A Study to Compare the Effect of Aerobic and Resistance Training on Cardiovascular (CVS) Fitness in Young Obese Sedentary Females

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Background & Objectives: Obesity is a major health problem worldwide having many long-term debilitating effects which may impair quality of life. Evidence suggests that exercise training improves CVD risk factors. However, it is unclear whether health benefits are limited to aerobic training or if other exercise modalities such as resistance training are as effective or more effective in obese female, so the aim of the study is to compare effect of moderate-intensity aerobic exercise and resistance exercise training programme which would induce and sustain improvements in cardiovascular risk profile in young obese sedentary female.

Materials & Methods: An experimental study was conducted on 20 obese sedentary female with age group of 19-25yrs (BMI>30). Subjects were selected by simple random sampling techniques. Subjects were grouped into aerobic training (n=10, 22.22±1.98 (SD) years) and resistance training (n=10, 22.67±1.50 (SD) years). Aerobic training was given for 3 days a week at and resistance training was given for alternate days for 6 weeks. The blood pressure (BP), heart rate (HR), and metabolic parameters like cholesterol, high density lipoprotein (HDL), very low density lipoprotein (VLDL) and anthropometric parameters were taken before and after the training.

Result: The findings of the study showed statistically significant differences in recovery HR ($t=8.066$, $P<0.001$) and in post-DBP ($t=6.249$, $p<0.05$) in aerobic training and in SBP (Pre- $t=4.617$, $P<0.001$ and post-exercise $t=4.590$, $P<0.001$) in both training groups. Significant differences were observed in VLDL ($t=5.378$, $p<0.05$) and HDL ($t=6.318$, $p<0.05$) levels in aerobic training group while BMI and body fat percentage showed significant improvements in both aerobic and resistant training groups.

Conclusion: Both aerobic exercise and resistance exercise resulted in improved performance and exercise capacity in obese women. While aerobic exercise appeared to be beneficial with regard to improving depressive symptoms and maximum oxygen consumption, resistance exercise was beneficial in increasing muscle strength.

Index Terms: Aerobic Exercise, Obesity, Resistance training

Introduction

Obesity is an increasingly prevalent health problem in developed and developing countries and poses a significant challenge to both individual and public health.[1] Adult-onset obesity is associated with an increased risk of developing, what seems to be an ever increasing number of medical complications, including type 2 diabetes, hypertension, cardiovascular disease, respiratory maladies, gout and musculoskeletal disorders. Thus, it is important to develop programs that improve the prevention and treatment of obesity. [2]

The World Health Organization has described obesity as one of today's most neglected public health problems, affecting every region of the globe and it is still increasing in both industrialized and developing countries.[3] In general, people become obese because of a combination of inherited genes and a lifestyle consisting of low levels of physical activity and consumption of excess calories. Obesity, especially the central or visceral type, is a predisposing factor for the development of type 2 diabetes mellitus, hypertension, and cardiovascular disease (CVD). [2]

Obesity has many adverse effects on hemodynamics and CV structure and function. Obesity increases total blood volume and cardiac output, and cardiac workload is greater in obesity. Typically, obese patients have a higher cardiac output but a lower level of total peripheral resistance at any given level of arterial pressure. Most of the increase in cardiac output with obesity is caused by stroke volume, although because of increased sympathetic activation, heart rate is typically mildly increased as well.[4]

Considerable research has been undertaken to identify efficacious method to help alleviate the array of health disorders commonly associated with obesity. Participation in regular aerobic exercises is now considered an essential component in any long term obesity management strategy because of its potential to provide metabolic benefits and assist in the maintenance of energy balance.[5] Epidemiological and clinical studies have demonstrated that the regular practice of aerobic exercise is important factor for prevention and treatment of this disease (Solomon et al., 1997). Research concluded that about 80–90 min of moderate-intensity physical training per day may be needed to avoid or limit weight regain and to prevent cardiovascular diseases in formerly overweight or obese individuals. [6]

The most recent studies mentioned that aerobic exercise training has capacity to improve the intrinsic pump capacity of the myocardium.[7] The constant stress of aerobic exercise forces the heart to gradually enlarge, thus further exercise eventually requires less effort to continue. Research suggested that HR increase immediately following a work bout which is affected by the amount of resistance, the number of repetitions and the muscle mass involved in the contraction (small vs. large mass exercises). A previous study showed weight loss improves HRR in overweight and obese population, suggesting that HRR may be a modifiable risk factor via changes in body weight.[8]

In terms of chronic adaptations of training, there is a reduction in HR following resistance training, which is considered beneficial.[8] Resistance exercise improves muscular strength and can improve body composition provided that a sufficient exercise stimulus is prescribed. Effects of resistance exercise training on body composition and metabolic profile are well established in obese adults, but warrant further investigation in obese youth. Many researcher reviews the rationale for including a resistance training component with interventions geared toward overweight and obese adolescents by discussing the effects on various health measures. [9]

Though aerobic and resistance trainings induce improvement in body fat composition and have favorable metabolic effects in obese women, it is still unclear whether health benefits are limited to aerobic training or if other exercise modalities like resistance training or endurance training are as effective or more effective in obese female.

Methodology

Study design: The Experimental study design

Sampling Technique: Simple Random Sampling

Sample collection: 20 healthy female subjects in age group of 19-25 yrs were taken for the study from various OPD centers in and around Rajkot.

Inclusion Criteria:

1. Age group: 19-25 years.
2. Only female participants with BMI>30 were included.
3. Subjects living sedentary life style (no regular sports activities for at least 2 years).

Exclusion Criteria:

1. Healthy subjects without any history of pathologic or orthopedic limitation were included in the study.
2. Subject who is currently engaged in any of the other exercise programs.
3. Subjects with no cardiovascular, musculoskeletal, respiratory, or other chronic diseases that might limit training or testing,
4. Menstrual irregularities,
5. Subjects using medication (eg. beta-blockers),
6. Subjects following any dieting programme.

Materials used:

1. Sphygmomanometer
2. Stethoscope

3. Weighing machine
4. Treadmill
5. Weight cuffs
6. Kinanthropometric rod
7. Heart rate monitor (cardio-vigil)
8. Body composition measurement

Testing Procedure:

- The proposed title and procedure was being approved by ethical committee members, written consent was taken from subjects who fulfilled the inclusion and exclusion criteria and they were randomly selected for aerobic training(n=10) and resistant training group(n=10).
- All participants were familiar with the exercise testing protocol by going through preliminary exercise test. Height was measured using kinanthropometric rod and weight was measured by the weighing machine. BMI was calculated as weight (kg)/height (m2) and body fat percentage was calculated by using formula as body fat %=1.37× BMI -3.47 (Durnin & Womersley, 1974).
- Systolic (SBP) and diastolic blood pressure (DBP) were measured in a sitting position by using an inflatable cuff and mercury sphygmomanometer before and after the exercise. Cardiovigil was used to monitor the HR continuously.
- Blood samples for lipid analysis (10 ml) were drawn early in morning only at baseline (fasting). Metabolic parameters like cholesterol, high density lipoprotein (HDL), Very Low Density Lipoprotein (VLDL) and anthropometric parameters were assessed prior to training, at the first week and then after the six weeks of training by making the subjects sit on the chair.

Training program:

Aerobic Training:

- The program included warm-up phase for 5 minutes of stretching exercises, 30 minutes of aerobic exercises like walking, jogging, aerobic dance with music at 50-75% of maximum heart rate (MHR) and cool-down phase for 5 minutes of stretching, three times a week for 2 months.
- All sessions were supervised by a professional physiotherapist.
- Cardiovigil heart rate monitor was used to maintain 60% to 70% of maximum HR during the aerobic exercise session.
- HR, SBP and DBP were measured before and after the exercise in the sitting position and recovery heart rate rHR was measured at third minute of post exercise session.
- Maximum heart rate was calculated by using the formula:

$$HRmax = 220\text{-}Age$$

Resistance training:

- Resistance training program was given for alternate days for 6 weeks. In resistance training 4 sets of 10 repetitions were performed by the subjects, based on the Delorme and Watkins technique.
- Training was started with 10 lifts with 50% of 10 RM, then 75% of 10 RM and progressed to 100% of 10 RM.
- Seven different types of exercises like abdominal curl ups, biceps curls, triceps extension, back extension, leg curls, side leg raises and knee extension were included.

Statistical Analysis:

All data are presented as mean ± standard deviation (SD). The pre and post exercises data were analyzed with a statistical paired sample t-test. Statistical significance was accepted at $P<0.05$. An alpha level of 0.001 was used in determining statistical significance using the SPSS program for Windows, version 14.0.

Result

- The pre & post training results of paired t-test for MHR showed a statistically significant difference in aerobic training (t=7.643, P<0.001) compared to resistance training (t=2.327, P=0.04). The HR recovery results of paired t-test in case of aerobic training showed significant changes (t=8.066, P<0.001) as compared to resistance training (t=2.121, P=0.06).
- Results of paired t-test in aerobic training in pre SBP (t=4.114, P=0.003) and post SBP (t=7.108, P<0.001) showed more significant changes than resistance training in pre SBP (t=4.617, P<0.001) and post SBP (t=4.590, P<0.001) values and pre DBP (t=6.249, p<001) and post DBP (t= 7.652, p<0.001) showed statistically significant changes as compared to resistance training.
- The pre to post training paired t-test of cholesterol, triglycerides, HDL (pre 45.40±3.533, post 53.60±3.134, t=6.318, p<0.05) and VLDL (pre 28.10±1.415, post 26.86±0.760, t=5.378, p<0.05) in aerobic training group were significant as compared to resistance training group.
- The pre to post training results of weight, BMI and body fat percentage were statistically significant in cases of aerobic and resistance training (P<0.001) in both group (P=0.06).

Table 1: The Pre and post test Differences in studied variables in Two groups

Variables	Aerobic		Resistance	
	Pre	Post	Pre	Post
Weight (kg)	77.30±5.870	73.40±6.114	77.10±6.045	75.40±5.739
BMI	31.93±1.466	30.32±1.5383	32.19±2.571	31.47±2.362
Body %	40.27±2.009	38.07±2.107	40.63±3.523	39.64±3.236
Chol (mg/dl)	242.70±21.176	233.00±19.539	247.50±13.360	242.60±13.945
HDL (mg/dl)	45.40±3.533	53.60±3.134	46.10±5.724	49.40±4.993
VLDL (mg/dl)	28.10±1.415	26.86±0.760	27.82±27.34	1.48±1.139
Pre SBP(mm Hg)	128.10±4.954	124.20±2.820	129.70±4.498	126.70±3.713
Post SBP(mm Hg)	131.70±4.083	123.70±2.540	131.70±4.667	127.20±3.910
Pre DBP(mm Hg)	85.00±3.265	81.80±3.119	83.70±2.311	83.50±2.877
Post DBP(mm Hg)	86.20±2.820	80.70±2.750	83.00±2.160	82.60±1.349

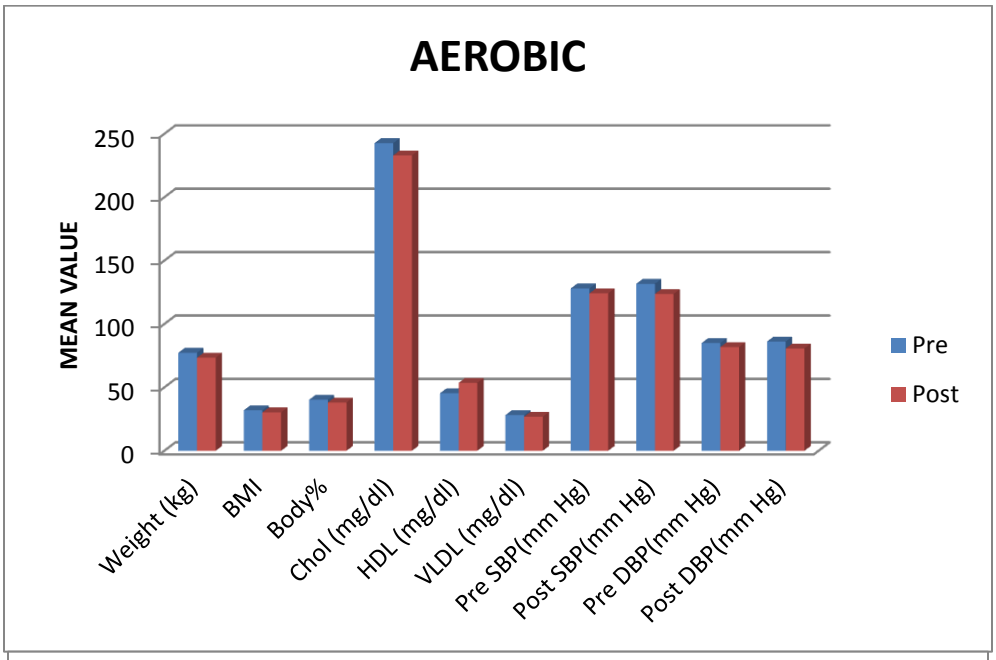
HDL: High Density Lipoprotein; VLDL: Very Low Density Lipoprotein; SBP : Systolic Blood Pressure; DBP : Diastolic Blood Pressure

Table 2: The t-values and 95% confidence intervals of variables in two groups

Variables	Aerobic			Resistance		
	t value	95% CI		t value	95% CI	
		Upper	Lower		Upper	Lower
Weight (kg)	16.714	4.428	3.372	7.965	2.182	1.217
BMI	14.773	1.856	1.363	7.383	0.940	0.499
Body %	14.773	2.543	1.867	7.383	1.288	0.684
Chol (mg/dl)	6.746	12.952	6.447	5.770	6.820	2.979
HDL (mg/dl)	6.318	5.26	11.135	6.128	2.081	4.518
VLDL (mg/dl)	5.378	1.761	0.178	2.092	0.998	0.038
Pre SBP(mm Hg)	4.114	6.044	1.755	4.617	4.469	1.530
Post SBP(mm Hg)	7.108	10.545	5.454	4.590	6.717	2.282

Pre DBP(mm Hg)	6.249	4.358	2.041	0.259	1.945	1.545
Post DBP(mm Hg)	7.652	7.126	3.873	0.557	2.024	1.224

CI: Confidence Interval; HDL:High Density Lipoprotein; VLDL : Very Low Density Lipoprotein; SBP : Systolic Blood Pressure; DBP : Diastolic Blood Pressure



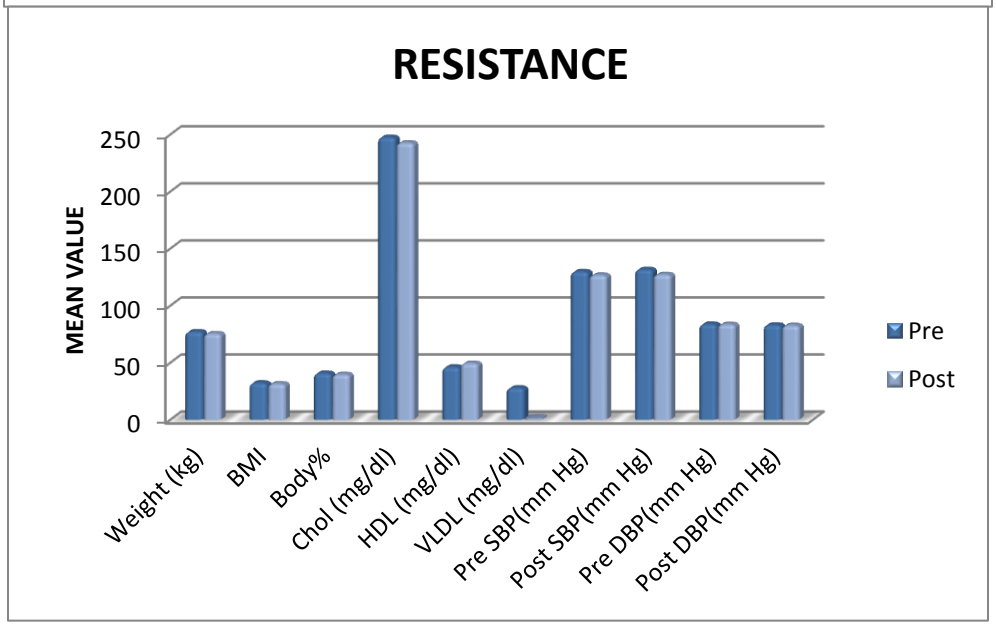


Table 3: The Comparison of pre and post test HRmax of aerobic and resistance exercises group

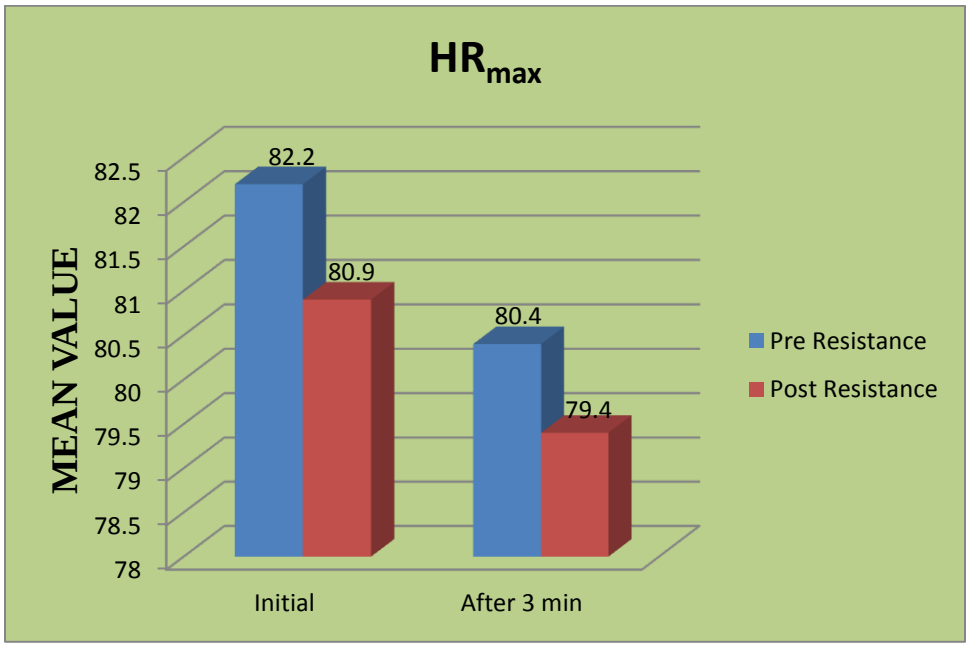
Variable		Mean	SD	t Value	p	95% CI Upper	95% CI Lower
AEROBIC	Pre (week 1 HR max)	109.40	2.988	7.643	<0.001	9.460	5.139
	Post (week 6 HR max)	116.70	2.626				
RESISTANCE	Pre (week 1 HR max)	82.20	5.432	2.327	<0.04	2.564	0.035
	Post (week 1 HR max)	80.90	4.306				

CI: Confidence Interval; HR max: Heart Rate Maximum (beats/min)

Table 4: The Comparison of Pre and Post Test value of rHR 3min of aerobic and resistance groups

Variable		Mean	SD	t Value	p	95% CI Upper	95% CI Lower
AEROBIC	Pre (week 1 rHR 3min)	97.40	5.378	8.066	<0.001	8.579	4.820
	Post (week 6 rHR 3min)	90.70	4.599				
RESISTANCE	Pre (week 1 rHR 3min)	80.40	(5.758)	2.121	0.06	2.066	0.066
	Post (week 6 rHR 3min)	79.40	(4.595)				

CI: Confidence Interval; rHR (beats/min) 3 min: Recovery heart Rate 3rd min



DISCUSSION

The present study support the experimental hypothesis, study evaluated the effects of two different exercise program on cardiac fitness variables such as BP and HR, metabolic parameters such as HDL, VLDL and anthropometric parameters. In the present study, aerobic exercise and resistance training resulted in reduction in very low density lipoprotein (VLDL) and improvement in HDL levels while aerobic training showed more statistically significant results than resistance training group. Aerobic training increases HDL cholesterol.

The result of present study shows changes in metabolic parameters which is supported by **Sunami Y et al., (1999)** which says that the concentration of HDL is inversely correlated with the risk of coronary heart disease. He also explained that exercise enhances the production of the enzymes that facilitate HDL transportation of cholesterol back into the liver to be broken down. Thus, HDL acts as a scavenger in the reverse transport of cholesterol.[10]

Although the present study did not include a diet modification component in the two training groups, body weight, BMI and body fat percentage showed a marked reduction when observed individually in both groups. The alterations in body composition are most

often attributed to aerobic exercise with a decrease in fat weight and a maintenance or slight increase in fat-free mass indicating the importance of aerobic exercise in burning calories and losing body fat was explained by **Banz WJ et al., (2003)**, support the result of present study.

Statistically significant changes have been observed in recovery heart rate in case of aerobic training in present study can be justified by study of **Mcardle WD et al., (2001)** who explained that exercise training creates an imbalance between the tonic activity of sympathetic accelerator and parasympathetic depressor neurons in favor of greater vagal dominance, a response mediated primarily by increased parasympathetic activity and a small decrease in sympathetic discharge. The reduction in recovery HR of the present study could be due to the fact that active recovery immediately after the event encourages recovery and reduces muscle lactate levels faster than complete rest. It also enhances performance, as there is continued use of free fatty acids as fuel during active recovery.[12]

The decrease in both systolic and diastolic blood pressure was observed after aerobic and strength training in present study. Statistically significant differences were observed more frequently in aerobic program, it may be because of favorable changes in vascular compliance, thus could reduce peripheral resistance. The results of the present study are in accordance with study of **Kravitz L (2001)** who explained that the aerobic exercise may lower blood pressure partly involve with the effects of two hormones, epinephrine and nor-epinephrine.[8]

HR which is acutely elevates immediately after a work bout can be affected by the amount of resistance, the number of repetitions and muscle mass involved in the contraction (small vs. large mass exercises). **Kelley GA (2000)** stated that systolic and diastolic blood pressures may show dramatic increases during and after a resistance exercise bout, so the patients with cardiovascular diseases should be monitored more attentively. He also suggested that the effects of resistance training on blood pressure are varied largely due to differences in the study design.[13]

CONCLUSION

The results of the present study indicated that aerobic training is more beneficial than resistance training in improving cardiovascular fitness of the person. It can be used as a preventive measure in obese female who are at risk of developing cardiovascular diseases. Aerobic training also increases energy expenditure by activation of lipolysis and affects the reduction of body weight and body fat percentage.

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