RESEARCH ARTICLE

Effects of supervised structured aerobic exercise training programme on level of Exertion, dyspnoea, VO_2 max and Body Mass Index in patients with type 2 diabetes mellitus

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Abstract

Objective: To determine the effects of supervised structured aerobic exercise training programme on level of exertion, dyspnoea, maximum oxygen consumption, and body mass index in type 2 diabetics.

Methods: The randomised, controlled trial was carried out at Riphah Rehabilitation and Research Centre, Islamic International medical College Trust, Pakistan Railways General Hospital, Rawalpindi, Pakistan, from January 2015 to June 2016, and comprised type 2 diabetics. Sedentary individuals of both genders, aged40-70 years, diagnosed on World Health Organisation's criteria were included. Participants were randomly divided into two groups, i.e. A (experimental) and B (control), by toss and trial method.

Intervention in the experimental group were supervised structured aerobic exercise training programme, routine medication and dietary, while the control group was treated by routine medication and dietary plan for 25 weeks at 3 days per week for both groups. Level of exertion, dyspnoea, maximum oxygen consumption and body mass index were assessed and documented at baseline (0 week) and at the completion of intervention (after 25 weeks). SPSS20 was used for data analysis.

Results: Of the 102 participants, there were 51(50%) in each group. Pre- and post-intervention analysis showed that a 25-week training programme, routine medication, and dietary plan significantly improved level of exertion, dyspnoea, maximum oxygen consumption and body mass index ($p<0.05$)) in the experimental group compared to the control group treated with routine medication, and dietary plan.

Conclusion: The supervised structured aerobic exercise training programme along with routine medication and dietary plan positively influenced level of exertion, dyspnoea, maximum oxygen consumption and body mass index than routine medication and dietary plan in patients with type 2 diabetes.

Keywords: Aerobic exercise, Level of exertion, Dyspnoea, VO2max, BMI. (JPMA 67: 1670; 2017)

Introduction

Diabetes mellitus (DM) is a global health burden affecting 285 million (6.4%) people over the world, costing $367 billion annually.[1] Type 2 diabetes mellitus (T2DM) is one of the leading causes of morbidity and mortality in 90 to 95% of all diabetic cases. The number of T2DM patients is expected to rise to 300 million by 2025.[2] T2DM is at least 4 times more common in South Asian residents in the United Kingdom (UK) than in the general population. It is observed that South Asian also has high-risk diabetic complications. There is 40% higher mortality among them and they develop the disease 10 years earlier than their white counterparts.[3]

Exercise therapy is considered one of the most important treatment options for diabetes mellitus along with routine management of nutrition and medication for the past 100 years.[4] Evidences has demonstrated that structured exercises programme or lifestyle modification are effective strategies for decreasing risk of cardiovascular diseases in T2DM patients. Physically inactive individuals with T2DM experience higher cardiovascular morbidity and increase mortality as compared with active diabetic individual. It is observed that chronic exercise programme alters the metabolic profile and has a very good effect on cardiovascular system.[5] Ina majority of interventional studies, aerobic exercises are relied upon, may be due to their higher energy expenditure compared to resistance exercises.[6]

Maximum oxygen consumption (VO_2 max) reflects person's maximum capacity to absorb, transport and consume oxygen. Practically, VO_2 max is considered to equivalent to the highest VO_2 value obtained in peak exertion which usually classified as cardio-respiratory fitness.[7] Aerobic exercise training has been shown to improve glycaemic control, insulin sensitivity and VO_2 max. The more intense the aerobic exercise the better the

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glycaemic control and insulin sensitivity.[8] Clinically and statistically, regular exercise has significant effect on VO_2 max in type 2 diabetic patients. Exercises with higher intensities may have some additional effects on cardiopulmonary fitness and glycated haemoglobin (HbA1c).[9]

Another study suggested that all exercises should be done within the human capacity; therefore, it is important to measure metabolism and oxygen consumption during work. There is a strong relationship between any rate of perceived exertion and VO_2 max, as well as a significant correlation between heart rate (HR) and VO_2 max.[10] According to National Health Interview Survey (NHIS) data, the highest proportions of overweight (23.0 < body mass index (BMI) < 27.4 kg/m^2) and obesity (BMI > 27.5 kg/m^2) adjusted for age and sex were reported among Filipinos (46.5% overweight, 20.8% obese) and Asian Indians (46.7% overweight, 16.6% obese).[11]

The current study was designed to investigate the effect of supervised aerobic structured exercise on dyspnoea, level of exertion and VO_2 max in T2DM patients.

Patients and Methods

This single-blinded, randomised controlled study was carried out at Riphah Rehabilitation and Research Centre, Islamic International Medical College Trust (IIMCT), Pakistan Railways General Hospital, Rawalpindi, Pakistan, from January 2015 to June 2016, and comprised T2DM patients.

Sedentary individuals of both gender, age 40-70 years, and diagnosed with T2DM as per World Health Organisation's (WHO) criteria with minimum 1-year history were included (Table-1). Patients on regular exercise, diet plan, chronic systemic disease and smoking were excluded.[12] Participants were randomly assigned to experimental (A) and control (B) groups by toss and trial method.

The sample size was calculated by a pilot study on first 20 patients. Online calculator "EpiTools" was used. The statistical parameters were mean of insulin resistance (IR) in the experimental group (0.4340), mean of IR in the control group (0.6402), variance (0.137), confidence level (0.95) and power (0.8).

Supervised structured aerobic exercise training (SSAET) programme, routine medication, and dietary plan were interventions in the experimental group, while patients in the control group were treated by routine medication and dietary plan for 25 weeks at 3 days per week.

Treatment outcomes in both study groups were assessed by Borg scale and dyspnoea index for level of exertion (LOE) and dyspnoea, respectively, while resting heart rate method was used for VO_2 max calculation, and BMI by weight (kg) divided by height squared (m^2). Assessments were done at baseline and at the completion of 25 weeks intervention programme. Informed consent was taken from all participants in Urdu language. The research protocol was approved by the institutional review board (IRB) of the University of Lahore and University Institute of Physical Therapy. Approval was also obtained from the ethics review committee (ERC) of Riphah College of Rehab Sciences.

The SSAET programme was applied through medically graded treadmill and 25 weeks intervention was divided in 5 phases of 5 weeks each. Phase-I was carried out at zero inclination, phase-II with 3 degree inclination, and then 3 degree increase followed in every subsequent phase, and finally phase 5 was at 12 degree inclination with the ground. Speed of the treadmill was kept as normal speed of each participant and determined by 20-metre distance test at the start of study (Table-2). Data was analysed using SPSS 21. Normality was calculated by Shapiro-Wilk test and parametric test (independent t-test) was applied.

Results

Of the 195 patients, 102(52%) fulfilled the inclusion criteria. Of them, there were 51(50%) participants in each group. The participants' mean age was 54.73±8.17 years (range: 40-70 years). Moreover, 68(66.7%) patients were female and 34(33.3%) male. The mean duration of T2DM was 7.12±4.32 years (range: 1-16 years). Family history of T2DM was positive in 64(62%) participants.

Table-1: Diagnosis of T2DM as per WHO criteria.[12]

A1C $\geq$ 6.5%. conducted by method certified by NGSP and standardised to the DCCT assay
OR
FPG $\geq$126 mg/dL (7.0 mmol/L) where fasting described as no caloric intake at least 8 hours
OR
2 hours PG > 200 mg/dl (11.1 mmol/L) during an OGTT by using WHO test criteria and using glucose load equal to water dissolved 75 gram anhydrous glucose.
OR
A random Plasma glucose > 200 mg/dL(11.1 mmol/L) in patients with classic symptoms of hyperglycaemia or hyperglycaemic crisis.

T2DM: Type 2 diabetes mellitus.
WHO: World Health Organisation.
NGSP: National Glycohaemoglobin Standardisation Programme.
DCCT: Diabetes control and complications trial.
FPG: Fasting plasma glucose.
PG: Plasma glucose.
OGTT: Oral glucose tolerance test.

Table-2: illustrated details of 25 weeks intervention in experimental group.

Phases	Exercise Duration per session	Exercise duration per week	Inclination with ground
I	10 minutes/ session	30 minutes/ week	0 degree
II	20 minutes/ session	60 minutes/ week	3 degree
III	30 minutes/ session	90 minutes/ week	6 degree
IV	40 minutes/ session	120 minutes/ week	9 degree
V	50 minutes / session	150 minutes/ week	12 degree

Table-3: Showing comparison of mean, standard deviation and p-value in experimental and control groups for dyspnoea, LOE, VO2max, and BMI.

Variables	Pre mean±SD Exp group (n=51)	Pre mean ±SD Control group (n=51)	p-value (independent t test)	Post mean ±SD Exp group (n=51)	Post mean ±SD Control group (n=51)	p-value (independent t test)
LOE	10.56(±1.62)	10.54(±1.60)	0.951	07.39(±1.40)	12.07(±1.16)	0.001
Dyspnoea	14.88(±1.99)	14.52(±2.42)	0.425	11.25(±2.28)	16.29(±2.38)	0.001
VO2max	36.90(±2.78)	38.00(±3.26)	0.071	40.11(±3.30)	37.13(±3.04)	0.001
BMI	29.95(+5.31)	29.93(+4.92)	0.988	27.73(+4.84)	30.10(+5.06)	0.017

LOE: Level of exertion.
VO2 max: Maximum oxygen consumption.
BMI: Body mass index.
SD: Standard deviation.

In group A, pre- and post-intervention mean values for LOE were 10.56±1.62 and 7.39±1.40, dyspnoea 14.8±1.99 and 11.25±2.28, VO2max 36.90±2.78 and 40.11±3.30, and for BMI were 29.95±5.31 and 27.73±4.48. In group B, pre- and post-intervention mean values for LOE were 10.54±1.60 and 12.07±1.16, dyspnoea 14.52±2.42 and 16.29±2.38, BMI 29.93±4.92and 30.10±5.06, and VO2max 38.00±3.26and 37.13±3.04. The difference in values in the experimental group was more significant ($p<0.05$) than the control group (Table-3).

Discussion

Results of the current study suggest that the SSAET programme combined with routine medication and dietary plan significantly improved LOE, dyspnoea level, VO_2 max, and BMI in patients with T2DM as compared with non-exercise group of T2DM patients with treated routine medication and dietary plan.

Diabetes is a global epidemic affecting 300-600 million world population, of which 90-95% are T2DM patients. Obesity is one of the key independent risk factors for T2DM with worldwide prevalence of 1.9 billion and becoming alarming due to longevity in aging and constant increase in obesity. Diabetes and obesity are at the top of list in human sufferings by its multi-systemic complications.[13] Obesity increases difficulties in the management of T2DM with increasing insulin resistance and blood glucose. Lifestyle modifications including physical activity, exercise, counselling and diet have positive effects in patients with T2DM.[14]

Sedentariness and physical inactivity are independent risk factors causing obesity, insulin resistance, initially gestational and later on T2DM in obese pregnant women.[15] The American Diabetes Association (ADA) recommended weight reduction through lifestyle modifications in both at-risk obese individuals and those diagnosed with T2DM. Furthermore, the ADA suggested physical activity and exercise as a key component of lifestyle modification strategies for obesity management.[16]

VO2max is reduced in diabetic patients as compared to the non-diabetic. Initially, exercises with 10-12 rate of perceived exertion should be advised. As the tolerance for physical activity and exercise develops, intensity might be increased.[17] Regular aerobic exercises are suggested to be an appropriate intervention in the management multi-systemic symptoms, including VO_2 max and HbA1c.[18] Another research reported 24% reduction in walking time and 20% reduction in maximal oxygen consumption during exercise testing by graded treadmill protocol in patients with T2DM as compared with non-diabetics. A positive co-relation between VO_2 max and HbA1c was also found.[19]

Like BMI and VO_2 max, the cardio-respiratory fitness is also compromised and cause deconditioning in dyspnoea level and rate of perceived exertion (RPE) in patients with T2DM. Different types of aerobic and resistance exercises have positively influenced functional capacity, lean body mass, muscle strength and glycaemic control in patients with T2DM as compared with the non-exercise control group.[20]

Aerobic exercises (such as bicycling) have been found to significantly reduce exercise effort and improve exercise performance in old diabetic patients (50-75 years) as compared with controls, with a positive co-relation of RPE with higher lactate, higher heart rate and diagnosis of hypertension.[21] Another research proved the positive relation between cardio-respiratory performance and duration of exercise in obese population, including both at risk and diagnosed patients with T2DM.[22]

Conclusion

The SSAET programme along with routine medication and dietary plan more positively influenced LOE, dyspnoea, VO_2 max and BMI than routine medication and dietary plan in patients with T2DM.

Disclaimer: This study is part of a PhD Physical Therapy project of Syed Shakil-ur-Rehman supervised by Hossein Karimi and co-supervised by Syed Amir Gillani. It has not been presented to any journal or conference.

Conflict of Interest: None.

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