study (15).

Another benefit of aquatic training is the 3 dimensional resistance offered by the water which creates unique training specificity options. Dowzer et al. (4) investigated the effects of deep and shallow water running on spinal shrinkage. Results found reduced spinal compression in deep water running as compared to shallow water and treadmill running, supporting the use of deep water running for decreasing the compressive load on the spine. The benefits of training in the water during injury rehabilitation are well documented.

Huff: Aquatic exercise offers a number of benefits to athletes. However, in order to experience the benefits the athlete must first be comfortable exercising in the water and second have been instructed on the proper techniques and form of the exercises.

AQUATIC EXERCISE OFFERS THE FOLLOWING BENEFITS:

- Adds variety to the normal training program (3).
- Provides an opportunity to recover from the stress of a previous training session (3,6).
- Provides an alternative training mode for athletes that have reached a training plateau.
- Provides an opportunity to maintain cardiovascular fitness while rehabilitating an injury (1,3,5).
- Provides the opportunity to rehearse the neuromuscular pattern of the movements without the concern of impact.

Sherlock and Sherlock: The aquatic environment is unique and beneficial for many reasons. The effects of immersion alone create changes within the cardiovascular, renal, pulmonary, lymphatic, and the musculoskeletal systems that promote circulation and waste removal as well as strengthening and range of motion (1,3,5,6,8,10,11, 13,14). The buoyancy provided by the water allows the weight bearing joints of the body to unload and provides gentile traction, promoting increased circulation and decreased joint strain. For these reasons, the aquatic environment is perfect for rehabilitation of an injury. However, it is also an ideal atmosphere for injury prevention and training. Athletes would be able to perform sport-specific training in an environment that allows for little to no joint stress, faster recovery rates and diminished delayed onset muscle soreness (9,12). The aquatic environment provides a new, challenging environment allowing for different body postures as well as decreasing the boredom of training and supplementing a bit of fun into the exercise session.

Stolt: Athletes can become stale or bored in training. Doing something different can be fun and challenging. Using a different arena can provide a means in which the athlete can condition in the off-season without over training. It provides methodologies for challenging athletes differently. I am currently working with a soccer goalie on reaction time and dives. By working with different weighted balls that I throw at a goal, he needs to react appropriately to defend said goal. He needs to move quickly through the water, or dive over the water to block a shot. Training in the water can be fun.

With increased venous return, the training can help in increasing recovery (3,7). As discussed in question two, physiological responses are different expectations than land due to external hydrostatic pressure (1,5,6). If the external hydrostatic pressure aids in training response with increased venous return, it can certainly aid in recovery (5). This might be advantageous to perform a moderate intensity training session between games or after a day of play in a tournament setting.

QUESTION 10: IN YOUR OPINION, SHOULD AQUATIC CROSS TRAINING BE INTEGRATED INTO AN ATHLETES TRAINING SCHEDULE?

Becker: Aquatic cross training can be very beneficial in an athletic training program. The combination of the physiologic effects of immersion in addition to the benefits of offloading joints can provide an extremely beneficial adjunct to an athletic training program. In elite competitive horseracing, it is routine to use an aquatic exercise tank for horse training. This is not because the jockeys enjoy riding clean horses. It is because owners of this very expensive livestock have found that they can often triple the number of races that a horse can likely sustain over the horse's racing career (11). The cardiovascular and respiratory effects produced during immersion can be very useful in an elite athlete, and are not easily duplicated in a land-based exercise program.

Lindle-Chewning: I feel there are many sport applications that can benefit from cross training in the water. Proper monitoring of intensity, proper form and technique, the proper use of equipment, the maintenance of training volume, and a firm knowledge of training principles in the aquatic environment will contribute to the success of aquatic cross training. As long as the athlete is comfortable in the water, the properties and multidimensional resistance of the water offer unique opportunities for competitive edge.

Huff: Aquatic cross training will definitely enhance the training program for certain athletes. However, it may not be recommended for all athletes. The choice to include aquatic cross training into the program would be based on a number of factors. The athlete must have a positive attitude toward the use of aquatic exercise, must feel comfortable exercising in the water and must have skills necessary to maintain proper form and technique during the training session. Second the decision must consider the goal of the program. A program that is designed to increase isolated strength such as with weight lifting may not benefit from an aquatic component. A program that is designed to improve speed or power may benefit. Third, the decision would be based on the phase of the training cycle. Aquatic cross training would be valuable during the off-season to assist with the development of the basic components of fitness. It would also be valuable as an active rest during the more intense phases of training. However, it may not be as valuable as the athlete moves closer to the competition phase.

Aquatic cross training definitely plays a beneficial role in most training protocols. However the role may change with each athlete, each sport and each phase of training.

Sherlock and Sherlock: As aquatic professionals, we would highly recommend aquatic cross training be utilized by the majority of sports and athletes. The benefits of the aquatic environment are plentiful and would be advantageous to athletic performance and overall well-being. Using the aquatic environment during the off-season to maintain cardiovascular fitness or throughout the season to promote range of motion are only a few options when considering aquatic training. The water provides such a unique exercise environment along with many recuperative benefits that it is difficult to believe that the athletic population does not employ this medium more often.

Stolt: Absolutely, Using this medium is an excellent tool not only for rehab, but also for pre and post-season conditioning. It is fun, it is challenging, and the athletes enjoy the change of pace and scenery.■

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