Efficiency of Land and Aquatic Based Exercises on the Reduction of Blood Cholesterol and Triglyceride Levels among Haramaya University Gymnasium and Swimming Pool Users

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Abstract
A study was conducted to investigate the comparative efficiency of land and aquatic based exercises on the reduction of blood cholesterol and triglyceride levels with equal demand of intensity, duration, frequency, and types of exercise. Both overweight (BMI between 25 and 29.9 kg/m^2) and obese (BMI $\geq$ 30.00 kg/m^2) individuals were involved in the study and the evaluation lasted twelve consecutive weeks. Individuals used for the study were HU Gymnasium and Swimming Pool users, aged twenty up to thirty five years old and free from any impairment or chronic diseases. Purposive sampling techniques were used to select the study participants. Twenty five overweight and obese individuals, men (n = 8) and women (n = 17) were recruited for the study and randomly assigned to land based (n=12) and aquatic exercise groups (n=13) with matched mode of exercise. Assessments to measure progress made after the exercise program were conducted in terms of reduction made in blood cholesterol, triglyceride, and LDL levels; and promote HDL (good cholesterol) levels. Descriptive statistics and ANOVA (using SPSS version 16 software) were used to analyze the data collected and test the significance of the aquatic and land based exercises. The study confirmed that water or aquatic exercise resulted in higher reduction of blood cholesterol, and triglyceride levels for overweighed and obese individuals than land based exercise. Thus, overweighed and obese individuals are advised to use water based exercise than land based exercise to bring about significant reduction in blood cholesterol, triglyceride, and LDL levels and to promote HDL (good cholesterol) levels in the blood.
Keywords: Obesity, Overweight, blood cholesterol, triglyceride, LDL (low density lipoprotein), and HDL (high density lipoprotein)

1. INTRODUCTION

Abnormality in body fat can be drawn-closer from many factors for instance; family life (feeding habits), passive physical activity (sedentary life style), age, and heredity. James and Jennifer (2007) indicated that over the past 20 years, the predominant mode of working has become computer based in developed and high-income countries. This resulted in many people spending most of their workday in sitting.

Now a days, in most Ethiopian urban areas people tend to use technological outlets (devices and transportations), and this makes them physically inactive or remain with less physical exertion in their daily activities. As a result, there happens an imbalance between people energy consumption (calories intake) and their energy expenditure.

An excessive amount of body fat leads to health problems. The most costly chronic diseases which are consequences from obesity are: hypertension, cardiovascular disease, arthritis, stroke, musculoskeletal problem, mental retardation, type 2 diabetes, cancer, and general public health challenges.

From the above it can be noted that obesity and overweight problems need remediation to prevent or treatment. Substantial evidences show that physical activity can protect the development of chronic disease and increase longevity either for healthy individuals or obese and overweight individuals. Considering the combined and independent effects of physical activity and obesity on various health outcomes, is important to help develop health recommendations for obese individuals (Lee *et al.,* 2008).

Aquatic programs for achieving fitness and restoring function can be designed for a broad range of individuals through an understanding of the fundamental principles of aquatic physics and the application of those principles to human physiology. There are unique attributes to aquatic therapy that both preserve and protect health and longevity (Bruce, 2009). Land based exercise, including floor aerobic dance, ball games, running, rope-skipping, and the like are also very important to reduce obesity and overweight. The purpose of aquatic and land based exercise are mainly to expend energy and avoid storage of excessive fat and blood lipid in the body.

Because of contradictory results reported to date, the impacts of aerobic exercise intensity on body fat storage in overweight person was unclear and were not focused on comparing aquatic and land based exercises for the best of body weight reduction. Thus, the purpose of the study was to investigate the comparative efficiency of land and aquatic based exercises in reducing body weight, blood cholesterol, and triglyceride levels among Haramaya University Gymnasium and Swimming Pool Users with equal intensity, duration, frequency, and types of exercises.

With the above in mind, the research was designed to answer the following research questions:-

- How much an obese or overweighed individual could reduce his/her blood cholesterol and triglyceride levels through land and aquatic based exercises?
- Which types of the selected land and aquatic based exercises were best to reduce LDL levels and to promote HDL (good cholesterol) levels in the blood?

The general objective of the study was to investigate and compare the efficiency of land and aquatic based exercises on the reduction of blood cholesterol, and triglyceride levels in HU Gymnasium and Swimming Pool Users.

2. LITERATURE REVIEW

Blood Cholesterol and Triglyceride

According to American Heart Association (2012), triglycerides are the most common form of fat in the blood. Cholesterol is another fat-like substance used to help build cell membranes, make some hormones, synthesize vitamin D, and form bile secretions that aid indigestion. Since fat can't mix with water, which is the main ingredient of blood, cholesterol's most important job is to help carry fat through blood vessels. Before cholesterol can enter the bloodstream it is coated with a protein. These cholesterol-protein packages are referred to as lipoproteins.

According to Rogers (2009) the high-density lipoproteins (HDL) do a valuable job in scavenging excess cholesterol from circulation and returning it to the liver for excretion. For this reason, HDL is often called the 'good' cholesterol. However, more recently, HDL has been found to have additional properties such as anti-inflammatory and antioxidant behavior. More focus is being placed on increasing HDL, especially in cases where LDL (bad cholesterol) lowering has not been sufficiently effective. One of HDL improvement in physical activity principles is a decrease in blood triglycerides.

How to read a cholesterol blood test

Total cholesterol is usually a measure of HDL and LDL. HDL is the 'good' cholesterol and tends to protect the heart and blood vessels, while LDL is considered the 'bad' cholesterol as they are easily subject to oxidation and free radical formation. Another lipid group often measured in routine blood tests is the Triglycerides. Elevated Triglycerides are often a result of poor insulin utilization, excess carbohydrate consumption and lack of exercise (Steven, 2011).

Table 1 and 2 show a general guideline to interpreting the blood cholesterol and triglyceride levels in adults

Table 1. Standards in blood cholesterol

Rating	mg/dL	mmol/L
Desirable	< 200 mg/dL	< 5.18 mmol/L
Borderline high	200 - 239 mg/dL	5.18 - 6.22 mmol/L
High	≥ 240 mg/dL	≥ 6.22 mmol/L

Source*: http://www.topendsports.com/testing/tests/cholesterol.htm*

Table 2. Standards in blood triglyceride

Triglyceride	Risk classification
< 150 mg/L (< 1.70 mmol/L)	Normal
150 - 199 mg/L (1.70 - 2.25 mmol/L)	Border line/high
200 – 499mg/L (2.26 – 5.63 mmol/L)	High
≥ 500 mg/L (≥ 5.65mmol/L)	Very high

Source*:* LINEAR CHEMICALS S.L Joaquim Costa*. www.linear.es*

Consequences of excess cholesterol in the blood

High blood cholesterol and high triglyceride levels lead to plaque formation that blocks the blood vessels, thereby restricting the blood flow to various organs and tissues to dysfunction the proper works. Lowering LDL-C (bad cholesterol) and triglycerides along with raising HDL-C (good cholesterol) significantly lowers the risk of developing cardiovascular diseases such as stroke and heart attack. These can be achieved through a combination of nutrition, exercise and the use of medications. Monitoring your progress helps in modifying the therapy and reducing the risk of complications (American Heart Association, 2012).

The role of physical activity on the reduction of blood lipid and lipoprotein levels

Exercise training has a positive impact on triglycerides and free fatty acid in obese and type 2 diabetes though the results on cholesterol are less well established. Exercise does increase HDL cholesterol and decrease total cholesterol (Gormley and Hussey, 2005).

Nikkila *et al*. (1980) reported that aerobic fitness and exercise programs such as walking, jogging, and aerobics have been encouraged as a means to reduce total cholesterol, low-density lipoprotein cholesterol (LDL-C), and triglycerides while elevating the "good" high-density lipoprotein cholesterol (HDL-C).

3. MATERIAL AND METHODS

The study was conducted at Haramaya University Gymnasium and Swimming Pool which is found on Haramaya University campus, Ethiopia. The place is located 09^o 24' N latitudes and 42^o 02' E longitudes. The elevation of the place premises is 2013 - 2085 meters above sea level. The mean maximum and minimum temperature, where the University is located at 24.4^{0}c and 8.25^{0}c, respectively (ALARC, 1997).

Source of Data

The primary data was obtained from the experimental investigation on the basis of the parameters selected for the study. Secondary data was obtained from different documents, journals, books, internet sources, and unpublished booklets.

Table 3. Overview of Research Design

Study objectives	Study data requirement	Source of data	Method of data collection	Method of data analyses
To find out the significance differences between effects of land and aquatic exercise on reduction of blood cholesterol, triglyceride, and LDL level.	Exact value of total blood cholesterol before, during and after exercise.	25 Study participants (12 land based group and 13 aquatic group)	Laboratory based data collection (collect blood sample from participants and analyze blood cholesterol level by blood chemistry analyzer, Humalyzer 3000)	Descriptive statistics and ANOVA by using SPSS version 16.
To investigate the significance difference between effects ofland and aquatic exercise on improvment of HDL level in the blood.	Exact value of total blood triglyceride before, during and after exercise.	25 Study participants (12 land based group and 13 aquatic group)	Laboratory based data collection (collect blood sample from participants and analyze blood triglyceride level by blood chemistry analyzer, Humalyzer 3000)	Descriptive statistics and ANOVA by using SPSS

Source: own design, 2012

Study Sample

Participants of this study were HU Gymnasium and Swimming Pool users, who fulfilled the requirements for the study, BMI ≥ 25.0 kg/m^2, aged 20 - 35 years, free from any impairment or chronic diseases, and volunteer in response to the desired study.

Sample Size and Sampling Techniques

Purposive sampling technique was used to select the study participants. This sampling technique was used to select individuals in accordance with the parameters decided up on measurements.

Participant information sheet or consent form and questionnaire was developed and administered to enabled the acquisition of information on past and present health status, sex, age, type of food commonly consumed, and resting or idling time of potential candidates for the study.

Medical checkups for pregnancy and chronic disease (heart problem, hypertension, stroke, diabetes, cancer, and etc.) were made in the University Clinic before deciding up on the individuals for the study. The presence of pregnancy or any chronic diseases such hypertension, heart problem, stroke, diabetes, cancer, and etc. were used as the exclusion criteria.

Experimental Measurements

Analysis the level of cholesterol, triglycerides, high density lipoprotein, and low density lipoprotein in the blood was done at Haramaya University Higher Clinic laboratory. Blood samples from each individual for analysis were taken after 24 hours of physical activities. Alcoholic consumption was prohibited before provision of blood samples. The level of cholesterol, triglycerides, high density lipoprotein and low density lipoprotein in the blood samples collected were estimated read using a calibrated clinical blood chemistry analyzer (*Humalyzer 3000*) and calculated to compare with the standard values.

These experimental measurements were made three times throughout the study period i.e. (pre exercise measurement, during exercise/starting after six weeks measurement and after exercise/starting after twelve weeks measurement. The only medical checkup for chronic disease was made for the first recruitment purpose only.

Based on the medical report, laboratory results, measurements made, and an index calculated values, **twenty five** participants (fifteen females and ten males) were selected for the study in total. The criteria for the selection were willingness to participate in the study, health as recommended by physicians, age between 20 and 35 years, and BMI (≥ 25 kg/m^2). The sample size was decided up on the basis of availability of willing participants, cost and convenience of handling and managing the study, potential and prospect of small sample size for detailed and thorough investigation, and ease of control over the participants with regard to the sport activities.

Tools for Data Collection

Calibrated clinical blood chemistry analyzer (*Humalyzer 3000*) for blood cholesterol and triglyceride level examination, cloth-plastic tape for regional body circumference measurements, calibrated balanced beam scale for weight-height measurements, and thermometer for measuring the temperature of the water in the pool were utilized during the study. Haramaya University Swimming Pool for aquatic exercise program and the Gymnasium for land based group exercise were used.

Exercise Training Protocol

Eligible individuals with the same number of sex, age, BMI, and blood cholesterol level (with two interval approximation) were randomly divided in to two groups. The first group was assigned in aquatic exercise program, which was conducted in the pool (25 by 12 m^2 widths with 1.25 m, 2.00 m, and 2.90 m of step depth) and others in gymnasium. The water in the pool had 25-27$^0{}_c$ which was normal temperature. The exercise modality in the study was low intensity exercise (40-50 HRmax) in the first six weeks, and moderate intensity (50-60% HRmax) in the last six weeks, for both groups.

Applications of the exercise in a session were performed in three phases, namely: warm-up and simple stretching phase, main exercise phase, and cool down phase. Frequency and duration of exercise for both groups were 3 days per week and 60 minutes per session. After 6 weeks of training, the progress of the training program was ensured by increasing & adjusted the amount of sets, the number of repetitions, and the speed of the exercises for each groups accordingly.

During the study period the feeding habits of participants was informed that the diet should be as usual amount and more of carbohydrate. But there was no measured of nutritional status at the beginning and at the end of the study.

Ethical Issues

The study was designed in such way that ethical issues were properly addressed and privacy of research participants and **confidentiality were strictly observed and maintained throughout the study.** The study was conducted under the auspices of Haramaya University rules, policies and code conduct governing research activities and ethical issues. The study obtained approval from the Institutional Research Ethics Review Committee (IRERC) stationed in College of Public Health Science and Medical Science, Haramaya University, Harar campus. The written consent was given and informed the concerned bodies (participants, department, School of Graduate Studies and others).

Method of Data Analysis

Descriptive statistics was used to analyze data. The mean and standard deviations (mean ± SD) were calculated using the established equations.

Data collected from land and aquatic based exercises were compared with changes in body weight, blood cholesterol and triglyceride level and the effect of the exercises on above was analyzed. Analysis of Variance (ANOVA) was made using SPSS version 16.

4. RESULTS AND DISCUSSION

Baseline information of participants

Table 5 gives the mean and standard deviations of all parameters or change indicators (blood cholesterol, triglyceride, HDL, LDL levels, and BMI) considered being pertinent for the study.

There was no significance difference between two groups due to age and sex deference. From land based exercise group six participants were female and four male. Similarly, in aquatic exercise group eight participants were females and three male. There were no significant differences in any of these ages (23.90±2.95 and 23.82±2.60 of land and aquatic exercise groups, respectively) and characteristics measured between the two groups as can be seen in table 4.

Table 4. Baseline data of the Subjects

Parameters	LBE (m ± sd)	ABE (m ± sd)
Age	23.90±2.95	23.82±2.60
Weight (cm)	71.41 ± 6.07	73.04 ± 7.71
Height (cm)	1.60 ± 0.07	1.63 ± 0.06
BMI (kg/m^2)	27.68 ± 2.51	27.37 ± 1.77
Blood cholesterol (mg/dl)	195.54 ± 17.34	201.69 ± 28.91
Blood Triglycerides (mg/dl)	181.21 ± 16.03	193.59 ± 21.94
HDL (mg/dl)	41.03 ± 6.07	35.43 ± 7.87
LDL (mg/dl)	127.35 ± 30.80	155.25 ± 30.44

LBE= land based exercise, ABE= aquatic based exercise, and m ± sd= mean and standard deviation.

Interventions

All the training programs were well tolerated; there was no significance difference between attendance (session interruption) rates in all 36 attainable sessions for both exercise groups. And no serious injuries or related problems occurred during land based exercise sessions.

Postoperative measurements output

Postoperative measurements were taken at the end of the exercise program (end of 12th week). All characters of the participant considered during the first and the second phases of measurement were included.

Table 5. Mean values and standard deviation of postoperative body characteristics

Parameters	LBE			ABE		
	M ± Sd	M.d-lp	P-value lp	M ± Sd	M.d-Ap	P-value Ap
Weight (kg)	68.53 ± 5.52	2.38	0.04**	68.29 ± 7.01	4.74	0.02**
Height (cm)	1.60 ± 0.07	0.00	1.00NS	1.63 ± 0.06	0.00	1.00NS
BMI (kg/m^2)	26.90 ± 2.49	0.78	0.05**	25.60 ± 1.70	1.76	0.02**
Blood cholesterol (mg/dl)	133.53 ± 25.79	62.01	0.01***	123.95 ± 14.97	77.74	0.01***
Blood Triglycerides (mg/dl)	105.64 ± 44.51	75.57	0.01***	90.35 ± 37.26	103.25	0.01***
HDL (mg/dl)	60.91 ± 10.59	-19.88	0.01***	63.88 ± 10.14	-28.46	0.01***
LDL (mg/dl)	64.02 ± 10.24	63.33	0.04**	72.39 ± 11.74	82.86	0.01***

Note: ***, **, and *; significant at 1%, 5%, and 10% probability level respectively. LBE= land based exercise, ABE= aquatic based exercise, M ± Sd= mean and standard deviation, NS= Not significant, M.d-lp= Mean difference between baseline and postoperative data of land based exercise, M.d-Ap= Mean difference between baseline and postoperative data of aquatic based exercise, P-value lp= significance value of land based exercise between postoperative data, and P-value Ap= significance value aquatic based exercise between postoperative data.

Source: own experimental result, 2012.

Blood cholesterol and triglyceride levels at postoperative measurements

Comparisons of blood cholesterol and triglyceride levels between aquatic and land based exercise groups within baseline and postoperative measurement outputs are indicated below in Figure 7.

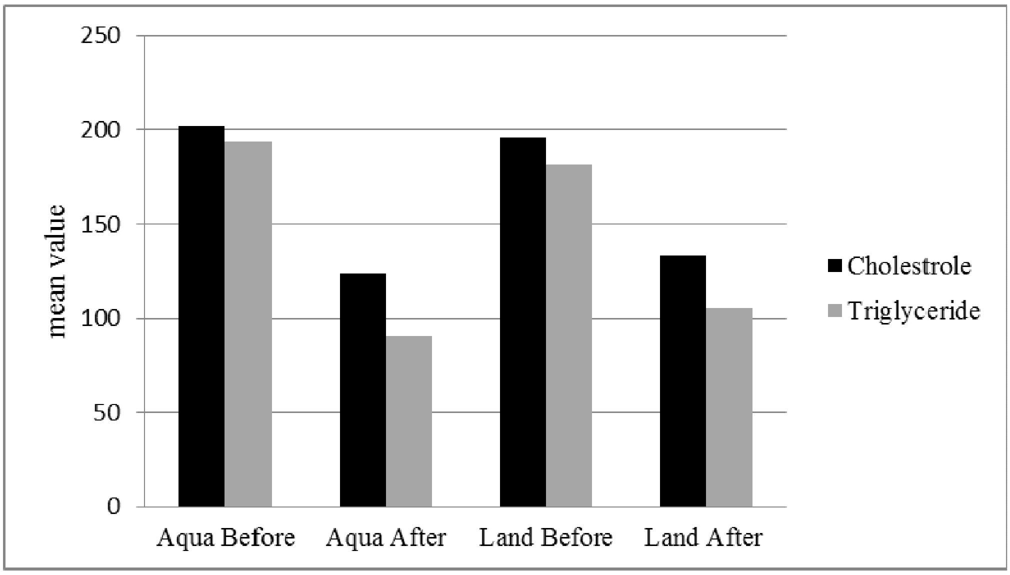

Figure 4. Comparisons of aquatic and land based exercise groups' blood cholesterol and triglyceride levels between baselines versus postoperative measurement results.

As indicated in Figure 7 and Table 7, the reduction in blood cholesterol and triglyceride levels were significant at p= 0.01 for land based exercise groups, and aquatic based groups also significant at 0.01 of both blood cholesterol and triglyceride levels respectively (see Table 10). Blood cholesterol reduced the mean value from 195.54±17.34 mg/dl to 133.53±25.79 mg/dl and 201.69±28.91 mg/dl to 123.95±14.97 mg/dl for land and aquatic based exercise groups', respectively. Triglyceride levels also reduced the mean value from 181.20±16.03 mg/dl to 105.64±44.51 mg/dl and 193.59±21.94 mg/dl to 90.35±37.26 mg/dl for land and aquatic based exercise groups', respectively.

At the end of the study, land based exercise groups were reduced mean difference of blood cholesterol levels by 24.06 mg/dl and triglyceride levels by 6.49 mg/dl. Similarly, aquatic exercise group reduced mean difference of cholesterol levels by 24.45mg/dl and triglyceride levels by 39.35 mg/dl significantly as compared as the average difference of the six weeks training outputs.

In postoperative data, mean difference values of cholesterol level reduced by 62.01 mg/dl and 77.74 mg/dl, and triglyceride levels by 75.57 mg/dl and 103.25 mg/dl for land based and aquatic based exercise groups', respectively as compared with the baseline data.

The 12 week training program results induced favorable changes in the level of total cholesterol and triglycerides. These comparison data indicates aquatic based exercise groups were a greater significant difference than land based groups accordingly. This is because all participants during the last six weeks training program could swim in every direction of the pool (shallow and deep area of the pool) and exposed for additional calorie expenditure. The American College of Sports Medicine (ACSM) reported that, water depth is another factor to consider when discussing caloric expenditure and water exercise. Exercising at chest depth (if performing shallow water exercise) is for efficiency and safety. Higher water depths affected by buoyancy, resistance (viscosity) and control of movements, which can influence caloric expenditure (ACSM, 2012).

High density lipoprotein (HDL) and low density lipoprotein (LDL) levels at postoperative measurements

Comparisons of HDL and LDL levels in aquatic and land based groups between baseline and postoperative measurement outputs are described below in Figure 8.

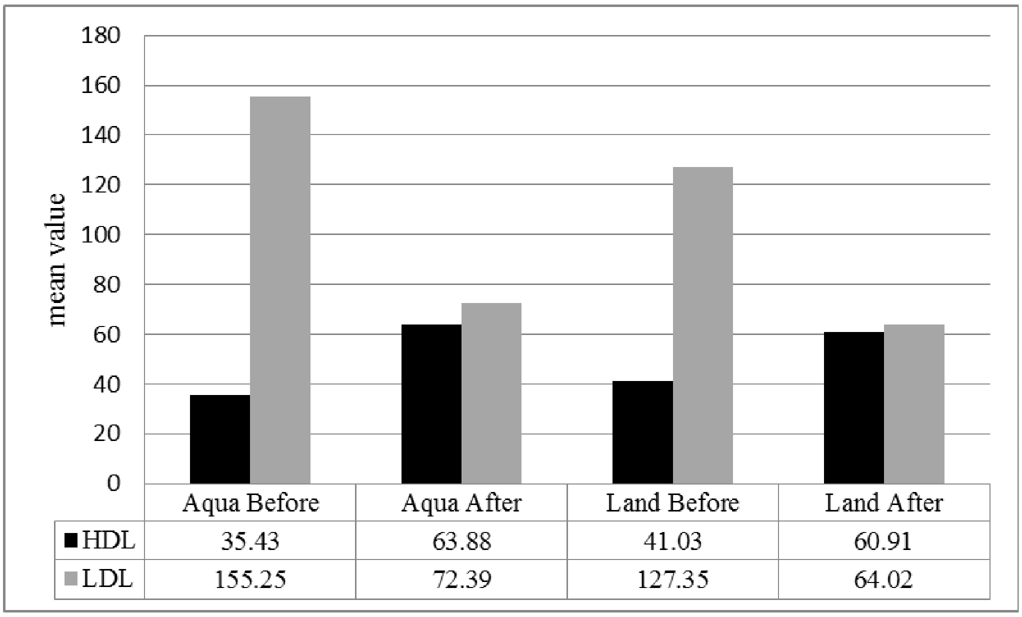

Figure 5. HDL and LDL levels between baselines versus postoperative measurement results

As can be seen from Figure 8 and Table 7, the reduction in HDL and LDL levels were significant at p= 0.01 and 0.04, respectively for land based exercise groups', and aquatic based groups also significant at 0.01 of both HDL and LDL levels respectively (see Table 7). HDL was significantly reduced the mean value from 41.03±6.07 mg/dl to 60.91±10.59 mg/dl and 35.43±7.87 mg/dl to 63.88±10.14 mg/dl for land and aquatic based exercise group, respectively. LDL also reduced from 127.35±30.80 mg/dl to 64.02±10.24 mg/dl and 155.26±30.44 mg/dl to 72.39±11.74 mg/dl for land and aquatic based exercise group, respectively.

As can be seen from postoperative data, land based exercise groups show a mean difference of HDL by -8.92mg/dl, and LDL level 19.09 mg/dl. In a similar pattern aquatic exercise group reduced mean difference of HDL by -17.02 mg/dl, and LDL by 25.40 mg/dl significantly as compared as the six weeks measurement outputs.

In other words, the postoperative output had a greater significance improvement in mean difference of HDL by -19.33 mg/dl and -28.45 mg/dl, and LDL by 63.33 mg/dl and 82.86 mg/dl for land and aquatic based exercise groups, respectively as compared with the baseline data.

As the description indicated, LDL levels were significantly decreased and HDL levels tend to increased at the last 12 weeks assessment output as compared with baseline data. Nikkila *et al*. (1980) reported that, aerobic fitness and exercise programs such as walking, jogging, and aerobics have been encouraged as a means to reduce total cholesterol, LDL, and triglycerides while elevating the "good" HDL. The primary reason for the elevation in HDL is an increase in lipoprotein lipase activity in response to exercise. Lipoprotein lipase accelerates the breakdown of triglycerides, resulting in a transfer of cholesterol and other substances to the HDL. It is interesting to note that healthy patients whose physical activity was restricted to bed rest for three to six weeks because of some type of traumatic fracture, showed a significant decrease in HDL levels (American Heart association, 2012).

5. SUMMARY, CONCLUSION AND RECOMMENDATION

Conclusions

Based on the results obtained the following conclusions are made:

1. Extended/continued aquatic or land based exercise had the ability to farther reduced cholesterol and triglyceride levels significantly, but reduction of cholesterol was slight greater in aquatic exercise as compared to land based exercise groups.
2. Exercises, land and aquatic based, are appropriate to manage body weight, blood cholesterol and triglyceride levels. Nonetheless, aquatic based exercise resulted in higher caused reduction of body weight, blood cholesterol, triglyceride and LDL level, and improved HDL level for overweighed and obese individuals than land based exercise.

Recommendations

Although the study indicated the importance of land and aquatic based exercises to control body weight, blood cholesterol and triglyceride levels and to improve life, the research conducted had its own limitation due to lack of appropriate laboratory and field equipments. Hence, further studies using better instruments and equipment, and large number of samples, different age classes, life style and parameters or indicators, must be conducted. Continuous moderate physical activity combined with balanced dietary intake is needed to prevent weight regain after substantial weight loss program. In the area to generate information on intensity, duration and type of exercise, better method to reduce obesity and overweight effect and on importance of the aquatic based exercise in therapy and performance improvement.

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