

Effects of aerobic exercise on blood glucose levels and lipid profile in Diabetes Mellitus type 2 subjects

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Abstract: *Introduction and Background:* Diabetes mellitus is a metabolic disorder resulting from defective insulin secretion, insulin action, or both. A consequence of this is chronic hyperglycaemia with disturbances of carbohydrates, proteins and fat metabolism. Exercise plays a major role in the prevention and control of insulin resistance, type II diabetes, and diabetes-related health complications. Both aerobic and resistance training improve insulinaction and can assist with the management of blood glucose levels, lipids, blood pressure, cardiovascular risk, mortality, and quality of life. *Aims:* Effects of aerobic exercise on blood glucose level and lipid profile in Type 2 diabetes mellitus subjects. *Materials& Methods:* Sedentary men and women suffering from Type II diabetes mellitus (n=20) were selected randomly for this study. Subjects were made to do aerobic exercises for 4 days/week for 30 min duration. They were made to do stepping at a stepper of 9 inches height for first 10 minutes. This was followed by 20 minutes of cycling at the resistance of 5 (according to the static cycle used). The heart rate of the subjects was monitored during the exercises. Blood glucose level and lipid profile were measured biochemically. HbA1c was also checked before and after exercise protocol. *Results:* Very high density lipoprotein (VLDL) and triglycerides (TG) parameter in lipid profile showed significant decrease as p values were less than <0.001 and <0.05 respectively. Blood glucose levels did not show any significant changes when compared between pre-test and post test values. *Discussion and Conclusion:* We concluded four weeks of aerobic training significantly decreases VLDL and triglycerides of lipid profile but the changes in other lipid profile parameters i.e, high density lipoprotein (HDL), low density lipoprotein (LDL) Chylomicrons were not significant (p>0.05). The changes in the glycaemic control and HbA1c were also insignificant (p>0.05). We concluded that duration of 4 weeks aerobic exercise on Type II diabetic patients to improve their glycaemic control and lipid profile was not sufficient as it showed significant changes only in the VLDL and triglycerides parameter of lipid profile.

Keywords: Diabetes Mellitus Type II, Lipid profile, Aerobic exercise, Blood glucose, HbA1c.

Introduction

Type II diabetes mellitus is associated with a cluster of interrelated plasma lipid and lipoprotein abnormalities, including reduced HDL cholesterol, a predominance of small dense LDL particles, and elevated triglycerides. These abnormalities occur in many patients despite normal LDL cholesterol levels. These changes are also a feature of insulin resistance syndrome which underlies many cases of type II diabetes. In fact, pre-diabetic individuals often exhibit an atherogenic pattern of risk factors that includes higher levels of total cholesterol, LDL cholesterol and triglycerides and lower levels of HDL cholesterol than individuals who do not develop diabetes. Insulin resistance has striking effects on

lipoprotein size and subclass particle concentrations for VLDL, LDL and HDL.

There is an evidence that each of these dyslipidemic features is associated with increased risk of cardiovascular disease, the leading cause of death in patients with type II diabetes. Numerous studies have demonstrated an association between LDL size or density and coronary artery disease. Altered metabolism of TG-rich lipoprotein is crucial in the pathophysiology of the atherogenic dyslipidemia of diabetes. Alterations include both increased hepatic secretion of VLDL and impaired clearance of VLDL and intestinally derived chylomicrons [1-2].

The reductions in HDL associated with type II diabetes and insulin resistance are multifactorial, but a major factor appears to be increased transfer of cholesterol from HDL to TG-rich lipoproteins with reciprocal transfer of TG to HDL. TG rich HDL particles are hydrolysed by hepatic lipase and as a result, are rapidly catabolised and cleared from plasma. Typically, the reduced HDL levels in plasma of patients with type II diabetes are manifested as reductions in the HDL2b subspecies and relative or absolute increases in smaller denser HDL3b and HDL3c [3].

Exercise, in addition to diet modification and medication has long been recommended as one of the three main components to diabetic therapy. Studies have found that exercise may reduce hyperglycaemia and body fat and improve protection against developing cardiovascular complications. Regular exercise reduces dyslipidemia and increases insulin sensitivity. By increasing the GLUT-4 receptor concentration on the plasma membrane or sarcolemma, the insulin resistant state is positively affected through enhanced glucose uptake into cells. It is important to note that glycaemic control, reductions in visceral adiposity, and decreased plasma triglycerides can be achieved even without systemic weight loss [4].

Gregory R. Waryasz et al stated that physical activity reduces both morbidity and mortality in all populations. Authors concluded that self management interventions, including proper exercise recommendations can improve metabolic control and reduce other negative risk factors. It was stated that for most patients with type 2 diabetes mellitus the benefits of walking are substantial with little to no harm to the patient [5].

Exercise training has been shown to be beneficial in decreasing body fat and improving lean mass in patients with Type II diabetes mellitus [6-7] although, these improvement may not be necessary to induce improvement in glycaemic control. Exercise stimulus also results in muscle fiber type conversion. Because most type II diabetes patients are sedentary, they have a sub optimal ratio of type I (aerobic) to type 2 (anaerobic) muscle fibers. Muscle fiber type conversion of type IIb to IIa (fast twitch, power fibers) increases muscle insulin receptor number

and GLUT-4 concentration, thereby enhancing the glucose shuttle mechanism. The muscle fiber hypertrophy and general increase in skeletal muscle mass associated with exercise have also been associated with decreased hemoglobin A1c, possible related to increased glycogen and glucose within muscle [8].

Authors reported a significant lowering of plasma triglycerides in the exercise intervention group compared with the controls, but there was no significant difference between groups in either total cholesterol or blood pressure. They found that exercise significantly decreased glycated haemoglobin levels (0.6% HbA1c), and hence improved glycaemic control in people with type 2 diabetes mellitus [9]. It was stated that both progressive resistance training (PRT) and aerobic exercise (AE) were effective in improving metabolic profile of adults with type II diabetes but the percentage of improvement in triglycerides, total cholesterol levels and general well being with PRT was more as compared to AE [8].

C.R. Mikus et al demonstrated that short term daily exercise reduces PPG and glycaemia variability in patients with type 2 diabetes and does not produce the increases in the incidence of hypoglycaemia sometimes associated with some intensive pharmacological interventions. Their findings reinforce the utility of daily exercise to reduce glycaemic variability quickly and safely in patients with well controlled type II diabetes [10].

N. G. Boule et al found a relationship between intensity of exercise with VO₂ max and HbA1c and concluded that intense exercise produced greater improvements in blood glucose control and reflected in reductions in HbA1c [11]. Connie L. Tompkins et al performed studies in children and adolescents to demonstrate a positive association between physical activity and insulin dynamics, with increased activity significantly related to lower fasting insulin and greater insulin sensitivity. Studies evaluating exercise and diet together resulted in a decrease in fasting blood glucose and HbA1C levels in children [12].

The aims of the present study were to find out the effects of 4 weeks aerobic exercise on plasma glucose level and lipid profile in patients with type II diabetes. The purpose of this study was to determine whether short term exercise training program could improve blood glucose levels (fasting and postprandial) and dyslipidemia in patients with type II diabetes mellitus. Could this same exercise protocol reduce HbA1c in patients with type II diabetes to improve insulin sensitivity in these subjects.

Material and Methods

Subjects: Sedentary men and women suffering from Type II diabetes mellitus (n=20) at the age group 45-65 years were selected randomly for the study. Subjects were excluded from the study if they had any cardiovascular diseases and if the level of HbA1c ≥ 10%. They were subjected to aerobic exercises along with medications. Glycaemic control was assessed by weekly glucose level monitoring (both fasting and postprandial) before the start of the protocol and for 4 weeks duration of exercise program. Lipid profile tests were done before the start of exercise protocol and at the end of 4 weeks. Blood glucose levels were tested by Glucometer every day during entire duration of exercise protocol. HbA1c and lipid profile of the subjects were examined by SRL Diagnostics, Pitampura, Delhi.

Methods: The demographic data was recorded before the start of the exercise protocol. The baseline measurements of HbA1c, blood glucose levels (fasting and postprandial), and lipid profile were done. It was made sure that all the subjects fulfilled the inclusion criteria and written consent was signed by them. The subjects were made to do exercises for 4 days/week for 30 min duration. They were made to do stepping at a stepper of 9 inches height for first 10 minutes. This was followed by 20 minutes of cycling at the resistance of 5 (according to the static cycle used). The heart rate of the subjects was monitored during the exercises. At the end of every week, blood glucose levels (fasting and postprandial) were measured and at the end of 4 weeks lipid profile tests were evaluated.

Statistical Analysis: Student’s t-test (paired) was applied to compare the mean of pre-exercise and post exercise blood glucose level and lipid profile

parameters in Type II diabetic patients. P was considered to be significant at <0.05.

Results

The demographic data of the subjects were presented in table1.

Table-1: Demographic data of subjects

Sl. No.	Variables	Mean+/- SD
1	Age(yrs)	56.57 ± 7.21
2	Duration of Type II diabetes mellitus (years)	11.49 ± 9.91
3	SBP/DBP (mm Hg)	152.06± 5.4 / 92.09 ± 7.33
4	BMI (kg/m ²)	31.27 ± 4.61
5	HbA1c (gm%)	7.1 ± 1.06

Table-2: Comparison of pre-exercise and post exercise experimental variables

Variables	Pre-Exercise (Mean ± SD)	Post-Exercise (Mean ± SD)	P-Value
Fasting blood sugar (mg/dl)	125.14 ± 27.43	124.57± 30.69	>0.05
Postprandial blood sugar (mg/dl)	171.0 ± 53.29	167.14 ± 37.37	>0.05
LDL (mg/dl)	94.43 ± 35.99	92.71 ± 37.73	>0.05
VLDL (mg/dl)	36.46 ± 19.18	28.11 ± 10.77	<0.001
Triglycerides (mg/dl)	182.29 ± 95.91	140.57 ± 53.85	<0.05
HDL (mg/dl)	32.14 ± 7.49	32.43 ± 5.03	>0.05

It was observed from table 2 that the % of decrease in fasting blood glucose after implementation of 4 weeks duration of aerobic exercise was 0.45% (p>0.05) and postprandial was down by 2.25% (p>0.05). The % of fall in LDL (mg/dl) was 1.82 % (p>0.05) and improvement in HDL (mg/dl) was 0% (p>0.05). The decrease in triglycerides (mg/dl) was 22.88 % which was significant at p<0.05 and decrease in VLDL (mg/dl) was 22.90 % which was significant at p<0.001.

The change in HbA1c (gm%) was also not significant ($p>0.05$) after completion of exercise protocol.

Figure-1: Comparison of pre and post values of fasting and postprandial blood glucose levels

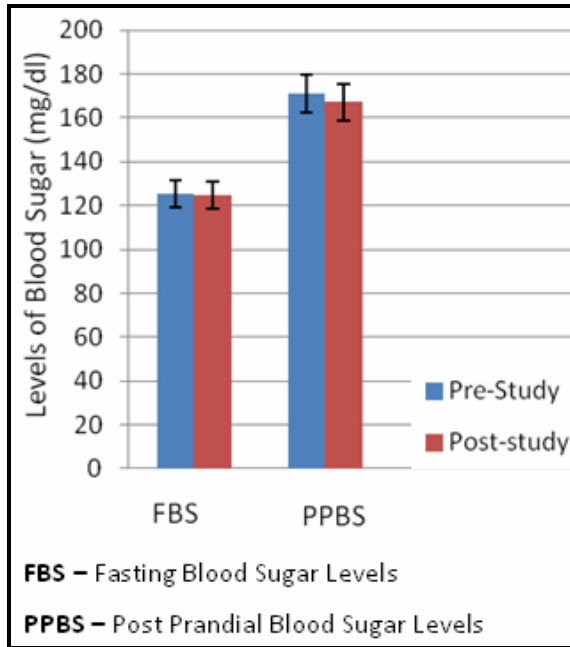
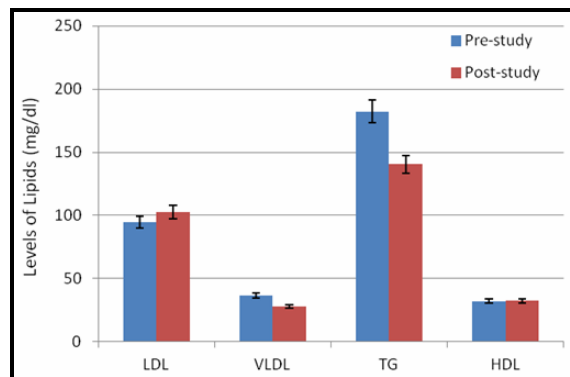


Figure-2: Comparison of pre and post study values of LDL, VLDL, TG and HDL



Discussion

The key findings of our study were that there was no significant changes in the blood glucose levels (fasting and postprandial) and lipid profile of the subjects except there were a significant change in VLDL and triglycerides parameter of lipid profile respectively at $p<0.001$ and $p<0.05$.

The changes in level of blood glucose and lipid profile were insignificant ($p>0.05$) might be due to a small sample size, short duration of the

training program and the subjects were overweight or obese which were not considered in this study. There are few studies who demonstrated that aerobic exercise has small to moderate beneficial effects on glucose control and lipid profile in type 2 diabetic subjects and small beneficial effects on some related risk factors for complications of diabetes. Some other authors found that exercise training can favorably affect glycaemic parameters, lipid profile, and blood pressure [12].

It was stated that physical exercise has significant effects on glucose excursion during an OGTT and exercise tolerance in elderly patients with type 2 DM [13]. Aerobic exercise training is an accepted therapeutic strategy in management of type 2 diabetes mellitus because of its beneficial effects. Exercise improves diabetic status and reduces the metabolic risk factors, insulin sensitivity and lipid profile. The effect of aerobic exercise on lipid profile and glycaemic control was heterogeneous. Adults with diabetes should be advised to perform at least 150 min/week of moderate intensity aerobic physical activity (50–70% of maximum heart rate), spread over at least 3 days/week with no more than 2 consecutive days without exercise [14].

The principal limitations of our study were that the size of sample was small, limited duration which might have limited the power of our study to uncover the differences between the subjects. Another problem might be the fact that most of the subjects had good metabolic control before the intervention and their BMI were high. Thus, the impact of exercise might be less significant when implemented on these subjects. Even the diet chart was not prescribed to the subjects.

Conclusion

We concluded that duration of 4 weeks aerobic exercise on Type II diabetic subjects to improve their glycaemic control and lipid profile were not sufficient as it brought significant changes only in the VLDL and triglycerides parameter of lipid profile but not on other parameters and no significant change was found in glycaemic control.

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