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Effect of aerobic exercise versus resistance exercise on body mass index in obese patients with type 2 diabetes mellitus

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Abstract
Materials and Methodology: Obese with type 2 diabetes mellitus patients (n=24)both the male and female, age group 39-55yrs were included in this study and patient with current insulin therapy, any exercise therapy from previous 6 months, blood pressure >160/95mmHg and any musculoskeletal, cardiovascular or neurological condition were excluded from the study. A comparative study was done where two groups were made, Group A (n=12) received Aerobic exercise and Group B (n=12) received Resistance exercise. Exercise was given for 3 times a week for 16 weeks. Outcome measures were Body Mass Index and Skinfold Caliper.
Aerobic exercise and Resistance exercise both were effective for reducing Body Mass Index in obese with type 2 Diabetes mellitus. But There were significant changes on BMI (p<0.001) in the Aerobic exercise group as compare to Resistance exercise group, But there were no significant changes seen in the skinfold thickness on both the groups.
The study concluded that Aerobic exercise is more effective than Resistance exercise on obese in patients with type 2 DM.

Keywords: Exercise, aerobic, resistance, obesity, type 2 DM Diabetes Mellitus, BMI body mass index, skinfold thickness

Introduction
World Health Organization (WHO) has defined overweight and obesity as 'abnormal or excessive fat accumulation that may impair health [1]. Obesity is one of the most common public health problem in both developed and developing countries [2]. Diabetes mellitus (DM) is defined as a heterogeneous metabolic disorder characterized by common feature of chronic hyperglycaemia. In India, it's incidence is estimated at 7% of adult population (approximately 65% million affected people), largely due to genetic susceptibility combined with changing life style of low activity and high calorie diet. DM is classified into two groups:
Type 1 DM: It constitute about 10% cases of DM. Also known as insulin-dependent DM (IDDM)
Type 2 DM: It constitutes about 80% cases of DM. Also known as Non – insulin dependent [3]
Type 1 diabetes mellitus (T1DM) is a chronic autoimmune disease characterized by increased blood glucose levels (hyperglycemia), which are due to the insulin deficiency that occurs as the consequence of the loss of the pancreatic islet beta –cells [4].
Type 2 diabetes mellitus (T2DM) is a chronic illness marked by decreased insulin sensitivity and overall poor glucose control. A universally accepted component of the nonpharmacologic treatment for Type2DM is exercise [5].
Exercise training may improve insulin action via changes in regional adipose tissue (AT) deposition, a recognized predictor of risk for type 2 diabetes and cardiovascular disease [6].
Resistance exercise: Resistance exercise is an activity in which dynamic and static muscle contraction is resisted by an outside force applied manually or mechanically.

Aerobic exercise
Aerobic exercise is any bodily movement produced by the contraction of skeletal muscles that result in a substantial increase over resting energy expenditure [7].

Aerobic exercise refers to activities such as walking or jogging with continuous, repetitive movement of large muscle groups for at least 10 minutes at a time. Aerobic exercise may modify the insulin action of each fiber without increasing fiber size [8].

Resistance Exercise

The benefits of resistance exercise are not limited to enhanced glucose control but also include the maintenance and improvement of muscular strength, endurance, and power. In addition, increases in tissue mass are possible if the resistance exercise induces high muscle forces [9]. The greatest force production stimulus to increase muscle size and strength is possible when an external force exceeds that of the muscle and the muscle lengthens eccentrically. Eccentric muscle contractions can result in 2 to 3 times greater force production than more- traditional isometric or concentric muscle contractions. Additionally, this high force production occurs at the lowest metabolic cost, making eccentric-induced, negative work resistance exercise less difficult for individuals to perform [10]. Some researchers reported that regular exercise helps to reduce TG, TC, LDL, BMI, body mass, body fat and increase HDL, Body mass and BMR [11].

Obesity

Obesity is defined as an excess of body fat. Body fat is difficult to measure. However, increased body fat is usually accompanied by increased total body mass, so indices of relative weight are commonly used to diagnose obesity and to track progress in the treatment of the obese person [12]. One of the most commonly used indices of relative weight is body mass index (BMI; sometimes referred to as the Quetelet index) [13].

Body Mass Index (BMI)

BMI (body mass in kilograms divided by height, or meters, squared) was not originally intended as an index of obesity but is now commonly employed as such in epidermiologic studies, where it accurately predicts obesity related morbidity and mortality [14]. The epidemiology of obesity has for many years been difficult to study because many countries had their own specific criteria for the classification of different degrees of overweight. Gradually during the 1990s, however, the body mass index (BMI; weight/height^2) become a universally accepted measure of the degree of overweight and now identical cut-points are recommended. This most recent classification of overweight in adults by the World Health Organization is shown in table 1.1 [15].

Table 1: WHO classification of overweight and obesity [15].

Classification	BMI(kg/m^2)	Associated health risks
Underweight	<18.5	Low
Normal range	18.5-24.9	Average
Overweight	25.0 or higher	
Pre-obese	25.5-29.9	Increased
Obese class 1	30.0-34.9	Moderately increased
Obese class 2	35.0-39.9	Severely increased
Obese class 3	40 or higher	very severely increased

There are many studies showing the effect of aerobic exercise and resistance exercise on glycemic level in type 2 DM patients. But there is no study done to compare the effects of aerobic exercise versus resistance exercise on BMI in obese patient with type 2DM so therefore for the depth of knowledge there was a need to carry out the study.

Objectives

1. To find out the effect of aerobic exercise on BMI in obese with type 2 DM.
2. To find out the effect of resistance exercise on BMI in obese with type 2 DM.
3. To compare the effect of aerobic exercise and resistance exercise on BMI in obese with type 2DM.

Materials and Methods

An approval for the study was obtained from the Institutional Ethical Committee. An experimental study was conducted in obese with type 2 Diabetes mellitus patients. Sample was achieved by Purposive Sampling method. All the subjects were screened for inclusion criteria i.e. Both the Male and Female with the age group 39-55yrs and obese (BMI 25-30) with type 2 Diabetes mellitus after 3 years of diagnosed were included in this study and patient with current insulin therapy, any exercise therapy from previous 6 months, blood pressure >160/95mmHg and any musculoskeletal, cardiovascular or neurological condition were excluded from the study. Subjects were divided into two groups with: Group A=12 subjects Group B=12 subjects. Subjects were briefed about the nature of the study and intervention. The demographic data including age, gender height, weight, heart rate, BSL values, BMI and skinfold thickness values was collected through data sheet. Subject was given written consent prior to the intervention. Group A (n=12) subjects received Aerobic exercise and Group B (n=12) subjects received Resistance exercise. The data was collected pre-treatment and post-treatment by calculating Body Mass Index (BMI) and Using Skinfold calliper. Exercise was given 3 times a week for 16 weeks.

Group A - Aerobic Exercise.

Mode-Static bicycle.

Frequency- 3 times per week.

Duration- Start from 20 min per session (at 60% of maximum heart rate) to 60 min per session (at 75% of maximum heart rate) required heart rate was calculated by the karvonen formula.

Group B- Resistance exercise

Frequency- 3 times per week

Intensity-Training was started during weeks 1 and with intensity 60% (1RM) was progressed to intensity 75%-80% (1RM).

Number of sets was 1-2 during first month

Mode- This program was included of 7 different exercises for upper and lower body.

Participants performed 3 sets of 8-10 repetitions (with a 90-120 sec rest between sets).

Bicep curls, triceps push-down, abdominal crunches, squats, lunges, plank, triceps dips, push-ups.

Analysis and Interpretation of data:

The researcher conducted a study on effects of aerobic exercise versus resistance exercise on BMI in obese patient with type 2DM. For the purpose of this study the researcher collected data on 24 adults of Wanless Hospital Miraj.

Analysis of Data

Data analysis was performed with SPSS version 20.0. Paired t test was done to compare different variables of patients undergoing aerobic and resistance exercises. Following results were obtained.

Level of Significance

There were significant changes on BMI ($p< 0.001$) in the

Aerobic exercise group as compared to Resistance exercise group. Effectiveness on Body Mass Index (BMI) in both the groups was observed.

Findings of the statistical analysis have been shown in the following tables.

Table 2: Descriptive statistics of different variables of patients undergoing aerobic and resistance exercises

Sr. No.	Group	Variables	N	Mean	Std. Deviation	t statistic	p value
1	Aerobic exercise	Weight pre	12	67.25	2.53	13.01	<0.001
		Weight post	12	63.92	2.71		
	Resistance exercise	Weight pre	12	67.25	3.67	9.00	<0.001
		Weight post	12	65.00	3.69		
2	Aerobic exercise	BMI pre	12	29.13	0.88	7.19	<0.001
		BMI post	12	27.85	0.98		
	Resistance exercise	BMI pre	12	29.82	0.65	5.68	<0.001
		BMI post	12	28.86	0.75		
3	Aerobic exercise	Chest pre	12	-1.05	0.10	2.97	0.01
		Chest post	12	-1.07	0.11		
	Resistance exercise	Chest pre	12	-1.11	0.08	3.29	0.01
		Chest post	12	-1.15	0.07		
4	Aerobic exercise	Midaxillary pre	12	-1.07	0.08	2.04	0.07
		Midaxillary post	12	-1.08	0.09		
	Resistance exercise	Midaxillary pre	12	-1.09	0.07	3.96	<0.001
		Midaxillary post	12	-1.11	0.07		
5	Aerobic exercise	Subcapular pre	12	-0.96	0.18	2.87	0.02
		Subscapular post	12	-0.99	0.19		
	Resistance exercise	Subcapular pre	12	-1.01	0.20	1.46	0.17
		Subscapular post	12	-1.04	0.19		
6	Aerobic exercise	Tricep pre	12	-1.18	0.36	0.51	0.62
		Triceps post	12	-1.23	0.40		
	Resistance exercise	Tricep pre	12	-1.03	0.10	6.00	<0.001
		Triceps post	12	-1.09	0.10		
7	Aerobic exercise	Thigh pre	12	-0.80	0.39	0.36	0.73
		Thigh post	12	-0.83	0.34		
	Resistance exercise	Thigh pre	12	-0.73	0.12	4.03	<0.001
		Thigh post	12	-0.82	0.12		
8	Aerobic exercise	Suprailiac pre	12	-0.86	0.10	5.03	<0.001
		Suprailiac post	12	-0.97	0.12		
	Resistance exercise	Suprailiac pre	12	-0.87	0.11	4.98	<0.001
		Suprailiac post	12	-0.93	0.13		
9	Aerobic exercise	Abdomen pre	12	-0.81	0.09	5.14	<0.001
		Abdomen post	12	-0.93	0.11		
	Resistance exercise	Abdomen pre	12	-0.78	0.12	8.41	<0.001
		Abdomen post	12	-0.87	0.12		

Paired t test was done to compare different variables of patients undergoing aerobic and resistance exercises. Following results were obtained:

- Aerobic and resistance exercises both were significantly effective in reduction of weight ($p< 0.001$).
- Aerobic and resistance exercises both were significantly effective in reduction of BMI ($p< 0.001$).
- Skinfold thickness of chest of type II DM patient's receiving aerobic and resistance exercises both were significantly lower (p=0.01).
- Skinfold thickness of midaxillary of type II DM patient's receiving aerobic and resistance exercises ($p< 0.001$) both were lower.
- Skinfold thickness of subcapular of type II DM patient's receiving aerobic (p=0.02) and resistance exercises both were lower.
- Skinfold thickness of tricep of type II DM patient's receiving aerobic and resistance exercises ($p<0.001$) both were lower.
- Skinfold thickness of thigh of type II DM patient's receiving aerobic and resistance exercises ($p<0.001$) both were lower.
- Skinfold thickness of suprailiac of type II DM patient's receiving aerobic and resistance exercises both were significantly lower ($p<0.001$).
- Skinfold thickness of abdomen of type II DM patient's receiving aerobic and resistance exercises both were significantly lower ($p<0.001$).

Table 3: Descriptive statistics of different variables of patients

Variables	Group	N	Mean	Std. Deviation	t statistic	p value
Age	Aerobic exercise	12	47.58	3.96	0.44	0.67
	Resistance exercise	12	48.25	3.47		
Height	Aerobic exercise	12	1.52	0.03	1.32	0.20
	Resistance exercise	12	1.50	0.04		
Weight	Aerobic exercise	12	67.25	2.53	0.00	1.00
	Resistance exercise	12	67.25	3.67		
BMI pre	Aerobic exercise	12	29.13	0.88	2.17	0.04
	Resistance exercise	12	29.82	0.65		
Chest pre	Aerobic exercise	12	-1.05	0.10	1.43	0.17
	Resistance exercise	12	-1.11	0.08		
Midaxillary pre	Aerobic exercise	12	-1.07	0.08	0.79	0.44
	Resistance exercise	12	-1.09	0.07		
Subcapular pre	Aerobic exercise	12	-0.96	0.18	0.70	0.49
	Resistance exercise	12	-1.01	0.20		
Tricep pre	Aerobic exercise	12	-1.18	0.36	1.36	0.20
	Resistance exercise	12	-1.03	0.10		
Thigh pre	Aerobic exercise	12	-0.80	0.39	0.53	0.60
	Resistance exercise	12	-0.73	0.12		
Suprailiac pre	Aerobic exercise	12	-0.86	0.10	0.06	0.95
	Resistance exercise	12	-0.87	0.11		
Abdomen pre	Aerobic exercise	12	-0.81	0.09	0.70	0.49
	Resistance exercise	12	-0.78	0.12		
Weight post	Aerobic exercise	12	63.92	2.71	0.82	0.42
	Resistance exercise	12	65.00	3.69		
BMI post	Aerobic exercise	12	27.85	0.98	2.85	0.01
	Resistance exercise	12	28.86	0.75		
Chest post	Aerobic exercise	12	-1.07	0.11	2.10	0.05
	Resistance exercise	12	-1.15	0.07		
Midaxillary post	Aerobic exercise	12	-1.08	0.09	0.87	0.39
	Resistance exercise	12	-1.11	0.07		
Subscapular post	Aerobic exercise	12	-0.99	0.19	0.68	0.51
	Resistance exercise	12	-1.04	0.19		
Triceps post	Aerobic exercise	12	-1.23	0.40	1.25	0.24
	Resistance exercise	12	-1.09	0.10		
Thigh post	Aerobic exercise	12	-0.83	0.34	0.03	0.97
	Resistance exercise	12	-0.82	0.12		
Suprailiac post	Aerobic exercise	12	-0.97	0.12	0.87	0.40
	Resistance exercise	12	-0.93	0.13		
Abdomen post	Aerobic exercise	12	-0.93	0.11	1.32	0.20
	Resistance exercise	12	-0.87	0.12		

Paired t test was done to compare different variables of patients undergoing aerobic and resistance exercises.

Above table depicts that, aerobic exercises were more effective than resistance exercise in reducing BMI (p=0.01).

Skinfold thickness of chest of patients doing aerobic exercise (-1.07) was significantly higher than patients doing resistance exercise (-1.15).

- There was no significant difference between skinfold thickness of midaxillary of type II DM patient's receiving aerobic and resistance exercises before and after doing exercise (p>0.05).
- There was no significant difference between skinfold thickness of Subcapular of type II DM patient's receiving aerobic (p-0.02) and resistance exercises before and after doing exercise (p>0.05).
- There was no significant difference between skinfold thickness of Tricep of type II DM patient's receiving aerobic and resistance exercises before and after doing exercise (p>0.05).
- There was no significant difference between skinfold thickness of Thigh of type II DM patient's receiving aerobic and resistance exercises before and after doing exercise (p>0.05).
- There was no significant difference between skinfold thickness of suprailliac of type II DM patient's receiving aerobic and resistance exercises before and after doing exercise (p>0.05).
- There was no significant difference between skinfold thickness of abdomen of type II DM patient's receiving aerobic and resistance exercises before and after doing exercise (p>0.05).

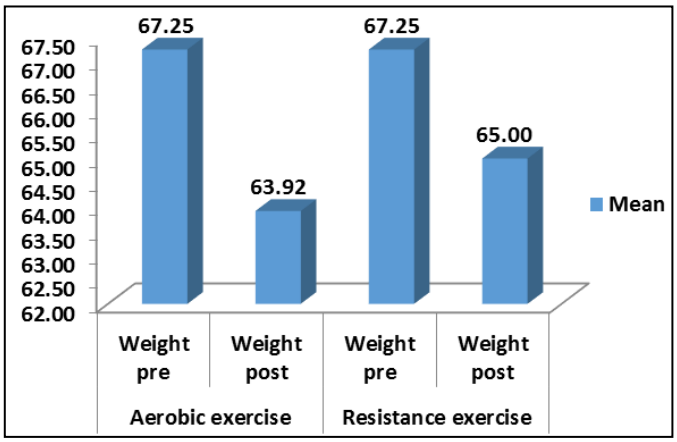

Fig 1: Weight of patients after aerobic and resistance exercise

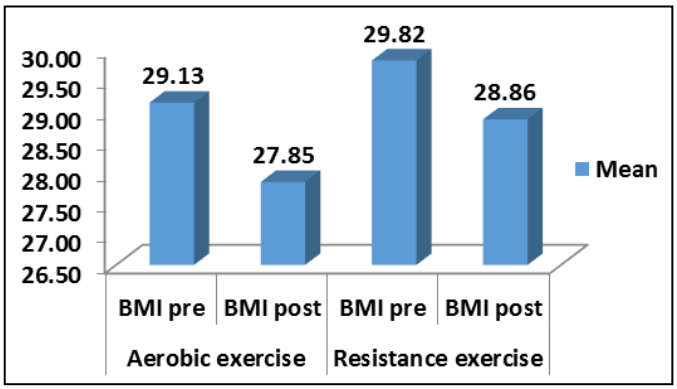

Fig 2: BMI of patients after aerobic and resistance exercise

Discussion on Findings

Our study shows the Aerobic exercise (Group A) and Resistance exercise (Group B) were effective for reducing Body Mass Index (BMI) in obese with type 2 Diabetes mellitus (DM). But the effectiveness with Aerobic exercise was much greater as compared to Resistance exercise. There were significant changes on BMI (p<0.001) in the Aerobic exercise group as compared to Resistance exercise group. Effectiveness on Body Mass Index (BMI) in both the groups was observed. But there were no significant changes seen in the skinfold thickness in both the groups.

It is very important to perform Aerobic exercise at specific intensity to obtain the proper effect and benefit. While prescribing exercise programme, it is crucial to monitor appropriate exercise intensity during the whole programme. Exercise intensity should be kept in proper training heart zone. 50-60% of MHR (maximum heart rate) is effective to reduce body fat and this zone is called as 'healthy heart zone' or 'fat burning zone'. Exercise intensity of 60-70% of MHR is required to maintain cardiovascular fitness and this zone is called as 'fitness zone'. 70-80% of MHR is called as 'aerobic zone' which increase the vital capacity. 80-90% of MHR is required for anaerobic zone which improves endurance. 90-100% of MHR is redline zone [17].

Loss of visceral fat may be an important benefit of exercise that leads to a significant improvement in metabolic indices [17]. Yavari A *et al*, showed that, Both Aerobic the combination training group showed a statistically significant improvement in BMI (p=0.044)

Waist circumference decreased in people who adhere to diet and aerobic exercise for 60 to 90 minutes in 5 to 7 days a week due to the increase in VO2 max and HDL levels. Most of the studies recommended aerobics compared to other type of exercise because physical activity significantly reduces body fat content for treatment of heart disease [18]. Ayse Sarsan *et al*, reported that 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 mass [19]. Another study has investigated that aerobic exercise alone results in clinically significant body weight loss in men and women [20].

Some previous study concluded that Aerobic exercise may be associated with greater BMI reduction and better physical fitness than resistance exercise [16]. The biological mechanism underlying this difference is unclear. A possible explanation is that resistance exercise mainly increases in size and strength of muscles, while aerobic exercises forces the body to burn the stored fat for energy. Aerobic exercise may also enhance the strength of respiratory muscles and thus facilitate the body's utilization of oxygen [21]. Hwi Ryun kwon *et al*, concluded that aerobic exercise appears to be beneficial than resistance exercise for improving endothelial function in T2DM [22].

Elsner *et al*. (1990) also found that properly hydrated skin is "stiffer" and less elastic. This current skinfold measurement recommendation is not based on after exercises instead it is based on research by keys and brozek (1953) in which skinfold thickness is related to the accumulation of extracellular water in the subcutaneous tissue caused by peripheral vasodilatation (edema) [23].

Golding *et al*. (1998) and Heyward (2002) stated that skinfold measurements should not be taken immediately after exercise because it would inflate the normal skinfold thickness due to increased extracellular water in the subcutaneous tissue caused by peripheral vasodilatation [24]. Our study also showed no significant differences between the pre and post exercise skinfold thickness values.

Conclusions

This study concluded that Aerobic exercise and Resistance exercise both were effective in reducing BMI in obese patients with type 2 diabetes mellitus. But after the comparison it showed that Aerobic exercise was statistically more effective than the Resistance exercise on BMI in obese patients with type 2 diabetes mellitus. But there were no significant changes seen in the skinfold thickness in both the groups.

Limitations and Suggestions

Limitation of the study is that, Small sample size in both the groups and the small size of obesity criteria may limit the possibility of generalization of the finding in the present study. Taking skinfold measurement after exercise was not different, it could be difficult to pinch and maintain a good fold during the post skinfold measurement. It is due to heavy sweating. Therefore, before taking post skinfold measurement use towel to dry the skin. Our results are limited to these two outcomes measurements while it is possible that Further, research might be carried out by assessing more outcome measurement to see the effects of both the exercises.

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Ethical Clearance: Ethical clearance obtained from the ethical committee of College of Physiotherapy, Winless Hospital, Miraj.

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