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EFFECTS OF CONCURRENT AEROBIC AND RESISTANCE EXERCISE TRAINING ON OBESE MEN ADULTS, NORTHWEST ETHIOPIA

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ABSTRACT

*The aim of the study was to assess the effects of combined aerobic and resistance exercise training (CART) on body weight and body composition, muscular strength and cardio respiratory fitness in obese adults. We examined the 12 weeks combined aerobic and resistance exercise training on 30 obese men adults (mean age 45.2±5.4). Data was analyzed by using SPSS statistical package software (version 16.0 for window). Paired sample T test was employed for pre and post test difference assessment. After 12 weeks training significant (p<0.001) reduction was observed on body weight (*5.32±1.2kg*), Waist circumference (*4.2±1.1cm*), body fat percentage (11.6%), Visceral fat (10.8%), Fasting blood glucose (*6.2± 3.2mg/dl*) and total cholesterol (*8.3±4.8mg/dl*). The intervention brought significant (p<0.001) greater change on Skeletal muscle percentage, VO2max and on 1RM from baseline. In conclusion, intervening combined training in a workout-base brought significant improvement on weight loss and body fat control, Fasting Blood Glucose and Total cholesterol. Moreover, significant parallel improvement on cardio-respiratory and muscular strength fitness was resulted due to combined exercises intervention. Combining the two types of exercises in a session gives a chance the participants to enhance their aerobic and strength fitness simultaneously.*

Keywords: Intervention, Aerobic exercise, Resistance Exercise, combined Exercise, Obesity

INTRODUCTION

Obesity is a serious public health problem in both developed and developing countries. According to world health organization, Overweight and obesity, had taken the fifth rank of leading risk factors cause of death in 2004(WHO, 2009). A healthy body requires a minimum amount of fat for the proper functioning of the hormonal, reproductive, and immune systems. Fat is essential for physiological homeostasis, not only as a source of energy but also to synthesize cell membranes and facilitate intracellular reactions. Fats play a vital role in maintaining healthy skin and hair, insulating body organs against shock, maintaining body temperature, promoting healthy cell function and serve as energy stores for

the body. Despite the fact that fat is required for the proper functioning of our body, too much storage of fat above the required amount can cause the rise of metabolic abnormalities called metabolic syndrome.

OBJECTIVES OF THE STUDY

- To assess the effect of workout-based combined aerobic and resistance exercises training intervention on Anthropometric and body composition variables.
- To assess the effect of workout-based combined Aerobic and Resistance Exercises training on Cardiovascular and metabolic variables.
- To evaluate the effect of workout-based combined Aerobic and Resistance Exercises training on cardiorespiratory and muscular strength fitness

LITERATURE REVIEWS

Being obese refers to an excess accumulation of body fat, which is defined by a Body Mass Index of 30 and above (WHO, 2010). Body mass index (BMI) is the method used to assess the body fat content which is defined as a person's weight in kilograms divided by the square of height in meters. Based on fat distribution obesity classified in to general and abdominal obesity. General obesity is characterized by the distribution of fat to all parts of the body and Abdominal (central) obesity is the excessive accumulation of fat in the abdominal region which resulting in an increase of waist size. A central distribution of body fat is associated with a higher risk of morbidity and mortality than a more peripheral distribution (Kissebah and Krakower, 1994). Most obesity expert considered that abdominal body fat is the main predictor of obesity-related disease especially metabolic disorder and cardiovascular disorder. Persons become overweight or obese as they get older, which is associated with a decrease in physical activity and basal metabolism, and a body fat redistribution to the abdominal area (Inelman, 2003).

Risk Factors for Obesity

An unhealthy diet: it is a major risk factor for obesity and a number of chronic non communicable diseases including: high blood pressure,diabetes, abnormal blood lipids, cardiovascular disease and cancer (WHO, 2004). The increasing industrialization, urbanization, mechanization and globalization occurring in most countries around the world is associated with changes in diet and behavior, in particular, diets are becoming richer in high-fat, high energy foods (WHO, 2002).

Physical inactivity: it is one of the factors for the increases of obesity and its complications. Physical inactivity levels are rising in many countries with major implications for increases in the prevalence of noncommunicable diseases and the general health of the population worldwide (WHO, 2009). In addition to its contribution for obesity prevalence, physical inactivity is estimated as being the principal cause for approximately 21–25% of breast and colon cancer burden, 27% of diabetes and approximately 30% of ischemic heart disease burden (WHO, 2004). According WHO report physical inactivity has been identified as the fourth leading risk factor for global mortality (WHO, 2009). People who are insufficiently physically active have a 20% to 30% increased risk of all cause mortality.

Urbanization, industrialization and globalization are today contributes for the socioeconomic change in the society. Lifestyle change, Dietary habits change and reduction in physical activity are the associated outcomes which contribute for the increasing prevalence of obesity in Ethiopia especially in the urban areas. These changes associated with urbanization and industrialization has got no attention due to the fact that attention has given to infectious and communicable diseases. To date, physical activities have not received much importance in the daily life of the urban population. Awareness towards the healthy effect of regular physical activity has not created in the people so that it is considered only for sport competition, rather than an integral part of healthy living amongst the general public. To the author's knowledge no studies have conducted in Ethiopia to evaluate the effect of combined aerobic and resistance exercise training on obesity.

Aerobic training is characterized by the execution of cyclic exercises that carried out with large muscle groups contracting at mild to moderate intensities for a long period of time. On the other hand resistance exercise training is characterized by the execution of exercises in which muscles from a specific body segment are contracted against a force that opposes the movement. Substantial documented evidences have shown that Aerobic and Resistance exercise trainings have independent effects on obesity. But limited studies were conducted in developed countries to examine the effect of aerobic and resistance exercise combination in a training program on obesity .The combination of exercise in the training programme was in different days. There is no study conducted on this issue in Ethiopia. Therefore, it needs to be tested in the Ethiopian context because there are differences in lifestyle, genetic variations, environment and demographic characteristics.

METHOD AND MATERIALS

This study was conducted in Gondar town, North West Ethiopia. Obese men individuals whose BMI $\geq$ 30 and who have had no regular participation in physical exercise training for six months before the study were included. Individuals who were with heart disease, pulmonary disease, uncontrolled hypertension, kidney failure, musculoskeletal and/or neurological limitations to exercise and those who were participating in another research study were excluded. Ethical clearance was obtained from the institutional review board committee of the University of Gondar. For each individual, all pre- and post-tests were performed at the same time of the day.

Sample Size was calculated by taking the mean difference of waist circumference of the resistance training group from the study conducted by Sarsan et al., (2006). 90 % power was assumed to detect true mean difference at 5% level of significance and 15% dropout rate was expected. By using snow ball sampling techniques we were approached 45 individuals. 35 subjects were screened and recruited at baseline. Written consent obtained from all participants. Subjects were included after explaining the details of the objective of the study. Participants were encouraged to continue their normal nutritional habits during the study period.

Data was collected through Anthropometric measurements which was done by using standardized technique and calibrated equipments. Body composition (Body fat percentage, skeletal muscle percentage, subcutaneous fat percentage, and visceral fat) and resting blood pressure (systolic and diastolic) were taken by using sensitive body composition analyzer.

Fasting blood glucose and total cholesterol level were analyzed by using Lifescan glucometer and AMS Vegasys Blood chemistry analyzer. The test were done in the morning after at least eight hour fasting. Data obtained from the subjects were coded and locked in a safe place.

Exercise Training Procedure

In the 12-weeks period, the subjects were performed four exercise sessions per week; three supervised by the study investigators in the research Fitness center and one performed at home or in a gym, according to instructions. In every workout both aerobic and resistances exercises were combined. Sequentially, aerobic exercises were given first and resistance exercises followed (Cutts and Burns, 2010). During the first two visits all subjects were familiarized with the training as well as the equipments. Prior to the start of the training programme orientation was given to the participants on the overall activities they performed.

Aerobic exercise training: Aerobic exercise was performed on treadmill (Trimline 7800 treadmill, USA) and stationary bicycle. After a 10 minute warming up exercise participants were instructed to perform aerobic training before resistance training. Aerobic exercise intensity was adjusted based on maximum heart rate (220 - age =MHR). For the first two weeks the target intensity was 50-60% of maximum heart rate (MHR). From the 3rd week onwards, the intensity progressively increased to moderate level 60-85% MHR.15 minute was given for the first two weeks and increased to 20 minute from the third week onwards.

Resistance exercise training: Resistance exercise training was performed after aerobic exercise. Circuit training was employed. Subjects were guided to perform sensible resistance exercise with major body muscles. Sensible resistance training is characterized by lifting lighter weights for a higher number of repetitions, moving continuously and breathing throughout each exercise. six different exercises (Upper body: biceps curl, bench press; Core body: sit-ups or curl-up; Lower body: leg press, leg extension, leg curl) were conducted by using dumbbells, weight bench, and multipurpose studio-6 equipments. A one repetition of the maximum (1RM) was used to assess loading capabilities for each Subject. After two weeks of familiarization both the intensity, duration of a session and frequency per week were increased. From the third week onwards number of session was increased to four times per week which was arranged for every other day. All workouts were preceded by a 10 minute warm-up which consisted of stretching of the major muscle groups and slow walking around the gym (Table 1).

Table 1. Timeline of intervention

Dura-tion (week)	Workout Time line (in minute)					Freque /week	Intensity description
	Warm-up	Aerobic exercise	Resistance exercise	Cool down	Seater esting		
1st &2nd week	10	10-25	25-40	40-45	45-50	3	AE-50-60 % mHR, RE- 30-50% 1RM, 1-2 set, 5-8 reps. 6exercises.
3rd-12th weeks	10	10-30	30-50	50-55	55-60	4	AE- 60-85% mHR, RE-50-60% 1RM,2-3 set, 8-12 reps,7exercises

Note: AE-Aerobic Exercise, RE-Resistance Exercise, MHR-Maximum Heart Rate, RM-Repetition Maximum

Baseline and After 12 Weeks Training Measurements

All tests and measurements described below were performed before and after the training period. The Test was done in the morning in similar time of a day. Tests were made according to the standard.

Anthropometric Measurements: Anthropometric Measurements were taken by using standardized techniques and calibrated equipments. Body Mass Index calculated by dividing the weight in kilograms to the height in meters squared (kg/m^2). Participants were weighed to the nearest 0.1kg by Omron digital weigh machine and height was by using Stadiometer to the nearest 0.5cm recorded while wearing light indoor clothe with no shoes. Waist and hip circumference were measured at the midpoint of the lowest rib and the iliac crest at the end of a gentle expiration. Hip circumference was taken at the maximum circumference of the hip. In both case the measurement recorded to the nearest 0.5cm by using a flexible plastic tape. The average of two measurements was taken. Sensitive Body composition analyzer (Omron Body Composition Monitors Digital Weighing Scale, HBF-362 model) were used for body composition assessment. Body fat percentage, whole skeletal muscle, whole subcutaneous fat and visceral fat were analyzed.

Resting Blood pressure: Resting Blood pressure was taken by using Standardized Mercury sphygmomanometer. Measurement was taken from left arm. The subject was asked to remove all clothing that covers the location of cuff placement. The individual was comfortably seated, with the legs uncrossed, and the back and arm supported such that the middle of the cuff on the upper arm was at the level of the right atrium (the mid-point of the sternum). Before taking the first reading the subject ordered to take a 5 minutes rest while sitting with the arm resting on a table and the arm where the cuff rap was slightly bent. During measurement the subjects instructed to relax as much as possible and to not talk during the procedure. Before one day of the measurement the subjects were instructed to come without doing exercise and without having alcohol and beverage.

Cardio-respiratory and Muscular Strength test: Bruce Incremental treadmill protocol test (1972) was used to calculate peak oxygen consumption (Vo2max).The treadmill running time recorded in minute and used to compute peak oxygen consumption volume in ml/kg/min. Foster et al.,(1984) formulas was used for men and women respectively to estimate peak oxygen consumption volume. Maximum muscular strength was assessed by using one repetition maximum (1RM) testing. Maximal load calculation was employed to determine the 1 RM (1998)[11]. Dominant hand Biceps curl and seated leg press test was done by using dumbbell (free weight) and inclined leg press multi exercise unit to evaluate the 1 RM. The pre and post training test were done in similar time by the same person.

Laboratory determinants: Fasting Blood glucose level test was done by using commercially available Lifescan Glucometer (one touch ultra-2). Total cholesterol, was done by using AMS Vegasys blood chemistry analyzer at Gondar university referral Hospital laboratory. The test was done in the morning after at least 8 hour overnight fasting.

Statistical Analysis and Data Interpretation

The statistical computation of the data was analyzed by using SPSS statistical package software (version 16.0). Descriptive statistics (Mean and standard deviation) was used to analyze continuous variables. Paired sample T test was used to compare the difference

between baseline and after 12 weeks intervention. Differences were considered statistically significant at p-values < 0.05. Pearson correlation coefficient was used to assess the relationship between body composition and metabolic parameters at baseline.

RESULTS

A total of 30 (85.7%) obese men subjects (age 45.2±5.4 y; weight 86.8 ± 3.0 kg; BMI 30.4 ± 0.7 kg/m2,) were completed the 12 weeks intervention study. The descriptive characteristics of the subjects at baseline and after 12 weeks are summarized in Table 2. A paired sample T test between baseline and after training was done. The result showed after 12 weeks intervention statistically significant changes were observed in all variables from baseline.

Table 2. Baseline and after 12 weeks exercise training changes of all variables

Variable	Base line	After 12 weeks	Mean difference	Change (%)
Age, in year	45.2±5.4			
Subjects, N	30			
Anthropometric and Body composition				
Weight(kg)	86.8± 3.0	81.46±2.96*	5.32± 1.2	6.1
Waist circumference (cm)	111± 2.7	106.7± 2.7*	4.2± 1.1	3.8
Waist-hip ratio	1.05± 0.04	1.01± 0.04*	0.03± 0.01	2.9
BMI (kg/m^2)	30.4± 0.7	28.5±0.7*	1.9± 0.5	6.3
Body fat percentage	37.2± 3.3	32.8± 3.2*	4.3± 1.1	11.6
skeletal muscle %	27.0± 1.9	29.8± 2.1*	2.8± 0.9	10.4
subcutaneous fat %	25.6± 4.6	23.5± 4.4*	2.2± 0.6	8.6
Visceral fat	15.7± 1.9	14.0± 1.7*	1.7± 0.6	10.8
cardiovascular & Metabolic variables				
Systolic BP(mmHg)	126.4± 5.8	123.9± 5.2*	2.5± 1.7	1.97
Diastolic BP (mmHg)	81.3± 3.8	79.8± 3.9*	1.5± 0.9	1.8
Resting heart rate(bpm)	70.1± 3.6	68.8± 3.9*	1.4± 0.7	2.1
Fasting BG (mg/dl)	107.4± 6.4	101.1± 4.7*	6.2± 3.2	5.9
Total cholesterol (mg/dl)	194.9±16.2	186.7± 12.8*	8.3±4.8	4.3
Cardio respiratory & strength capacity				
Running time(minute)	8.9± 0.74	14.0± 0.8*	5.3± 0.9	59.5
VO2max(ml/min/kg)	30.5± 2.9	51.9± 3.5*	21.8± 4.4	71.5
Total 1RM (kg)	55.3± 6.0	69.8± 7.1*	14.5± 3.5	26.3

Note: Data is presented in mean ± SD. M- Male, RM-repetition maximum, BMI- body mass index, BG-blood glucose, VO2max-volume of maximum oxygen consumption, *p<0.001 vs baseline

Anthropometric and body compositions outcomes: At the end of the training programme, significant (p<0.001) reduction from baseline was observed on body weight (6.1%), waist circumference (3.8%) and waist-hip ratio (2.9%), Body fat % (11.2%), subcutaneous fat %

(8.6%), visceral fat (10.8%). Given the reductions on the above variables, an increasing of records from baseline was observed on skeletal muscle % (10.4%, p<0.001). (Table 2)

Cardio vascular and metabolic variables change: At the end of the training statistically significant(p<0.001) reduction was observed on systolic blood pressure (1.97%) and diastolic blood pressure (1.8%), resting heart rate (2.1%), fasting blood glucose (5.9%) and total cholesterol (4.3%). (Table 2. Figure 1)

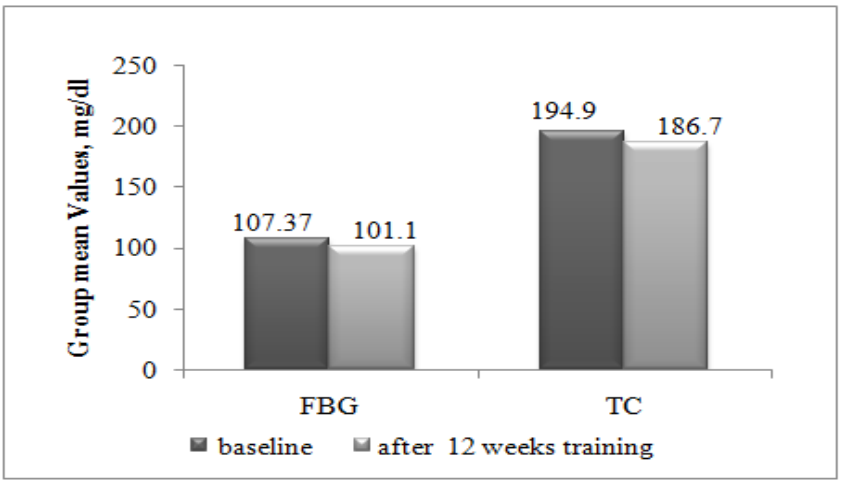

Figure 1. Baseline and after 12 weeks training test value of fasting blood glucose (mg/dl) andTotal cholesterol (mg/dl) among the group

Cardio-respiratory and muscular strength outcomes: After the intervention of 12 weeks combined aerobic and resistance exercises, significant (p<0.001) greater changes were observed on treadmill running time (59.5%), Vo2max (71.5%) and total 1RM (26.3%). (Table 2, Figure 2)

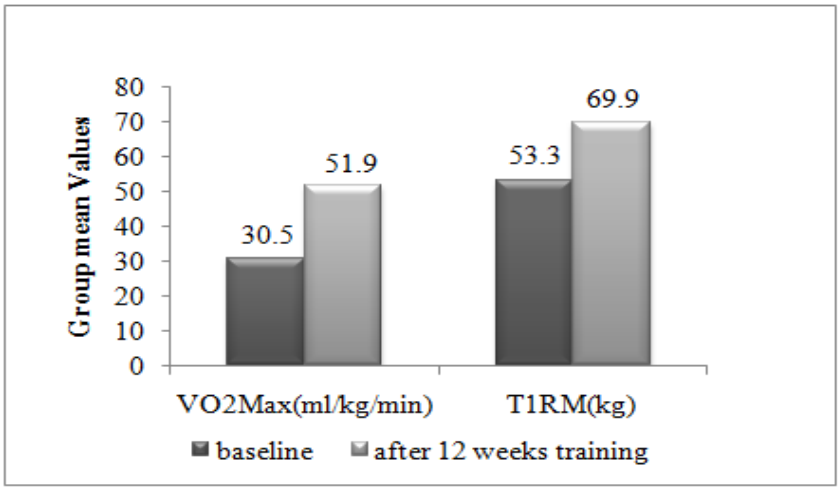

Figure 2. Baseline and after 12 weeks training test values of aerobic (VO_2max) and muscular strength(1RM) performance

DISCUSSION

Substantial studies have documented that independently both aerobic exercise training and resistance exercise trainings have made significant changes on body weight and body composition variable in obese individuals. Exercises have been useful as a way of controlling body weight. In our study a 12 weeks intervention of combined aerobic and resistance exercise training showed significant lowering changes on body weight, body mass index, waist circumference, percent body fat, fasting blood glucose, total cholesterol, systolic and diastolic blood pressure.(Table 2).

After 12 weeks intervention mean body weight of the group significantly decreased from 86.8±3.0 kg to 81.5±2.96 kg ($p<0.001$). A 6.1 % weight reduction from baseline was observed at the end of the training. Our result supports the weight reduction role of physical activities on obese participants. Sarsan and his colleagues were conducted a research to examine the effects of aerobic and resistance exercises independently in obese women. It was conducted for 12 weeks with 3 days/wk. Their result showed a 3.4% ($p=0.002$) and 4.02% ($p<0.001$) weight reduction from baseline in resistance and aerobic exercise training group respectively. Chaudary et al.,(2010), on the other hand conducted a 6 weeks intervention to evaluate the effects of aerobic versus resistance training on cardiovascular fitness in obese sedentary females. Their result showed a significant reduction of body weight in aerobic (3.75%) and resistance (2.2%) training groups.

On the other hand, substantial studies were conducted to assess the effect of combined intervention of diet and exercise on body weight reduction in obese participants. Results from short-term interventions, which are typically 6 months or less in duration, have shown the magnitude of weight loss that is achievable with exercise alone compare with diet alone or the combination of diet plus exercise. Bryner *et al.,* (1999) were conducted a 12 weeks intervention study to examine the effects of resistance verses aerobic training combined with an 800 calorie liquid diet on lean body mass and resting metabolic rate. Twenty subjects a mean weight of 95.16±13.0 kg, and a BMI of 35.26±2.9 kg/m2 were participated in their study. The resistance group was performed 3 days per week while the aerobic group 4 days per week. At the end of the study their result shows a 19.3 % and 14.7% weight loss in aerobic and resistance groups respectively. Geliepter *et al.,* (1997) also conducted the 8 weeks 3 days / week intervention to examine the effect of strength or aerobic training on body composition, resting metabolic rate and peak oxygen consumption in obese dieting subjects. Their result shows significant weight reduction (7.7%, 10% and 9.7%) in resistance, aerobic and diet only groups respectively.

A paired sample T test was conducted to evaluate the effect of combined aerobic and resistance exercise training on waist circumference, waist-hip ratio, and BMI. The result showed significant difference on WC (111±2.7 cm to106±2.7cm, $p<0.001$), waist-hip ratio (1.05±0.04 to 1.01±0.04, $p<0.001$) and BMI (30.4±0.7 to 28.5±0.7, $p<0.001$). The percent reduction from baseline was 3.8 %, 2.9% and 6.3% respectively for waist circumference, waist-hip ratio and BMI. Related studies showed significant changes on these variables. Even though, the duration of intervention is different significant changes was observed. Sarsan *et al.,* (2006) reported a 4.07 %($p<0.001$) and 3.35 %($p=0.002$) decrease on BMI in aerobic and resistance group respectively. Chaudary *et al.,* (2010) also showed consistent result that a 5.04% and 2.24% reduction on BMI in aerobic and resistance group

respectively. Given the decreasing effects of the independent intervention, our result showed relatively greater changes (6.3%, $p<0.001$). On the other hand, significant differences also observed between our result and previously done independent aerobic and resistance training intervention on waist circumference. Waist circumference is one of the indicators of cardiovascular disorders. In the present study after intervention significant reduction (3.8%, $p<0.001$) in waist circumference was resulted. In Sarsan *et al.* report a significant waist circumference reduction was resulted in aerobic (5.86%, $p<0.001$) and resistance (2.32%, $p=0.03$) training groups.

Physical activities have impacts on energy expenditure due to its effect on resting metabolic rate and muscular strength and muscle mass. In the present study after 12 weeks training significant ($p<0.001$) changes were observed on body composition variables: body fat percentage, subcutaneous fat and visceral fat from baseline records. Conversely, significant ($p<0.001$) increasing change of skeletal muscle percentage was resulted. Both body weight, waist circumference and body fat percentage showed significant reduction from baseline records. This reduction shows the presence of a positive association between these three variables.

The role of aerobic and resistance exercise training on cardiovascular diseases is well documented. Studies have conducted to examine the effect of physical activities on blood pressure and metabolic variable. Independently the effect of aerobic training and resistance training on these variables was assessed. From their result Sarsan et al., (2006) reported a significant reduction in systolic ($p=0.004$) and diastolic ($p=0.002$) blood pressure in aerobic group and systolic ($p=0.002$) and diastolic ($p=0.007$) blood pressure in resistance group after the intervention. A consistent result was observed in our study. At the end of the training a significant reduction in systolic ($p<0.001$) and diastolic ($p<0.001$) blood pressure was resulted. Moreover, we were assessed the effects of the intervention on metabolic variables. Pre and post training test was done on these metabolic variables. The result showed Significant ($p<0.001$) reduction change on both fasting blood glucose (5.9%) and total cholesterol (4.3%) at the end of the intervention. The result supports the previous studies that advocate the preventative and/or curative effects of regular physical training on type 2 diabetes and cardiovascular disease.

Sedentary lifestyle is one of the risk factors for obesity epidemic. Many studies revealed that physical activities made significant improvement on aerobic performance and strength capacity. Aerobic exercise training mainly focused on aerobic performance. In our study, significant ($p<0.001$) increase in treadmill running time (8.9±0.74 to 14±0.8 minute), VO2max (30.5±2.9 to 51.9±3.5 ml/kg/min) and total 1RM (55.3±6 to 69.8 ±7.1 kg) was observed at the end of the training. Independent studies have conducted to examine the effect of aerobic and resistance exercise training (Sarsan *et al.* 2006, Wallance *et al.* 1997). In these studies, aerobic training group showed greater VO2max and less 1RM record than the resistance group. The present intervention addressed both cardio-respiratory and strength training simultaneously unlike independent aerobic and resistance training intervention. The combination of the two training type in a session contributed to the concurrent improvements for aerobic performance and Muscular strength capacity to the participants.

CONCLUSION

Intervening Combining aerobic and resistance exercise training for 12 weeks resulted significant improvement on body weight, body fat percentage, systolic and diastolic blood pressure, fastening blood glucose and total cholesterol, aerobic performance and Muscular strength capacity in obese individuals. Adhering only on one type training (aerobic or resistance) will not be guaranteed to address different health related fitness components concurrently.

RECOMMENDATION

Combining two or more types (mode) of training in one training programme benefit the trainees to give equal chance to all health related fitness components. Based on the present study result, it is therefore recommended that obese individuals should perform regular physical training by combining aerobic and resistance exercises so that the body improves both cardio-respiratory fitness and muscular strength capacity simultaneously. It is also recommended that fitness trainers should take in to consideration the role of combining two or more types (mode) of training in one training program that enables their clients to give balanced improvement on Physical fitness.

FUTURE DIRECTION

Combined Aerobic and Resistance exercise training intervention for twelve weeks (three month) has given significant improvement in the reduction of body weight, body fat and fasting blood glucose in obese men adults. If this combined training intervention made for a period longer than three months better weight reduction and prevention of obesity associated complications would found in obese adults.

Combining diet therapy with only aerobic or only Resistance training has been studied so far. Significant results have been reported on weight reduction and body composition in obese individuals. In the present study significant reduction in body weight, body fat and fasting blood glucose also exhibited in obese men adults. If the combined training intervention combined with diet therapy (calorie restriction) a better reduction on body weight, boy fat and fasting blood glucose would be exhibited.

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