

Determining Which Population Underwater Treadmill Running is Most Effective

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19 November 2019

**Abstract**

There are many populations of people who need rehabilitation but sometimes normal treadmill and overground rehabilitation can bring more pain than help. This is because of the gravity and weight that is being put on the body and this causes patients to stop going to therapy because they are in pain and the cycle of deterioration begins. This is when it would be beneficial to try underwater treadmill training, which is using water's buoyancy to take pressure away from the body. The goal of these studies was to find which population would be affected by completing underwater treadmill training over certain periods of time. Each study used the Hydrotrak treadmill or one of the top leading underwater treadmills competitors. The hypotheses that were shown in the articles all showed the want to improve gait, balance, and overall personal mental health. Many different populations were being tested, such as, athletes, stroke patients, spinal cord injuries, cardiovascular patients, obese patients, and healthy patients. They almost all reacted positively to the training, and this shows that underwater training is used for more than what is known for with stroke patients. We have seen that even when the water is up to the navel it relieves the pressure of gravity up to fifty percent, and when it is up to the xiphoid process it relieves more than sixty percent. This presentation will discuss the different populations this training could be used for, as well as different activities that can be done in the water for rehabilitation.

### **Keywords**

Step Length, Underwater Treadmill, Velocity, Balance, Gait, Chronic Injuries, Biomechanics, Aquatic Exercise, Foot Strike patterns, Immersion, Impact, Training, Underwater

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Treadmill Training, Greenstick Fracture, Rehabilitation, Hydrotherapy, Aquaciser, Cardiovascular Fitness, Obesity, Underwater Exercise, Partial Body Weight-Supported treadmill training, Incomplete Spinal Cord Injury, Aquatic Gait Training, Water Therapy, Gait Training, Blood Pressure, Heart Rate, Treadmill, Stroke, Rehabilitation, Exercise, Outcome Measures, Stability.

### **Introduction**

Underwater Treadmill Training is a form of physical training that uses water buoyancy to lessen the weight of the person for a better result on the body. There would be less gravity pressure on the joints and that could be a helpful tool with a person who has arthritis and other physical problems with joints. The water height in the underwater treadmill can change depending on how much offset is needed and “xiphoid-depth immersion is equivalent to the effects of 60% or more offloading” (Lee, Yeol Jo, Kwon Do, Choi & Kim 2017). When water is as high as the pubis it relieves weight by 40%, as high as the navel it relieves by 50 % and when it is as high as the xiphoid the water relieves more than 60% and the higher the water the less weight there is in the body (Kim & Lee 2017). Water also has many properties such as “density, hydrostatic pressure, buoyancy, viscosity, and thermodynamics” (Lee et al., 2017) and this is important to know when doing research on different injuries. There are many different ways to use underwater treadmill training from cardiovascular use, stroke patient use, spinal cord injuries, healthy individuals, and injured athletes. The purpose of this research proposal is to determine which population underwater treadmill running is most effective.

## Literature Review

### Cardiovascular Patients

The first topic that can be affected by underwater treadmill training is cardiovascular. Cardiovascular problems are probably some of the most prevalent and dangerous problems in society today. Major prevention programs now focus on cardiovascular health and some of the best training specifically for overweight individuals who struggle with cardiovascular training is aerobic training because it is known to “counteract obesity by promoting body fat reduction, reduction in waist circumference, while improving maximal aerobic capacity” (Baxi, Palekar, Nair, Basu & Gohil 2018). Obesity and cardiovascular problems are known to go together but it is because “obesity is an established risk factor for coronary heart disease, ventricular dysfunction, congestion heart failure, stroke and cardiac arrhythmias” (Baxi et al., 2018). Training and exercise is important for this population but the pressure on the joints can be painful and the weight and strain of the body can result in injuries. Land treadmill training and “body supported exercise is associated with repetitive strain and stress injuries” (Macdermid, Fink & Stannard) and this is why the American College of Sports Medicine recommends exercises where they do not bear any weight and in underwater treadmill training they can lessen the pressure of the body weight. The “buoyancy and hydrostatic pressure exerted by the water help reduce the stress on the lower extremity joints and spine, when exercise training is done under water” (Baxi et al., 2018). Buoyancy is a topic that will be seen throughout the paper because it can help by taking the pressure off the patients. With the resistance and with the buoyancy there can be many effects on the cardiovascular system in normal and overweight individuals. By undergoing underwater treadmill training groups in six week study resulted in

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“reduced heart rate, blood pressure, rate of perceived exertion, and improved oxygen consumption” (Baxi et al., 2018). In this same study they mentioned that when patients are running in deep water they are likely to have lower heart rates than on land running and a possible reason is because “the hydrostatic pressure on the thoracic cavity causes the peripheral blood to be distributed centrally” (Baxi et al., 2018). This increases stroke volume and it causes a reduced heart rate. This can be good or bad problem depending on the patient’s previous cardiovascular health. Systolic Blood pressure is known to increase as well and VO2 max values also increased in this study. When doing underwater treadmill training it is shown a positive improvement in “heart rate, blood pressure, rate of perceived exertion” (Baxi et al., 2018) and this shows significant improvement in cardiac fitness.

### **Stroke Patients**

The next group that can benefit from underwater treadmill training are stroke patients. Some of the goals of stroke patients is the “restoration of walking ability” (Jung, Ozaki, Lai & Vrogistinos 2014), and training underwater can allow patients the buoyancy to take the pressure off of their legs and begin to form the ability to walk again. Many people who have had a stroke, “Approximately 20% remain primarily wheelchair users with gait disability” (Yoo, Lim, Lee & Kwon 2014) and this shows why it is important to allow the rehabilitation process that is accessible for those with gait disability. In all the studies of rehabilitation from strokes using underwater treadmill training they always make sure that the person is at least a year from the date that they had the stroke. The reason that people wait a year is because within the first year after having a stroke patients can majorly improve their function and that could skew the data. Just like cardiovascular patients, increasing aerobic capacity among stroke patients is important

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and “aquatic exercise may provide an ideal environment for both cardiovascular exercise and gait training of people post stroke” (Jung et al., 2014). It is found that people who are post stroke “consume less energy when they are walking on an aquatic treadmill compared with an overground treadmill” (Jung et al., 2014). Consuming less energy would be beneficial in this case because when recovering from a stroke, patients should not push themselves past their limits but should rehabilitate. When keeping their respiratory responses low then they would be able to do more training and do it safely. A key to restoring walking ability is to increase balance and in a study of 22 patients, “static and dynamic balance ability increased significantly” (Park, Lee, Shin, Shin, Lee, Song 2014) when completing underwater treadmill training. Overall the majority of underwater treadmill training for stroke patients is effective for gait, cardiovascular systems, and balance.

## Spinal Cord Patients

Spinal cord injuries are one of the most tested injuries with Underwater treadmill training and the goal is to build up the ability to have proper gait and balance by the end of training. There are many different studies that have been done about spinal cord injuries, and in every study they have been at least one year post accident and have no other injuries that could inhibit them from performing optimally in the training. Spinal cord injuries are “often considered permanent and irreparable, even slight improvements in physical function are noteworthy” (Stevens & Morgan 2010) and that is why these are the most successful stories. Patients do not expect improvement but leave learning they can improve the more they work with this training. With spinal cord injuries most patients suffer lower limb disabilities and “aquatic exercise is less

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damaging to joint integrity, and it can be an effective alternative to land-based exercise programs” (Stevens & Morgan 2010). By knowing this researchers can take the pressure off of patients and use underwater therapy. In water treadmill training the “unloading in the water provides buoyancy to the legs” (Steven & Morgan 2010) and the water levels can be selected depending on how much weight bearing the patient needs. This can be important because the pressure on the spine from the land treadmills can compress the nerves or re-injure what is in the process of healing. In many studies “physical function and walking ability were improved in adults with spinal cord injuries following underwater treadmill training” (Stevens, Caputo, Fuller & Morgan 2015) and this is important to know because spinal cord injuries are serious and can be helped by this method. This population can benefit the most from underwater treadmill training and can teach the most to other populations. In the study by Stevens and Morgan (2010) one of their patients had a success story, a middle aged man had a spinal cord injury and throughout the training he began depending less and less on his crutches. One day in training the laboratory got a phone call and it was the patient calling from his parking lot asking if he left his crutches in the room. This shows that “he gained a small victory of gravity” (Stevens and Morgan 2010) and that is inspiring not just to this study but to any patient who is in this aquatic training.

## Athletes and Healthy Patients

The next population that could benefit from underwater treadmill training is healthy individuals. Healthy individuals believe that they do not need any training or physical improvement but there can always be places that can be improved, such as balance and gait. Gait

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training in general is “a common method of improving balance ability and it recommended for aerobic capacity improvement, lowering blood pressure, and improving gait and balance abilities” (Lee & Kim 2017). With these different types of benefits gait training would be good for any person healthy or injured but when adding water to rehabilitation it can reduce the stress on joints and enhance muscle function (Lee & Kim 2017). For healthy individuals who are active can also benefit from cross training and any population could as long as it is safe. An example of cross training would be training on an underwater treadmill one day and a land treadmill the next. This can show significant increases in “forefoot strike patterns across different speeds” (Bressel, Louder, Hoover, Roberts & Dolny), and this would show that athletes such as runners can benefit from this type of exercise as well. An athlete who went through a greenstick fracture in her fibula and went through 14 weeks of underwater training and her “ankle dorsiflexion, plantar flexion, and eversion were restored to 100%” (Harrison, Young, Stevens & Caputo 2017). Athlete’s and people with injuries main concerns are most of the time how they can get back to playing or functioning with no pain. This is a very tough point to master but the athlete who had the greenstick fracture went on to have no pain in her activities in the future. Underwater treadmill training is a good option for any population to get balance, gait, improvements in cardiovascular health, and metabolic increases.

### **Methods**

If I was going to be running a study to test which population would benefit from underwater treadmill training I would first have to find my subjects and split them into groups. I would first randomly select 25 stroke patients who are a year post stroke and have no injuries that could

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affect the study. I would also randomly select 25 spinal cord injury patients who are a year post injury and have no other injuries. I would then randomly select 25 cardiovascular patients who are looking to improve on their health. Then I would get 25 athletes who have had injuries and 25 healthy patients who did not have any injuries that could affect the study. I would have 125 people for the study and the study would last 30 weeks. Each group would go through a six week program of underwater treadmill training and in this training they would have a 20 minute training, four days a week, for 6 weeks. The training would be the same for each group so there is no variables for the method, and accommodations can be made for people who cannot complete the task. According to the research in the previously stated articles, there should be a positive effect of training on the different populations.

### **Results and Discussion**

By allowing patients to compete in studies like this they have a chance to rehabilitate which can help them physically and psychologically. There are many ways that patients have been proven to be helped psychologically because they are getting their strength back which also builds their confidence. Many different populations can benefit from underwater treadmill training, and there has been no statistical evidence of it decreasing any persons health.

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