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Investigation of the changes on muscular endurance in response to aerobic and anaerobic training among type 2 diabetic patients

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Abstract
The rationale of the study is to investigate the changes on muscular endurance in response to aerobic and anaerobic training among type 2 diabetic patients. To achieve the purpose of the study 45 male type 2 diabetic patients from Ongole, in the southern state of Andhra Pradesh, India, were selected as subjects. The subjects were selected in the age group of 45 to 50 years and they were randomly assigned into three equal groups of 15 each. Experimental group-I performed aerobic training, experimental group-II performed anaerobic training and group III acted as control. The muscular endurance was selected as dependent variable. The data collected from the three groups prior to and post experimentation on selected dependent variable was statistically analyzed to find out the significant difference if any, by applying the analysis of covariance (ANCOVA). Whenever the obtained 'F' ratio value was found to be significant for adjusted post-test means, the Scheffe's test was applied as post hoc test. In all the cases the level of confidence was fixed at 0.05 level for significance. The result of the study produced 20.48% percentage of improvement due to aerobic training and 15.32% of improvement due to anaerobic training in muscular endurance of the diabetic patients

Keywords: Aerobic training, anaerobic training and muscular endurance

1. Introduction
Recent data suggest that both aerobic and anaerobic training may exert beneficial effects on cardiac risk factors in subjects with type 2 diabetes. However, it remains unclear if the extent of improvement and the mechanisms underlying the metabolic effects of these exercise protocols are similar. Recent comparison studies reported similar cardiac risk factors alterations after aerobic or anaerobic training. However, the extent of these changes in other studies using either type of exercise varied considerably, and therefore the results cannot be considered conclusive.

No meta-analysis of the effects of aerobic and anaerobic training on coronary heart disease risk factors in people with diabetes has been published. In the general, predominantly non diabetic population, the effects of exercise training on blood pressure (Albright *et al*., 2000) [1] and lipids (Whelton *et al*., 2002) [15] are relatively modest. Greater increases in HDL cholesterol and decreases in plasma triglycerides have been seen with exercise programs that are more rigorous in terms of both volume and intensity than those that have been evaluated in diabetic subjects (Leon *et al*., 2001) [9]. Potential mechanisms through which exercise could improve cardiovascular health were reviewed by Stewart (Kraus *et al*., 2002) [17]. These include decreased systemic inflammation, improved early diastolic filling (reduced diastolic dysfunction), improved endothelial vasodilator function, and decreased abdominal visceral fat accumulation.

High levels of cholesterol in the blood can increase the risk of formation of plaques and atherosclerosis. High cholesterol can be caused by a high level of low-density lipoprotein (LDL), known as the "bad" cholesterol. A low level of high-density lipoprotein (HDL), known as the "good" cholesterol, also can promote atherosclerosis. Diabetes is associated with an increased risk of coronary artery disease. Both conditions share similar risk factors, such as obesity and high blood pressure. Excess weight typically worsens other risk factors. Lack of exercise also is associated with coronary artery disease and some of its risk factors, as well. Unrelieved stress in life may damage arteries as well as worsen other risk factors for coronary artery disease.

In particular, most of the benefit of regular exercise on cardiac risk factors in type 2 diabetes subjects is attributed to attenuation of insulin resistance. However, only a few studies have accurately assessed, the effects of aerobic training on insulin sensitivity in diabetic patients (Cuff *et al*., 2003; Yamanouchi *et al*., 1995; Tamura *et al*., 2005; Hey-Mogensen *et al*., 2010) [4, 16, 13, 7], and only one small study assessed the effects of anaerobic training. In contrast, little attention has been devoted to the potential effects of aerobic or anaerobic training on low density lipoprotein cholesterol in subjects with type 2 diabetes.

2. Methodology

2.1 Subjects and Variables

The purpose of the study is to investigate the changes on muscular endurance in response to aerobic and anaerobic training among type 2 diabetic patients. To achieve the purpose of the study 45 male type 2 diabetic patients from Ongole, in the southern state of Andhra Pradesh, India, were selected as subjects. The subjects were selected in the age group of 45 to 50 years and they were randomly assigned into three equal groups of 15 each. Experimental group-I performed aerobic training, experimental group-II performed anaerobic training and group III acted as control. Control group was restricted to participate in any specific training. The muscular endurance was selected as dependent variable (Bent Knee Sit-ups).

2.2 Training Protocol

The experimental group-I performed aerobic training alternatively three days in a week for twelve weeks. In this present investigation continuous running was given to the subjects as aerobic training. To fix the training load for the aerobic training group the subjects were examined for their exercise heart rate in response to different work bouts, by performing continuous running of two minutes duration for proposed repetitions and sets, alternating with active recovery based on work-rest ratio. The experimental group-II performed anaerobic training alternatively three days in a week for twelve weeks. The subjects were examined for their exercise heart rate in response to different anaerobic work bouts by the anaerobic exercise of 50 meters sprinting was performed for proposed repetitions and sets, alternating with rest time that enables complete recovery. The subject's training zone was computed using Karvonen formula (Karvonen, Kentala & Mustala, 1957) [18] and it was fixed at 60%HRmax to 85%HRmax. The work rest ratio of 1:1 between repetition and 1:3 between sets was given. Heart rate monitors were used to standardize exercise intensity (Polar S810i; Polar Electro, Kempele, Finland). Before entering the study, all subjects were encouraged to follow a healthy diet, according to standard recommendations for diabetic subjects (American Diabetes Association Standards of medical care in diabetes, 2011). Thereafter, patients were instructed to maintain their baseline calorie intake by consuming self-selected foods.

2.3 Statistical Technique

The data collected from the experimental and control groups on muscular endurance was statistically analyzed by paired 't' test to find out the significant differences if any between the pre and post-test. Further, percentage of changes was calculated to find out the chances in selected dependent variable due to the impact of experimental treatment. The data collected from the three groups prior to and post experimentation on muscular endurance was statistically analyzed to find out the significant difference if any, by applying the analysis of covariance (ANCOVA). Since three groups were involved, whenever the obtained 'F' ratio value was found to be significant for adjusted post-test means, the Scheffe's test was applied as post hoc test. In all the cases the level of confidence was fixed at 0.05 level for significance.

3. Result

The descriptive analysis of the data showing mean and standard deviation, range, mean differences, 't' ratio and percentage of improvement on muscular endurance of experimental and control groups are presented in table-1.

Table 1: Descriptive Analysis of the Pre and Post-test Data and 'T' Ratio on Muscular Endurance of Experimental and Control Groups

Group	Test	Mean	Standard Deviation	Range	Mean Differences	't' ratio	Percentage of Changes
Aerobic Training	Pre test	22.80	1.57	5.00	4.67	14.00	20.48%
	Posttest	27.47	2.45	8.00			
Anaerobic Training	Pre test	21.73	2.15	7.00	3.33	13.23	15.32%
	Posttest	25.07	2.66	9.00			
Control Group	Pre test	23.20	2.08	6.00	0.53	1.84	2.28%
	Posttest	22.67	2.16	6.00			

Table t-ratio at 0.05 level of confidence for 14 (df) =2.15 *Significant

Table- 1 shows that the mean, standard deviation, range and mean difference values of the pre and post-test data collected from the experimental and control groups on muscular endurance. Further, the collected data was statistically analyzed by paired't' test to find out the significant differences if any between the pre and post data. The obtained 't' values of aerobic training and anaerobic training groups are 14.00 and 13.23 respectively which was greater than the required table value of 2.15 for significance at 0.05 level for 14 degrees of freedom. It revealed that significant differences exist between the pre and post-test means of experimental groups however, no significant differences exists between the pre and post-test means of control group on muscular endurance.

The result of the study also produced 20.48% percentage of changes in muscular endurance due to aerobic training, 15.32% of changes due to anaerobic training and 2.28% of changes in control group.

The pre and post-test data collected from the experimental and control groups on muscular endurance is statistically analyzed by using analysis of covariance and the results are presented in table–2.

Table 2: Analysis of Covariance on Muscular Endurance of Experimental and Control Groups

	Aerobic training Group	Anaerobic training Group	Control Group	S o V	Sum of Squares	df	Mean squares	'F' ratio
Pre test Mean SD	22.80	21.73	23.20	B	17.24	2	8.62	2.27
	1.57	2.15	2.08	W	159.73	42	3.80	
Post-test Mean SD	27.47	25.07	22.67	B	172.80	2	86.40	14.63*
	2.45	2.66	2.16	W	248.00	42	5.91	
Adjusted Post-test Mean	27.47	25.07	22.67	B	219.42	2	109.71	85.51*
				W	52.61	41	1.28	

Table F-ratio at 0.05 level of confidence for 2 and 42 (df) = 3.23, 2 and 41 (df) = 3.23 *Significant

Table-3. shows that the pre-test means and standard deviation on muscular endurance of aerobic training, anaerobic training and control groups are 22.80 ± 1.57, 21.73 ± 2.15 and 23.20 ± 2.08 respectively. The obtained 'F' value 2.27 of muscular endurance is lesser than the required table value of 3.23 for the degrees of freedom 2 and 42 at 0.05 level of confidence, which proved that the random assignment of the subjects were successful and their scores on muscular endurance before the training were equal and there was no significant differences.

The post-test means and standard deviation on muscular endurance of aerobic training, anaerobic training and control groups are 27.47 ± 2.45, 25.07 ± 2.66 and 22.67 ± 2.16 respectively. The obtained 'F' value of 14.63 on muscular endurance was greater than the required table value of 3.23 at 2, 42 df at 0.05 level of confidence. It implied that significant differences exist between the three groups during the post-test on muscular endurance.

The adjusted post-test means on muscular endurance of aerobic training, anaerobic training and control groups are 27.47, 25.07 and 22.67 respectively. The obtained 'F' value of 85.51 on muscular endurance was greater than the required table value of 3.23 of 2, 42 df at 0.05 level of confidence. Hence, it was concluded that significant differences exist between the adjusted post-test means of aerobic training, anaerobic training and control groups on muscular endurance. Since, the obtained 'F' value in the adjusted post-test means was found to be significant, the Scheffe's test was applied as post hoc test to find out the paired mean difference, and it is presented in table-4.

Table 4: Scheffe's Post Hoc Test for the Differences among Paired Means of Experimental and Control Groups on Muscular Endurance

Aerobic Training	Anaerobic Training	Control Group	Mean Difference	Confidence Interval
27.47	25.07		1.22*	1.05
27.47		22.67	5.24*	1.05
	25.07	22.67	4.02*	1.05

*Significant at 0.05 level

As shown in table-4 the Scheffe's post hoc analysis proved that significant mean differences existed between aerobic training and anaerobic training groups, aerobic training and control groups, anaerobic training and control groups on muscular endurance. Since, the mean differences 1.22, 5.24 and 4.02 are higher than the confident interval value of 1.05 at 0.05 level of significance.

Hence, it is concluded that due to the effect of aerobic training and anaerobic training the muscular endurance of the subjects was significantly improved. It is also concluded that aerobic training is better than anaerobic training in improving muscular endurance. The pre, post and adjusted post-test mean values of experimental and control groups on muscular endurance is graphically represented in figure -1.

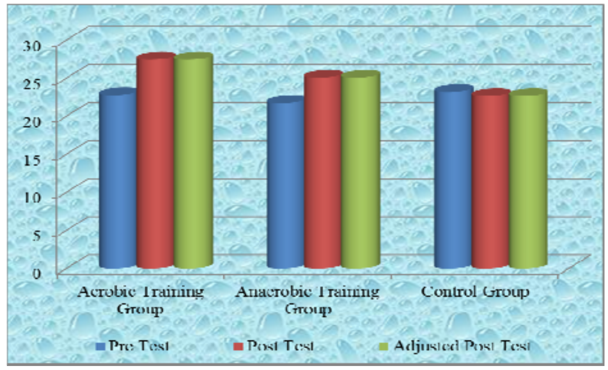

Fig 1: Bar Diagram Showing the Mean Values on Muscular Endurance of Experimental and Control Groups

4. Discussion

Use of physical activity in the form of aerobic and anaerobic exercise is widespread, with a general consensus about its beneficial effects in patients with type 2 diabetes. The therapeutic benefits include regulation of body weight, reduction of insulin resistance, enhancement of insulin sensitivity, and glycemic control. The result of the present study is in conformity with the findings of the previous research studies. It has been found that in previously sedentary individuals regularly performed aerobic and anaerobic training results in significant improvements in exercise capacity. The development of peak exercise performance is dependent upon several months to years of aerobic training. The physiological adaptations associated with these improvements in both maximal exercise performance, as reflected by increases in maximal oxygen uptake, and submaximal exercise endurance include increases in both cardiovascular function and skeletal muscle oxidative capacity.

Short-term daily conditioning protocol of aerobic exercise program induces significant improvements in both aerobic capabilities and anaerobic performance (Sartorio *et al*., 2003) [21]. The intermittent aerobic exercise produced an acute interference effect on leg strength endurance. Maximum strength was not affected by the aerobic exercise mode (DeSouza *et al*., 2007) [19].

The focus of aerobic training is to progressively overload the cardio respiratory system and not the musculoskeletal system. In response to an aerobic training program, Type I and II muscle fibers have been shown to remain the same (Bell *et al*., 2000; McCarthy *et al*., 2002) [25, 26], increase (Nelson, 1990) [27], and decrease in size (Kraemer *et al*., 1995). More consistent and well documented adaptations to aerobic training include increases in capillary and mitochondrial densities (Crenshaw, 1991) [28] as well as oxidative enzyme activity (Bell, 2000; Nelson, 1990) [25, 27] all of which contribute to the enhanced delivery, extraction, and utilization of oxygen by skeletal muscle. In conclusion, although 12-week aerobic and anaerobic exercise program in addition to conventional cares of patients with type-2 diabetes mellitus produce significant improvement on coronary heart disease risk factors and health related physical fitness components over those receiving conventional cares only, its inclusion will be beneficial on longer duration. The outcomes of this study suggest inclusion of an aerobic and anaerobic exercise program into the routine management of patients with type 2 diabetes could be beneficial.

5. Conclusion

It is also concluded that Due to the effect of aerobic training and anaerobic training the muscular endurance of the diabetic patients was significantly improved. It is also concluded that aerobic training is better than anaerobic training in improving muscular endurance. The result of the study produced 20.48% percentage of changes due to aerobic training and 15.32% of changes due to anaerobic training in muscular endurance of the diabetic patients.

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