

ORIGINAL RESEARCH

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EFFECTIVENESS OF LAND BASED ENDURANCE TRAINING VERSUS AQUATIC BASED ENDURANCE TRAINING ON IMPROVING ENDURANCE IN NORMAL INDIVIDUALS

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ABSTRACT

Background: Recently the exercises and fitness professionals have adopted water as an alternative medium for delivering programs to improve fitness and health. When exercise on dry land our skeletal muscular, cardiovascular, respiratory and other body systems are greatly affected by the forces of gravity. When exercise in water, the effects created by the gravitational pull on the body are attenuated. Therefore the aim of this study was to determine the effectiveness of land based endurance training and aquatic based endurance training for enhancing endurance in normal individuals.

Methods: An experimental study design with 30 subjects healthy individuals between 20-30 years of both sexes currently were divided equally into 2 groups. Group A underwent land based exercises while Group B underwent aquatic based exercises. The outcome measures consist of RPP (rate pressure product), REC HR (recovery heart rate), RHR (resting heart rate) and 6MWD (6 minute walking distance) was measured before (pre-training) and after four weeks of endurance training.

Results: In this study, the mean improvement between the 2 groups of land and aquatic based endurance exercises were tested for significance using a dependent t test. The calculated t value were 43.550, 4.583, 16, 5.870 for RPP, REC HR, RHR, 6MWD for group A respectively. For group B 25.922, 12.762, 27.495, 19.236 for RPP, REC HR, RHR, 6MWD for group A respectively with $p < 0.05$. This clearly indicated that both land based exercises and aquatic based exercises will improve cardiovascular endurance significantly and there is no significant difference between land based exercises and aquatic based exercises for enhancing endurance in normal individuals.

Conclusion: It is concluded that both land based and aquatic based endurance exercises methods produce equivalent, if not same effect on the enhancement of aerobic endurance. There was no significant difference between these two exercising mediums. Nonetheless, given the benefits of aquatic medium, aquatic based endurance exercises should be considered as an alternative for land based training.

Keywords: endurance, land based endurance training, aquatic based endurance training, 6 minute walking test, rate pressure product, recovery heart rate, resting heart rate, 6 minutes walking distance.

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INTRODUCTION

The nation's fitness level has dropped dramatically owing to the adoption of a sedentary lifestyle. As a result, higher levels of obesity, coronary heart disease (CHD), diabetes and a range of other disease are being experienced. This can be prevented from participating in a fitness program.¹ People should exercise at an intensity of 40-50 to 85% of VO₂ max or 55-65 to 90% of R max (lower number of unfit or sedentary individuals) for at least 20-60 minutes more than 2 days. Previously unfit individuals should exercise more than 2 days a week for at least 10 minutes. From a health perspective, further good news indicates that just moderate exercise performed to regularly reduce the risk of a first heart attack to the same extent as high-intensity workouts.^{2,3}

In modern society, physiotherapists have for many years used water to assist with their treatments for the rehabilitation of injuries and other medical conditions. Nevertheless, it is only more recently that exercises and fitness professionals have adopted water as an alternative medium for delivering programs to improve fitness and health⁴. When exercise on dry land our skeletal muscular, cardiovascular, respiratory and other body systems are greatly affected by the forces of gravity. When exercise in water, the effects created by the gravitational pull on the body are attenuated. However, water possesses its own unique properties which affect the body in a different way and provide us with a totally new experience⁴

The effects of the different attributes of water provide many benefits to the submerged body. The reduced effects of gravity and increased effects of buoyancy provide support to the body weight and lessen the strain placed on the weight-bearing joints. This makes water-based activities a potentially safer and more comfortable form of training⁵. Various training methods have been utilized by physiotherapists for enhancing cardiovascular endurance in sports people. Although aquatic exercises have numerous beneficial attributes as noted above pertaining to fitness development, there have been relatively few studies establishing its efficacy. The aim of this study was to determine the effectiveness of land based endurance training and aquatic based endurance training for enhancing endurance in normal individuals.

METHODOLOGY

Participants:

30 healthy individuals between 20-30 years of both sexes currently not suffering from any illness including water borne diseases like Typhoid,

cholera, Nephritic / UTI conditions, Infectious disease, Contagious skin disease, Epilepsy, Hypotension and hypertension, recent or current radiation treatment, people with known history of Cardiac conditions, pulmonary conditions and musculoskeletal deformities and people with fear of water were included. They were selected from

Sample Size and selection:

A total of 30 individuals were selected for the study and were assigned to experimental Group (A) land based training group and control group (B) Aquatic based training group with fifteen participants in each group. They were allocated randomly to the two groups using lottery method. The study was approved by the Ethical Committee and Informed consent was obtained from all the participants.

Intervention:

Group A included 15 subjects underwent land based endurance training program for 12 sessions at a frequency of three sessions per week for 4 weeks. Each session is divided into three parts

1. 5 min of warm-up and stretching activities
Spot jogs/ slow jogging, general stretching exercises for both upper limb and lower limb muscles
2. Interval training (main workout)
Main workout is for about 25 min, Subjects were asked to walk as fast as they can for about 10 mins, 5 mins active recovery and again 10 mins of walk
3. Cool-down and post exercise stretching for about 5mins , A slow, walking is performed, General stretching exercises for both upper and lower limb muscles, The exercise intensity was prescribed by using Borg's rate of perceived exertion of 13-15, which corresponds to 60-80% of vo₂ max^{8,9}.

In Group B 15 subjects underwent an aquatic endurance training program for 12 sessions at a frequency of three sessions per week for 4 weeks. Each session is divided into three parts

1. 5 min of warm up and stretching activities inside the aquatic pool , Spot jog/slow jogging, General stretching exercises
2. Interval training (main workout)
Main workout is for about 25 min, Subjects were asked to dress appropriately and walk as fast they can for about 10 min, 5 min of active recovery and again 10 min of walk inside the aquatic pool, the water level was maintained at chest height.
3. Cool down and post exercise stretching for about 5 min.
A slow/ restful walking is performed, General stretching exercises; the exercise intensity was

prescribed by using Borg's rating of perceived exertion of 13-15, which corresponds to 60-80% of vo₂ max.^{4, 5}.

These were conducted by a trained physio-therapist. He supervised the exercise program for the initial 2 sessions and randomly for 60% of the remaining sessions.

Outcome Measure

Pre-endurance training 6 MWD test⁶ for both groups (Land and Aquatic group)

Subjects were instructed to walk from one end to the other end of a 100 Mts track in an open field at their own pace, while attempting to cover as much ground as possible in the allotted 6 min. Therapists encouraged subjects with the standardized statement "you are doing well" or "keep up the good work". Subjects were allowed to stop and rest during the test, but were instructed to resume walking as soon as they felt able to do so.

At the end of the test following parameters were recorded: 6 min walking distance⁶, Peak systolic BP⁷, Peak heart rate⁷, Recovery heart rate at 2 min⁷. The outcome was measured by the same therapist who executed the treatment.

Statistical Analysis

Difference in outcome between the two groups was analyzed using independent t test.

Pre test values between the groups were compared for homogeneity. The average improvement within the groups was compared using dependent t test.

RESULTS

There were 30 individuals who completed the study with 23 male and 7 female participants. The individuals were recruited over a period of 3 months. The mean age of group A (N= 15) was 23.27 (2.1) yrs and (group B) (N=15), was 24.2 (1.6) yrs. All the participants were healthy with no contraindication for participation in an intensive training program. The subjects were habitually active participating in a regular weekly physical activity (2-3 times a week, 35-60 min per session). Walking and aerobics were the principal activities

reported by subjects. Both groups did not differ regarding the level of physical activity, which remained constant throughout the study.

As per the objective of the study, the data were collected for land based and aquatic base endurance exercises. All the participants who entered the trial completed the study. The following parameters were included Rate Pressure Product (RPP), Recovery Heart Rate at 2 min (REC HR), Resting Heart Rate (RHR), 6 Minutes Walking Distance (6 min MWD). The calculated f values for RPP= 2.479, REC HR= .539, RHR= .445 and 6MWD= .335 were greater than p=0.05 and hence the two groups are considered statistically similar to each other at the start of this study.

The mean improvement between the 2 groups of land and aquatic based endurance exercises were tested for significance using a dependent t test. The calculated t value were 43.550, 4.583, 16, 5.870 for RPP, REC HR, RHR, 6MWD for group A respectively. For group B 25.922, 12.762, 27.495, 19.236 for RPP, REC HR, RHR, 6MWD for group A respectively.

This clearly indicates that both land based exercises and aquatic based exercises will improve cardiovascular endurance significantly.

The analysis of significance for the improvement produced by land based exercises and aquatic based exercises was done using independent t- test, Parameters showed a calculated t value of 0.299 1.6236, 0.4963 which was insignificant at p=0.05, but heart rate recovery was only parameter which was significant. This indicates that both aquatic exercises and land based exercises produces similar improvements, which are not statistically variable.

The analysis was conducted on an Intention to treat basis and the absolute amount of improvement are provided in Table 1. None of the participants encountered severe injury nor had any other complaints on performance of the program other than Delayed onset muscle soreness.

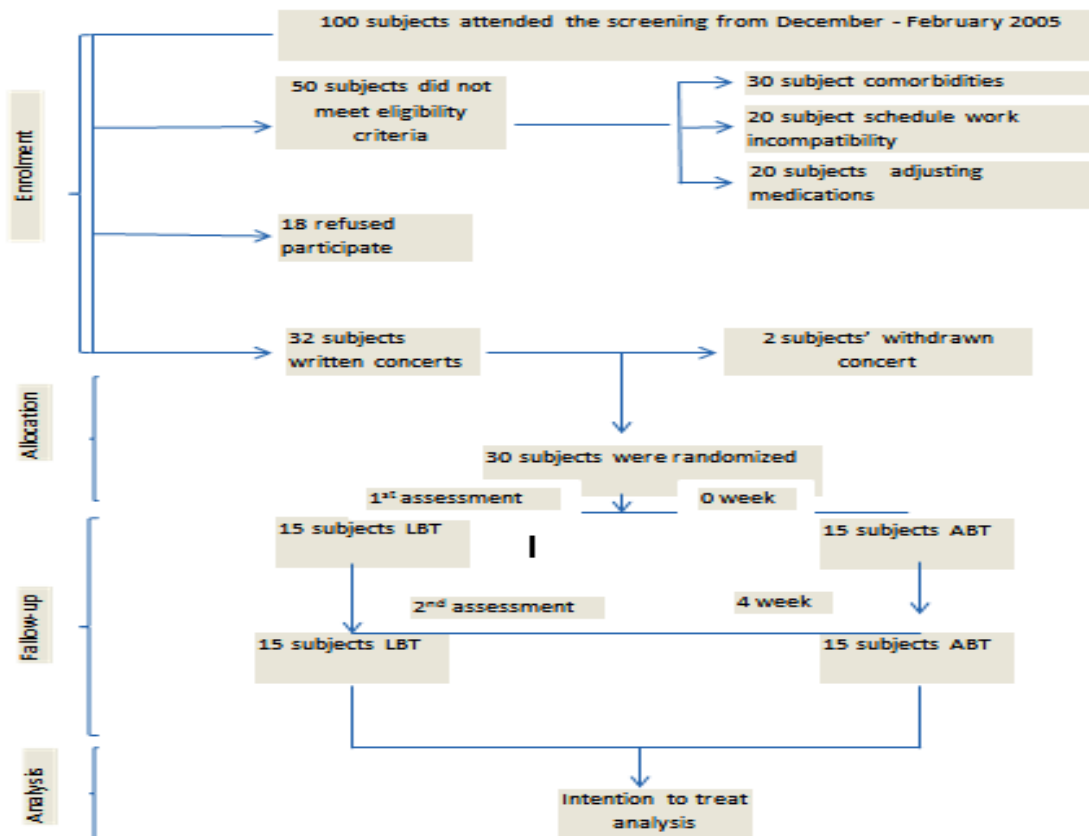
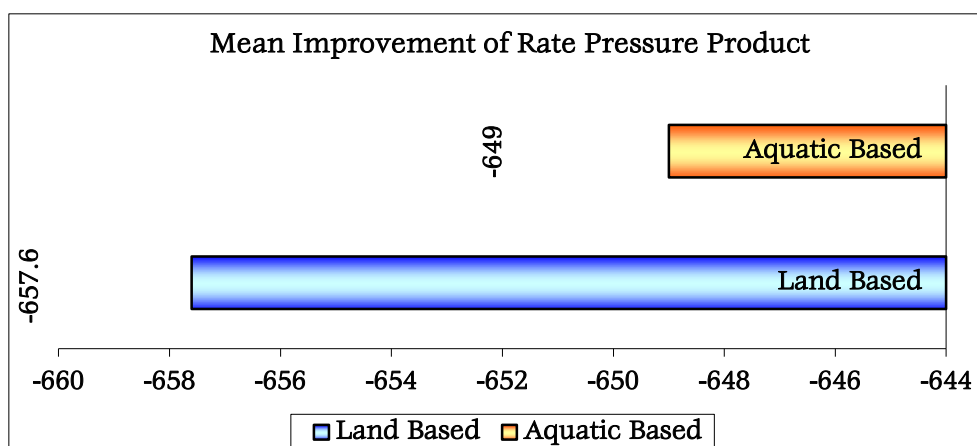


Figure 1. Diagram showing the flow of participants through each stage of the trial. LBT-Land base training and ABT- Aquatic base training.

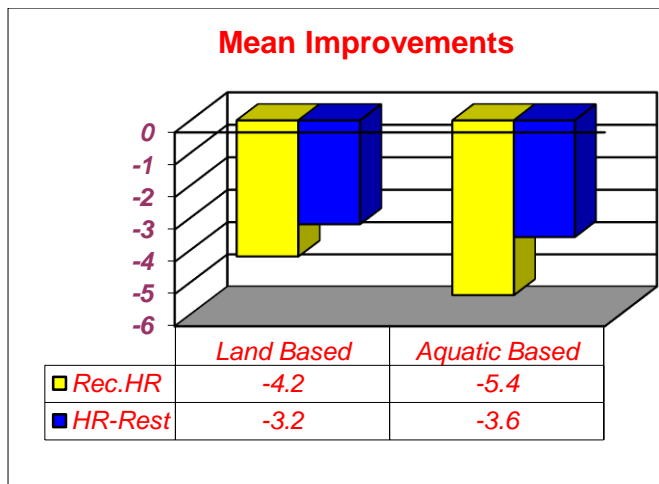
Table 1: Demographic and physical fitness data at study entry for the LBT and ABT in the intent to treat analysis and per protocol.

	Intent to treat analysis		Per protocol	
	LBT Group N = 15	ABT Group N = 15	LBT Group N = 15	ABT Group N = 15
Age, mean +/- SD yrs	23.27 +/- 2.12	24.26 +/- 1.62	23.27 +/- 2.12	24.26 +/- 1.62
RPP (MVO ₂)	29002.67 +/- 1113.742	28387.8 +/- 1638.4	29002.67 +/- 1113.742	28387.8 +/- 1638.4
REC HR(bpm)	90.133 +/- 2.924	89.4 +/- 3.56	90.133 +/- 2.924	89.4 +/- 3.56
RHR(bpm)	73.4 +/- 5.4	72.4 +/- 3.7	73.4 +/- 5.4	72.4 +/- 3.7
6MWD(meters)	626.06 +/- 52.0	655.33 +/- 52.217	626.06 +/- 52.0	655.33 +/- 52.217

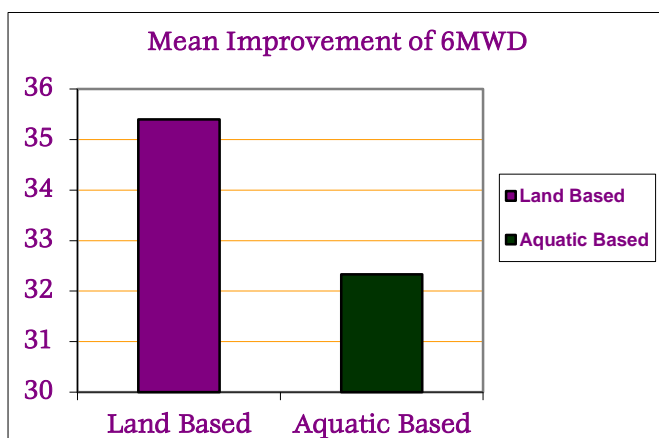
GRAPH 1: mean improvement of Rate Pressure Product



GRAPH 2: Mean improvement in Recovery and resting heart rate.



GRAPH 3: Mean improvement in 6MWD



DISCUSSION

The result of the study reveals that both the methods of training produce equivalent, if not identical improvement in cardiovascular endurance in normal individuals. In this analysis it should be noted that two parameters, which were recorded, showed different responses. The Recovery Heart Rate and resting heart rate were the parameters, which showed only minimal improvement in the land based training when compared to aquatic training. This can be due the reason that the density of water is approximately 800 times of air^{12, 13} and water provides a greater resistance to the movement than air, yet allows the joint to move more freely. The submerged body part encounters resistance in all directions of movement, which requires greater energy expenditure and puts more load on cardiac function, which may result in greater enhancement of endurance in subjects exercising in aquatic medium^{14, 15, 16}.

In contrast, the 6 MWD showed greater mean improvement in land based trained individuals when compared to aquatic trained individuals. The possible reason for this difference could be that the

individuals those were trained on land were more familiar with the walking test (6 MWD) done to measure their endurance when compared to other group individuals: the specificity principal of exercise testing^{1, 10, 11}.

Another important factor which was noticeable was that the percentage of DOMS reported in individuals exercising on land was more when compared to the aquatic exercising group. This could be because of the fact that the pattern of muscle recruitment in land and water is different, in water most of the eccentric muscle work, which is one of the factors responsible for the development of DOMS, will be eliminated and majority of the muscle work will be dual concentric work. Therefore water-based exercise is generally more comfortable and there is less likelihood of experiencing muscle soreness during or after the water-based workout¹⁷.

The unique combination of buoyancy and the hydrostatic pressure of water allow greater resistance to the movement with relatively little strain to the joint structures when compared to land based training, which puts greater strain on the joint structure and predisposes it to injuries. Water can be an excellent medium to exercise; especially for elderly population who has age related degenerative changes like osteoporosis to whom exercising on land could be harmful. ^{18, 19}

The primary limitation of this study comes from the fact that it has very small sample size, especially when considering the fact that these subjects were clinically normal. This study included a very few female subject, so any differences between genders are not clearly demarcated. The intervention was performed for 4 weeks which is a shorter time to identify major cardiovascular changes. The age group considered in this study was too narrow. Also this study didn't consider the subjects height and body weight which could have an impact on outcome measures. The results of the current study needs to be evaluated with due consideration to the above mentioned issues and rectification of the current limitations are warranted of future studies.

CONCLUSION

Based on the statistical outcome and available literature, it is concluded that both land based and aquatic based endurance exercises methods produce equivalent, if not same effect on the enhancement of aerobic endurance. There was no significant difference between these two exercising mediums. Nonetheless, given the benefits of aquatic medium, aquatic based endurance

exercises should be considered as an alternative for land based training.

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