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Efficacy of Circuit Weight Training on Exercise Tolerance in Type 2 Diabetes Mellitus Subjects

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***Abstract*: *Background:* To study and find the efficacy of circuit weight training on exercise tolerance in type 2 diabetes mellitus subjects. *Methods:* Ethical clearance was taken from the Institutional Ethical Committee. This study was carried out by analysing total 30 subjects with type 2 DM between the age group of 45 TO 55 years. The participants were divided into experimental and control group by random sampling. The experimental group was given circuit weight exercising for 8 weeks 3-4 times a week for 45-50 minutes. Borg's scale was used to check the exercise tolerance before and after the intervention. *Result:* There was an observed increase in the mean exercise tolerance parameters of the exercise group at the end of the 8 weeks. Statically the patients who were given circuit weight training showed there was extremely significant difference ($p<0.0002$) whereas in the control group it was not significant (p value0.4716). There was a considerable decrease in the systolic blood pressure of the exercise group and the control group remained steady. There was a considerable decrease in the mean heart rate of the exercise group and the control group remained steady. *Conclusion:* This study concludes that circuit weight exercise 2-3 times a week is useful to improve the exercise tolerance. It also prevents further complications and helps improve the quality of life. It also reduces the risk of cardiovascular diseases.**

***Keywords*: circuit weight, type 2 diabetes mellitus, insulin.**

1. Introduction

Type 2 DM (formerly known as non-insulin dependent DM) is the most common form of DM characterized by hyperglycaemia, insulin resistance, and relative insulin deficiency. It is assessed that 366 million people by 2030 will raise to 552 million. There are 80% of diabetes mellitus people living in low and middle- income countries. People living with type 2 DM are more vulnerable to various forms of both short- and long-term complications, which often lead to their premature death. There is a strong inheritable genetic connection in type 2 DM, having relatives (especially first degree) with type 2 DM increases the risks of developing type 2 DM substantially among monozygotic twins is close to 100%, and about 25% of those with the disease have a family history of DM [1].

The pathophysiology of type 2 diabetes mellitus is categorized by peripheral insulin resistance, impaired regulation of hepatic glucose production, and declining b-cell function which leads to b-cell failure.

A. The β-cell

β-Cell dysfunction is initially characterized by an impairment in the first phase of insulin secretion during glucose stimulation and may occur before the onset of glucose intolerance in type 2 diabetes [10]. Skeletal muscle, adipose tissue and liver are the three main extra-pancreatic insulin-sensitive organs that play major roles in the abovementioned processes. The development of systemic IR is due to defective action of insulin in these tissues, thus progressively leading T2DM [3].

B. The Liver

The ability of insulin to suppress hepatic glucose production both in the fasting state and postprandially is normal in first degree relatives of type 2 diabetic patients (26). It is the increase in the rate of postprandial glucose production that heralds the evolution of IGT (52). Eventually, both fasting and postprandial glucose production increase as type 2 diabetes progresses [10].

Risk factors for type 2 diabetes include older age, obesity, family history of diabetes, and inactivity. Of these, obesity and physical inactivity are changeable factors that are amenable to exercise. The major factor of type 2 diabetes mellitus is physical inactivity. Insulin sensitivity and glycemic control among nondiabetic individuals has shown improvement due to increase in physical activity. Also, in impaired glucose tolerance or overt type 2 diabetes. There are high rates of cardiovascular disease in patients with type 2 diabetes hence, exercise programs are particularly important to reduce risk factors for vascular complications [4]. The reduced exercise tolerance and with respect to gender and age-matched, sedentary, obese, non-diabetic subjects 20%- 30% reduction in VO2 peak is the sign of impaired cardiorespiratory fitness in T2DM(>5years) [9].

Insulin and exercise increase skeletal muscle glucose uptake by translocation of glucose transporter 4 (GLUT4), the predominant GLUT in muscle, from an intracellular location to the plasma membrane. Insulin and exercise stimulate GLUT4 translocation through distinct signalling mechanisms. Insulin signalling contains rapid phosphorylation of the insulin receptor, insulin receptor substrate-1/2 on tyrosine residues, and the activation of phosphatidylinositol 3-kinase [11].

The emergence of resistance training programs such as circuit weight training (CWT) as a popular exercise alternate

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has prompted increased interest concerning its benefits to both physical and metabolic fitness. Circuit weight training is the series of weight training exercises which contains moderate weight loads and frequent repetitions interspersed with short rest periods. A well-designed CWT programs commonly involves both upper and lower body muscle group exercises, which may not be readily possible in many aerobic activities such as walking and cycling5. Circuit weight training programs have been proved to improve strength and cardiovascular fitness but have not yet been associated with type 2 diabetes. The duration of the Circuit weight training program is 60 minutes including 10 minutes of warm-up and 10 minutes of cool down period. This are moderate weight exercises. The load is determined by 1RM (repetitive maximum) and 50% of the weight is used initially. The exercises are leg extension bench press, leg curl, dumbbell biceps curls, behind neck pulldown, calf rise, dumbbell overhead press, seated rowing, forearm extension using pulley (triceps) and abdominals curls. This aim of the study is to determine the efficacy of the circuit weight training on exercise tolerance of type 2 diabetes mellitus.

2. Materials and Methodology

The study was experimental pre/post study design. The study was conducted in Krishna hospital. 30 subjects with type 2 diabetes mellitus were selected by random sampling method by formula n = (Za+ ZB)2* (s12 + s22) / (m2- m1)2 for the study. Subjects with the age between 45-55 years and with the history of type 2 diabetes mellitus for past 10 years were included. Subject with any other comorbidities, decreased range of motion that limits the mobility and participation in activities like yoga, sports etc., were excluded. Written consent form was obtained from all the subjects. This study was approved by the ethical committee of the institution.

A. Outcome Measures

1) Minute walk test

- The distance is measured in meters.
- Heart rate was calculated before and after test by using pulse oximeter.
- Blood pressure was measured by sphygmomanometer before and after test.
- Saturated oxygen was measured by pulse oximeter before and after test.
- Rate of perceived exertion was measured by Borg's scale.

B. Procedure

An ethical clearance will be obtained from the institutional ethical committee. The study is conducted in Krishna hospital Karad. The purpose and procedure of the study were explained to the subjects. Eligible participant was randomised in to two group (simple random sampling) written informed consent were obtained from the participants. A brief demographic data with all the necessary information were obtained from the participants prior to the assessment. Pre assessment were done by using outcome measure. The subjects were divided into 2 groups as group A (Control group) and group B (experimental group). The experimental group will be given the set of exercises which will be conducted alternate days. Prior to the exercise session, warmup was done for 10 minutes. The exercise session was of 40 minutes with 1 minute of rest period. Post assessment were done by using outcome measure followed by statistical analysis of the data.

3. Result

Table 2 shows the mean demographic information about the subjects. Table 3 and 4 shows statistical mean values of the control group and experimental group parameters used in 6 minute walk test taken at the start and end of the study. The heart rate has reduced in the experimental group which was 78 ± 3.15 beats/min at the start of the test and has reduced to 76 ± 2.90 beats/min at the end of the test after 8 weeks. The mean heart rate of the control group slightly increased from 80±3.37 beats/min to 83±3.56 beats/min with p value of 0.1036 which is considered not significant.

The mean systolic blood pressure of the experimental group has decreased at the end of the 8 weeks. At the beginning of the test was 125 ± 1.37mmHg and at the end of the test was 123 ± 1.29mmHg with significant p value of 0.002 by paired t test. In the control group, increased systolic blood pressure has been

Table 1

1.	Warmup	Stretching exercises, stationery cycle (without workload).	10 minutes
2.	Circuit weight training	leg extension, bench press, leg curl, dumbbell biceps curls, behind neck pulldown, calf raise, dumbbell, overhead press, seated rowing, forearm extension using pulley (triceps), abdominals curls.	40 minutes
3.	cooldown	Side stretches, lunges, wrist elbow (flexion, extension), stationery cycle (without workload).	5-10 minutes.

Table 2

Variables	Control group		Experimental group	
	Males	Females	Males	Females
Height	1.71±3.08	1.61±2.97	1.74±3.42	1.61±2.06
Weight	82.66±3.46	72.56±5.39	83.85±4.52	68.12±3.98
Age	48.73± 3.55		51.00 ± 3.09	

Table 3

Group A (Control)	Pre test (Mean ± SD)	Post test (Mean ± SD)	t value	p value
Heart rate	80 ± 3.37	83 ± 3.56	1.682	0.1036
Systolic blood pressure	125 ± 1.89	126 ± 1.47	1.782	0.0856
Diastolic blood pressure	81 ± 1.44	82 ± 1.66	1.877	0.0719
SpO2	97 ± 1.08	98 ± 0.77	2.003	0.0557
Distance (m)	499.73 ± 43.39	488.13 ± 43.67	0.729	0.4716
Dyspnea	12 ± 2.18	13 ± 1.92	1.286	0.2097

Table 4

Group B (Experimental)	Pre test (Mean ± SD)	Post test (Mean ± SD)	t value	p value
Heart rate	78 ± 3.15	76 ± 2.90	2.105	0.0444
Systolic blood pressure	125 ± 1.37	123 ± 1.29	4.003	0.002
Diastolic blood pressure	83 ± 0.94	81 ± 1.32	2.203	0.0360
SpO2	97 ± 1.10	98 ± 1.03	2.054	0.0495
Distance (m)	485.53 ± 33.72	52973 ± 22.84	4.203	0.0002
Dyspnea	11± 1.95	9± 2.13	3.568	0.0013

observed from 125± 1.89mmHg to 126± 1.47mmHg with the statistical p value of 0.008.

The mean diastolic blood pressure in the experimental group was 83±0.94mmHg at the beginning and 81± 1.32mmHg at the end of the 8 weeks with the significant p value of 0.003 by paired t test, where as in the control group the diastolic blood pressure was increased in the post test by 1.77mmHg and the statistical p value is not significant (0.071).

The mean SpO2 of the experimental group was 97± 1.10% at the beginning and 98± 1.03% at the end with the significant p value of 0.04. whereas the control group has minor increase in the mean SpO2 at the end with p value of 0.055 which was considered not significant.

The mean rate of perceived exertion in the control group from 12± 2.18 at the beginning and 13± 1.92 at the termination of the 8 weeks with the p value of 0.209 which is not significant. The mean rate of perceived exertion was reduced in the experimental group which was 11± 1.95 at the beginning and 9± 2.13 at the end of the 8 weeks with extremely significant p value of 0.001 by paired t test.

4. Discussion and Conclusion

This study 'efficacy of circuit weight training on exercise tolerance in type 2 diabetes mellitus subjects' investigated the efficacy of 8 weeks protocol of circuit weight training on the exercise tolerance in type 2 DM subjects. The results obtained from the present study shows that the exercise tolerance has increased by circuit weight training.

Rana A. et al has demonstrated that circuit weight training on type 2 diabetes subjects and has shown significant effect in 6 minute walk test. The pre test mean of 6MWD in the experimental group was 368.8± 36.61mts and post test mean of 6MWD of experimental group was 385.53 ±42.71mts. The mean difference was 23.77mts (p=0.02) [13].

In the study of Alessandro Domingues Heubel et al concluded that there was significant effect of the circuit weight training on the 6 minute walk test in type 2 Diabetes Mellitus subjects. Pre test mean distance of the experimental group was 480mts [401-533mts] and post test mean distance of the experimental group was 511mts [478-562mts] (p=0.009) [14].

In this present study, the Pre test mean of 6MWD in experimental group was 485.53 ± 33.72mts and post test mean of 6MWD in the experimental group was 529.73 ± 22.84mts. The mean difference was 41.30mts (p=0.002). Resistance weight training program improves measures of workload and exercise tolerance as well functional status in patients with type 2 diabetes mellitus. Enhancements in the sympathetic response, autonomic heart rate control and variability occur. The improvement in endurance have been found to be accompanied by physiological changes, such as improved muscle function which includes more rapid oxygen uptake kinetics and altered breathing pattern that is higher tidal volume and lower breathing frequency.

D.W. Dustan et al concluded that short term circuit weight training in type 2 diabetes subjects has shown a significant effect on the heart rate. The pretest mean heart rate of the CWT group (experimental group) was 77±3 beats/min and posttest mean heart rate were 76± 2.5 beats/min (p=0.05) [5]. This present study has shown significant result in the pre test mean heart rate was 78±3beats/min and post test mean heart rate were 76±2.9 beats/min (p=0.04) in the experimental group. Resistance weight training suppresses sympathetic activity and there is increase in the autonomic nervous activity which increases vagus nerve activity resulting in decreased heart rate.

D.W. Dustan et al concluded that circuit weight training has shown a significant effect on the blood pressure in type 2 diabetes subjects. The post test mean systolic blood pressure was 126±3 mmHg has the significant p value of 0.05 and diastolic blood pressure was 73±2mmHg with p value 0.05 in the experimental group. The present study has shown significant result on the post test mean systolic blood pressure 127±2mmHg and p value was 0.002 and diastolic blood pressure was 81±1mmHg and p value was 0.003 in the experimental group.

The resistance training improvises an endothelial function which contributes in exercise induced decrease in blood pressure by activating endothelial nitric oxide synthase and increasing physiological levels of nitric oxide production, which has a key role controlling vascular tone, lowering blood pressure.

In this present study, circuit weight training in type 2 diabetes mellitus subjects has shown significant improvement on the mean oxygen saturation and rate of perceived exertion (RPE) of the experimental group. The pre test mean of oxygen saturation was 97 %± 1.10% and post test mean oxygen saturation was 98% ± 1.03% with the significant p value of 0.04. The pre test mean of RPE was 11±1.95 (according to Borg's scale) and post test mean RPE of the experimental group was 9± 2.13 with the significant statistical p value of 0.001. It has been studied that during resistance exercise there is increase in respiratory rate and heart rate which results into increased oxygen consumption and more oxygen is supplied to muscle which improves the oxygen saturation.

The result of the present study suggests that circuit weight training is more effective on exercise tolerance in type 2 diabetes subjects.

References

[1] Olokoba AB, Obateru OA, Olokoba LB. Type 2 diabetes mellitus: A review of current trends. Oman medical journal. 2012 Jul;27(4):269.

[2] Mehta SR, Kashyap AS, Das S. Diabetes mellitus in India: The modern scourge. Medical journal armed forces India. 2009 Jan 1;65(1):50-4.
[3] Galicia-Garcia U, Benito-Vicente A, Jebari S, Larrea-Sebal A, Siddiqi H, Uribe KB, Ostolaza H, Martín C. Pathophysiology of type 2 diabetes mellitus. International journal of molecular sciences. 2020 Jan;21(17):6275.
[4] Chipkin SR, Klugh SA, Chasan-Taber L. Exercise and diabetes. Cardiology clinics. 2001 Aug 1;19(3):489-505.
[5] Dunstan DW, Puddey IB, Beilin LJ, Burke V, Morton AR, Stanton KG. Effects of a short-term circuit weight training program on glycaemic control in NIDDM. Diabetes research and clinical practice. 1998 Apr 1;40(1):53-61.
[6] Williams, P. A., & Cash, T. F. (2001). Effects of a circuit weight training program on the body images of college students. International Journal of Eating Disorders, 30(1), 75-82.
[7] American Diabetes Association; Diabetes Mellitus and Exercise. Diabetes Care 1 January 2002; 25 (suppl_1): s64.
[8] Samuel S Gidding, Rodrigo Nehgme, Charles Heise, Carol Muscar, Annie Linton, Sandra Hassink: Severe obesity associated with cardiovascular deconditioning, high prevalence of cardiovascular risk factors, diabetes mellitus/hyperinsulinemia, and respiratory compromise, The Journal of Pediatrics, Volume 144, Issue 6, 2004, pp. 766-769.
[9] Nesti L, Pugliese NR, Sciuto P, Natali A. Type 2 diabetes and reduced exercise tolerance: a review of the literature through an integrated physiology approach. Cardiovascular Diabetology. 2020 Dec;19(1):1-7.
[10] Mahler RJ, Adler ML. Type 2 diabetes mellitus: update on diagnosis, pathophysiology, and treatment. The Journal of Clinical Endocrinology & Metabolism. 1999 Apr 1;84(4):1165-
[11] Stanford KI, Goodyear LJ. Exercise and type 2 diabetes: molecular mechanisms regulating glucose uptake in skeletal muscle. Advances in physiology education. 2014 Dec;38(4):308-14.
[12] Mendes R, Sousa N, Themudo-Barata J, Reis V. Impact of a community-based exercise programme on physical fitness in middle-aged and older patients with type 2 diabetes. Gaceta Sanitaria. 2016 May 1;30(3):215-20.
[13] Nagwa MH, Rana A, Heba A, Abeer A, Rashed A. Effect of High Intensity Interval Training versus Circuit Weight Training on Glycated Hemoglobin in Type 2 Diabetic Patients. The Medical Journal of Cairo University. 2021 Jun 1;89(June):995-1001.
[14] Heubel AD, Gimenes C, Marques TS, Arca EA, Martinelli B, Barrile SR. Multicomponent training to improve the functional fitness and glycemic control of seniors with type 2 diabetes. Journal of Physical Education. 2018 Jun 7;29.