CALA Canadian Aquafitness Leaders Alliance Inc.
Handout

The Truth About Aerobic Conditioning in The Water

Article by by Deborah L. MacLatchy, published in CALA Wavelink newsletter Spring 1994

Myth vs. Science

Many myths abound regarding the effectiveness of water workouts as an aerobic exercise. Some people, include fitness professionals believe that a person does not achieve a workout in the water comparable to that on land. This misconception stems from a variety of sources; that Aquafit is only for unfit individuals, pregnant women and seniors; that the lower heart rate measurement achieved during water exercise means that one is not working; that the lack of a good "sweat" means one is not burning any calories; and that swimming does not work off fat. Aquafit participants and leaders know otherwise. We experience the fitness gains and other benefits of aquafitness on a regular basis.

Science actually supports intuitive perceptions about the value of water workouts. Research shows that aerobic gains in the water are equal to those on land. In addition, strength increases from water exercises may be greater than those from land exercises, due to the water's resistance. This is great news for Aquafit instructors and participants alike.

Training and Adaptation

Training is adaptation to repeated exercise. Muscles respond to training independently in one of two ways. Strength training (such as weight lifting) primarily builds up proteins in muscles tissue which is used to develop tension.

Repetitive exercise in which a minimum of 75% of maximal muscles tension is attained leased to replication of these proteins. Consequently, the diameter of the muscles cells increase, as does the whole muscle. This leads to increased strength, as the force created by a muscle in directly related to its size.

Endurance training, such as swimming, running or Aquafit, mainly causes replication in proteins involved in aerobic metabolism (metabolism that requires oxygen as component of energy creation.) These metabolic proteins include myoglobin (stores oxygen in muscles) and enzymes that are involved in the production of ATP, the cell's chemical energy. Many athletes specifically train to allow their muscles to adapt to certain types of exercise. Runners train for endurance, weight lifters train for strength. Remember that suitability for one type of exercise does not necessarily equip a person for the other. Aquafit may be the perfect cross-training exercise, allowing for gains in training for strength and endurance.

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Aerobic adaptations arise from maximal and submaximal endurance exercise. Maximal exercise is a physical activity which requires oxygen to be used at rates beyond which it can be supplied. The maximal volume of oxygen a person can deliver to muscles during the most strenuous exercise is the VO2max It is a measure of aerobic capacity. The oxygen is delivered to the muscles via the respiratory and circulatory systems. More oxygen is often required than can be made available immediately. Increases in the dept and rate of breathing, and an increase in the heart rate and force of contraction are unable to meet the oxygen demands of the cells. In the absence of oxygen, cells switch to anaerobic metabolism (reactions that create energy without the use of oxygen). These reactions dominate in very intensive exercise, such as sprinting or interval training in an Aquafit class.

Anaerobic metabolism results in an oxygen debt. Oxygen is used to rid the cells of lactate a by-product formed during anaerobic metabolism. This debt is paid after the exercise is over. High levels of lactate are associated with muscle fatigue, and failure to remove it leads to metabolic imbalances in the muscle cells.

One purpose of aerobic training is to maximize the length and intensity of activity that a person can maintain before the cells need to switch to anaerobic metabolism to supply ATO. Remember that ATP supplies the energy required during muscle contractions. The body adapts to increased aerobic demand through submaximal exercise. Submaximal exercise, or endurance exercise, is activity requiring less than VO2max. Swimming jogging and Aquafit are submaximal activities. The intensity of endurance exercise on land is estimated by noting the heart rate as an indirect measurement of VO2max. VO2max increases linearly with heart rate. Optimal metabolic changes occur during land exercise when the following criterion are met;

The heart rate is in the target heart rate zone (60-90% of the maximum heart rate)

- ☑ The exercise lasts at least 15-20 minutes
- ☑ The exercise session is repeated 3-5 times a week.
- ☑ On land, our target heart rate is equivalent ot 50-80% VO2max.
- ☑ What are the relationships between heart rate and VO2max during water exercises?
- ☑ Do differences exist between strength training adaptations in the water versus land aerobics?

Water vs Land Conditioning: The Aerobic Factor

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It has been well documented by many researchers that during same intensity exercise, heart rates are lower in water than on land when the water is below 33oC (92oF). At 33oC, which is thermoneutral temperature the water does not conduct heat away from the body. Therefore, heart rates for intense exercise are the same as land and in the water. In colder water of 18-25oC (65-77oF) lower heart rates were measured (McArdle et all, 1976; Avellini et all, 1983; Svedenhag and Seger, 1992). Temperatures of 18 and 25oC are in the approximate range of most public swimming pools. The primary factors that act to decrease the heart rate in cooler water are the enhanced heat-dissipating quality of water compared to air and constriction of peripheral capillaries due to low external temperature. Does working in cool water mean less blood flow and therefore less oxygen supply to our working muscles? No! Lower heart rates are compensated for by a proportionate increase in stroke volume (McArdle et al, 1976) Stroke volume is the amount of blood pumped by the heart during one contraction or heart beat. With an increase in stroke volume adequate blood flows to the working muscles at the lower hart rate, because cardiac output (amount of blood ejected from heart/minute; cardiac output – stroke volume X beats/minute) remains the same. This has been repeatedly substantiated by various researchers. The amount of blood supplied to working muscles during water exercise is the same as on land, regardless of the lowered heart rate. If VO2max increases linearly with heart rate, and heart rate is lower in water, will VO2 in water be less than on land? Does this indicate that endurance (aerobic) training will be less effective in water than on land? Not necessarily. Research has shown that although the relationship between VO2 and heart rate remains linear when both are measured in water, submaximal and maximal VO2 are achieved at lower heart rates. (Sheldahl et al, 1984; Sheldahl et al, 1986; Svendehag and Seger, 1992) This mans that although heart rate is lower during exercise in water, the intensity level is at submaximal VO2 (50-80% VO2max). This intensity level allows for the adaptive changes which lead to increases in the aerobic capacity of muscles. These adaptive changes include:

- ☑ Decreased lactate formation (ability to work aerobically for longer periods):
- ☑ Increased use of fat as an energy fuel;
- ☑ Increased number and size of mitochondria (the “powerhouses” of cour cells)
- ☑ Increased protein and enzyme levels in mitochondria;
- ☑ Increased myglobin levels;
- ☑ Increased respiratory capacity;
- ☑ Increased aerobic generation of ATP

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Water vs. Land Condition: The Strength Factor

As stated earlier, strength condition differs from aerobic conditioning in its effects on muscle. The water offers increased resistance to movement as compared to land. Does this increased resistance lead to strength gains in Aquafit participants? Svendenhag and Seger (1992) studied the differences between running on land and in deep water. They were able to show that heart rates are lower in the same VO2, but the blood lactate levels and perceived exertion levels were higher in the water. Deep water may cause an increase in anaerobic exercise (producing increased lactate levels and increased perceptions of work) due to the resistance of the water. They also showed gains in strength by working in water. This supported by the study of Cassady and Neilsen (1992) in which the researchers looked at the accuracy of exercise intensity predictions in subjects on land and in water. The results are interesting. They show that differences exist between women and men in their responses. During both land and water exercise, men had a higher oxygen consumption level than women. It was suggested that this difference could be because women have less resistance (muscle mass), shorter limbs and cause less turbulence than men. Differences in boy composition and fat distribution were not ruled out as a possible explanations. Men also tended to have a no differences between land and water heart rates, whereas women shoed significant decrease in heart rate in the water as compared to on land. These results in conjunction with the results that more energy was needed to perform the same exercise in water as on land led the authors to conclude that the increased resistance of the water and the differing results between men and women in the study (the men produced more resistance due to their larger body sizes) could point to a strength component in the work being performed. Unfortunately, they did not do any strength tests as part of the experiment. The increased energy output for water work in this and the previous study (Svendnhag and Seger, 1992) is circumstantial evidence that strengthening exercises were being performed in addition to aerobic exercises.

Deep vs. Shallow Water Aquafit

Some evidence exists that shows that exercise performed in deep or shallow water can have an effect on the degree of metabolic changes occurring during water exercise. In one study (Town and Bradlet, 1991) it was shown that shallow water running is capable of eliciting metabolic responses comparable to treadmill running and that these responses were higher than those for deep water running. The authors noted that deep water running utilized different actions and therefore different muscle groups than shallow water running. Shallow water running had the added demands of pushing off a solid surface and the production of wave action producing frontal and suction drag around the

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vertical axis; the resistance of deep-water running is limited, however, to bodily movement in a fluid environment. More research needs to be done on comparison between deep and shallow water exercise.

Further Research

One additional note: Many studies were done with athletes who were specifically trained to water exercise. Yamaji et all (1990) demonstrated that the skill of the athlete performing the various water activities affected the results obtained from water exercise experiments. It is important that future studies utilize athletes trained in water exercise to determine its true effects of the physiological systems. Studies of unfit individuals could also lead to interesting comparisons between the gains achievable through training water as compared to on land. The research available suggests that aerobic gains may be achieved concurrently with strength gains. This is a plus for both active and inactive participants.

Summary

In summary the lower heart rates measured in Aquafit classes during cardio portions are not a true measure of the work being done by the participants. A level of activity is the water that is equivalent to 50=80% VO2max causes optimal metabolic changes in aerobic endurance at heart rates lower than the comparable activity and percentage VO2max on land. This debunks the myth that one doesn't work as hard on land as in the water, and supports the view that aerobic condition is clearly achieved during water exercise. In addition, evidence indicates that we may be working much harder in the water due to greater energy expenditure caused by the water's resistance (strength condition).

These conclusions reinforce the concept that perceived exertion and talk tests are the best way to check for activity levels in participants due to the inaccuracy of heart rate checks during Aquafit classes. As aquafitness professionals we can educate participants about the differences between land and water exercises from a physiological perspective. Through education myths and misconceptions can be replaced by knowledge and understanding.

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