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Effects of 8-weekaerobic exercise on blood glycemic indexes and anthropometric of patients with type 2 diabetes in the Dezful

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Abstract: Regular exercise represents an effective strategy to prevent and treat type 2 Diabetes. The present research examined the effects of aerobic training on glycemic control and blood pressure in males with type 2 diabetes. In this semi-experimental study, 30 men with type 2 diabetes with age ranging from 30-50 old were selected and randomly divided into aerobic exercise group (n=10) and control group(n=10). Exercise Group participated in aerobic training program at 50-70 % HRR for 8 weeks and 3 sessions per week. Fasting blood sugar (FBS), Fructosamine, systolic blood pressure (SBP) and diastolic blood pressure (DBP) were measured before and after 8 weeks. Paired and independent t-tests were used for data analysis at significant level of $P<0.05$. At the end of the 8 week period, significant decreases ($P<0.001$) have been found in FBS, fructosamine and SBP levels in exercise group and significant decreases have been found decreases FBS in control group ($P=0.001$). Also there was a significant difference in BBS ($p=0.007$) fructosamine ($p<0.001$) and SBP ($P=0.011$) between 2 groups after 8 weeks. Aerobic trainings effectively improve blood pressure and lead to better glycemic control in men with type 2 diabetes.

Key words: Type 2 diabetes; Aerobic training; Blood glycemic; Blood pressure

1. Introduction

Type 2 diabetes is a metabolic disorder caused by insulin resistance and relative reduction of insulin production. Insulin resistance is defined as the diminished ability of cells or tissues to respond to the physiological concentrations of insulin. According to World Health Organization, prevalence of T2D will have been increasing from 2.8 percent (177 million people) in 2000 to 4.4 percent (366 million people) by 2030. According to cognitive-pandemic studies, prevalence rate of diabetes in Iran has been reported between 5% and 8%. Notably, 90% of the patients have T2D and the other 10% have diabetes type 1. It is worth pointing out that nearly half the diabetic patients are not aware of their condition(Tavakolizadeh et al., 2014).Metabolic disorders resulting from diabetes lead to many cardiovascular complications, which will be followed by frequent problems for patients as well as the health system of society. Type 2 diabetes elevates the risk of micro vascular complications such as retinopathy and nephropathy. These patients often die because of macro vascular complications, including coronary artery disease and stroke(Ghalavand et al., 2014)and it brings many problems for the patient and the health system. Although the risk of micro vascular complications such as retinopathy and nephropathy increase in type 2 diabetes often these patients die due to macro vascular complications such as coronary heart disease and stroke. The risk of these complications is 200-400 percent(Sardar et al., 2008; Ghalavand et al., 2014)but cardiovascular complications is the most common problem in patients with type 2 diabetes and vision of therapy can help to control a cardio-metabolic risk factors. It can have beneficial effects on patients who have diabetes(Azadbakht et al., 2012). Its many years that exercise with diet and medical treatment are three methods are considered for diabetes(Ghalavand et al., 2014; Association AD, 2012). Research has shown that a decrease in physical activity can cause metabolic disorders that it is a problem in the development and exacerbation of diabetes. So regular exercise and increased physical activity can reduce the incidence of metabolic syndrome and can control it(Hajihasani et al., 2012).The positive role of exercise for people with type 2 diabetes can power muscle in uptake glucose without insulin(Tadibi et al., 2012),and reduction of diabetic complications such as reduce the blood pressure(Ghalavand et al., 2014; Morvan et al., 2013).Many studies have been concerning the effects of exercise and physical activity in the treatment of diabetes and hypertension. One of the significant issues in the field is the effects of exercise on sugar control and blood pressure in diabetic patients and studies have found that exercise reduced the sugar and blood pressure. Regular physical activity may lower blood pressure by an average of 8-10 mmHg. For most patients, who have high blood pressure, combine diet and exercise is the

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most effective way in the prevention and treatment of high blood pressure(Association AD, 2012; Kokkinos et al., 2001).The study aimed to investigate the effects of eight weeks of regular aerobic exercise, were included on sugar control and blood pressure in men with type 2 diabetes.

2. Material and method

2.1. Sample selection

In this quasi-experimental study, 30 males with type 2 diabetes were selected using available sampling method, and were randomly divided into two groups: aerobic training group (n = 15) and control group (n= 15).

$$n = \frac{(z_{1-\frac{\alpha}{2}} + z_{1-\beta})^2 (s_1^2 + s_2^2)}{(\overline{x_1} - \overline{x_2})^2}$$

Inclusion criteria were: type 2 diabetic males, 30 to 50 years old, FBS< 200 mg/dl, no smoking, no insulin injection, no history of cardiovascular or respiratory diseases or muscular and skeletal problems, inactive life style, no regular exercise within six months prior to the study, no hypoglycemia background at rest or exercise. Excluding criteria were: being absent from exercise sessions for more than two successive sessions, no regular participation in an exercise program except for this study exercise sessions for the exercise group and no regular exercise for the control group.

2.2. Body composition

Body mass was measured through calibrated clinical scale and height was measured through audiometer while the participants wearing light clothing with no shoes. Body Mass Index (BMI) was calculated as weight in kilograms divided by height in squared meters ($kg.m^2$). The subcutaneous fat thickness was measured according to the procedures of the Airlie conference on the standardization of anthropometric measurement. Percentage of Body Fat (PBF) was calculated form multicomponent predication equation using skin-fold thicknesses (Jackson and Pollock, 1978). Skin-fold thicknesses were measured with a Lafayette Caliper (Model 01127) at three sites (chest, abdominal and thigh). All measures were made in duplicate on the right site of the body, with subject standing and breathing normally(Jackson and Pollock, 1978).

2.3. Site skinfold equation for males

Body Density = 1.10938 - (0.0008267 × sum of chest, abdomen and thigh skinfolds in mm) + (0.0000016 × square of the sum of chest, abdomen and thigh) - (0.0002574 × age)

2.4. Biochemical Indices

Blood sample after 10 to 12 hours of fasting was taken from left antecubital vein for measuring biochemical parameters. FBS was measured in the biochemistry laboratory; serum and red globules of the blood sample were separated with centrifuge and the blood serum was used to measure FBS and fructosamine.

2.5. Cardiac Indices

Systolic and diastolic blood pressures were measured by Hansen mercury barometer made in Germany and Litmann stethoscope made in USA. Rakport test was used to measure aerobic capacity (VO_2 max) of the patients (Hoffman, 2006).

VO_2max= 132.853–(weight×0.0769)–(age×0.3877)+(sex×6.315)–(time×3.2649)–(HR×0.1565)

2.6. Exercise training

In this the semi-experimental research the Exercise program in experimental group included supervised aerobic training that was conducted safety (Association AD, 2012; Balducci et al., 2014). Warm up consisted of fast walking, jogging and static stretching for 10 minutes (Ghalavand et al., 2014). Main training program (table 1) was designed according to the recommendations of the exercise for diabetics (Association AD, 2012; Balducci et al., 2014). The Heart Rate Reserve (HRR) was determined by the Karvonen Formula

Table 1: Training program

week	frequency /week	Set	Interval time (min)	Interval		Rest/training
				training	rest	
1th	3	2	5	50-55%	30-40%	1:1
2th	3	2	5	50-55%	30-40%	1:1
3th	3	3	5	50-55%	30-40%	1:1
4th	3	3	5	55-60%	30-40%	1:1
5th	3	4	5	55-60%	30-40%	1:1
6th	3	4	5	60-65%	30-40%	1:1
7th	3	5	5	60-65%	30-40%	1:1
8th	3	5	5	65-70%	30-40%	1:1

(Ghalavand et al., 2014). At the end of every training session walking fast and stretching movements was conducted for 5 minutes (cool down)(Ghalavand et al., 2014). To avoid potential hazards a nurse was present in all training sessions. The patients was advised that to have sweet snack if they had hypoglycemia. The subjects' blood glucose and blood pressure were measured using digital glucometer model GC and blood pressure machine (BM1004)

before starting the training and if they had high glucose level or high blood pressure they were not allowed to participate in training.

2.7. Statistical Methods

SPSS 19.0 Software was used for analyzing the data. Normality of data distribution was assessed by Kolmogorov Smirnov test, which indicated that all the data had a normal distribution the data of the subjects before and after the eight-week training were compared between the training and the control group and were analyzed with paired and independent samples t-test. The significance level in all the tests was $P \leq 0.05$.

3. Result

In present study investigates the effects of eight weeks of aerobic exercise on indices of FBS, fructosamine, systolic blood pressure and diastolic blood pressure in men with type 2 diabetes was discussed. Table 1 shows the demographic characteristics of patents in pretest.

Table 2: Comparison of characteristics of the exercise and control groups a

Variables	Exercise Group	Control Group	t	P Value
Age $_{yr}$	43.93 ± 5.09	42.67 ± 4.92	0.603	0.494
Height $_{cm}$	172.60 ± 6.27	170.90 ± 5.10	0.815	0.422
Weight $_{kg}$	75.39 ± 9.01	74.54 ± 9.22	0.256	0.800
BMI $_{kg/m^2}$	25.28 ± 2.36	25.49 ± 2.61	-0.233	0.818
PBF	25.93 ± 3.53	26.17 ± 1.62	-0.239	0.813
VO_2max $_{ml.kg\text{-}1.min\text{-}1}$	33.72 ± 3.01	35.33 ± 1.22	-1.916	0.071
Disease Duration $_{yr}$	3.13 ± 1.60	3.80 ± 1.27	-1.267	0.216

[a]Abbreviations: BMI: Body Mass Index; PBF: Percent Body Fat, VO_2max: Maximal oxygen uptake.

After 8 weeks of aerobic training, a significant decrease was observed in FBS ($P < 0.001$), fructosamine ($P < 0.001$) and SBP ($P < 0.001$), in the aerobic training group. Also significantly decrease was observed in FBS ($P = 0.001$) in the control group (Table 2).

Table 2: Preintervention and post intervention Values for fasting blood sugar, fructosamine, systolic blood pressure and diastolic blood pressure a,b

Variable	Group	Pre-test	Post-test	t	P value
FBS $_{mg/dl}$	Exercise	151.60 ± 22.73	132.47 ± 21.94	8.969	0.000 c
	Control	165.93 ± 21.05	155.87 ± 20.02	4.425	0.001 c
Fructosamine $_{\mu mol/l}$	Exercise	481.13 ± 80.75	394.33 ± 55.98	6.050	0.000 c
	Control	448.27 ± 54.29	439.60 ± 49.98	0.819	0.426
SBP $_{mmHg}$	Exercise	141.00 ± 4.38	133.07 ± 4.43	5.603	0.000 c
	Control	138.27 ± 6.27	135.87 ± 5.30	1.659	0.119
DBP $_{mmHg}$	Exercise	88.07 ± 7.89	86.67 ± 5.23	1.345	0.200
	Control	91.13 ± 6.50	90.20 ± 5.60	1.33	0.204

[a]Abbreviations: FBS= fasting blood glucose, SB = systolic blood pressure, DBP= diastolic Blood Pressure, RHR= resting heart rate.
[b]Data are presented as mean ± SD.
[c]There was a significant difference between pre and post interventions at $P < 0.05$.

There was a significant difference between FBS ($P = 0.007$), fructosamine ($P < 0.001$) and SBP($P < 0.011$)between the two groups (Table 3).

Table 3: Comparison of the mean differences of investigated variables between the exercise and control groups a,b

Variables	Exercise Group	Control Group	t	P value
FBS $_{mg/dl}$	-19.13 ± 8.26	-10.07 ± 8.81	-2.907	0.007 c
Fructosamine $_{\mu mol/l}$	-86.80 ± 55.57	-8.67 ± 8.81	-4.384	0.000 c
SBP $_{mmHg}$	-7.93 ± 5.48	-2.40 ± 5.60	-2.733	0.011 c
DBP $_{mmHg}$	-1.40 ± 4.03	-0.93 ± 2.71	-0.372	0.713

[a]Abbreviations:FBS= fasting blood sugar, SBP= systolic blood pressure, DBP= diastolic Blood Pressure.
[b]Data are presented as mean ± SD.
[c]There is a significant difference between the exercise and control groups at $P < 0.05$.

4. Discussion

In the present study was to examine the effect of aerobic exercise with respect to eight weeks duration and volume of the recommended weekly exercise training in patients with type 2 diabetes(Association AD, 2012; Balducci et al., 2014). After training in significant improvements in FBS, fructosamine and systolic blood pressure were observed. But there was no significant difference in diastolic blood pressure.

According to the results of previous research training leading to a significant reduction in FBS(

Ghalavand et al., 2014; Lucotti et al., 2006; Shaban et al., 2014) and fructosamine (Ghalavand et al., 2014; Lucotti et al., 2006; Tamura et al., 2005) in type 2 diabetic patients that the findings of this study are consistent. Karstoftet (Karstoft et al., 2013)in a study of four months of walking did not report significant differences in glycemic blood that is inconsistent with the findings of the present study. The probable reason for this difference may be subject to different in features, Because the research Karstoftof was used elderly patients (over 57 years old) and body mass index (29 k/m^2) and may due to over weight gain and muscle weakness have not been able to exercise at the desired intensity.

Researches indicates that muscle contraction is an insulin-like effect and Large amounts of glucose(Cartee et al., 1989) and muscle contraction is likely to increase membrane permeability to glucose by the glucose transporter of the plasma membrane. By doing exercise in trained muscles increases the Glut-4; and it also improves insulin action on glucose metabolism and can reduce hyperglycemia(Kern et al., 1990). According to the accumulation of free fatty acids in muscle cells disrupted transport to the cell surface is Glut-4 and aerobic training increases fatty acid oxidation, preventing accumulation in muscle cells (Ersoy et al., 2004). Another positive mechanisms regulating glucose metabolism improves insulin action and is followed insulin increased signal intensity aerobic exercise (Ersoy et al., 2004; Teixeira-Lemos et al., 2011). The positive changes in glycemic control after exercise can increase the protein content of the insulin receptor and it can be increased activity of protein kinase B, which has a role in insulin signal transduction(Wang et al., 2009). It is possible that weight loss due to exercise or physical activity indirectly by influencing other biochemical mediators or peptide hormones that expression gene and their receptors in cells of the pancreas have been reported (Andersson et al., 2001; Nayak et al., 2010), improves beta cell function which is associated with reduced blood glucose levels in diabetic patients.

Sports in the intervention group had a significant reduction in systolic blood pressure after eight weeks of aerobic exercise and the findings are consistent with previous studies (Ghalavand et al., 2014; Ezema et al., 2014; Yavari et al., 2012).Shenoy et al (2009) after sixteen weeks of aerobic exercise significant difference in systolic blood pressure did not report the findings of this study are inconsistent. The probable reason for this difference may be due to individual differences in the two research subjects or the effect of nutrition intervention and cooperation in research Shenoy et al.

In the present study, diastolic blood pressure in the intervention group aerobic exercise was not observed significant difference. The findings of some studies(Ghalavand et al., 2014; Shenoy et al., 2009; Feyter et al., 2007), consistent with the findings of Ezema et al (2014) is inconsistent. The probable reason for this difference may be due to differences in practice in the research protocol or individual differences in the two studies because one of the main causes of diabetes. Yavari et al. (2012) after a period of aerobic exercise have reported a significant increase in diastolic blood pressure hypertension is genetic and ethnic differences, although the difference between the exercise and control groups was not significant but in the present study, the non-significant decrease was observed in the aerobic exercise group. The reasons can be the difference between the exercise training protocols in the two studies cited. Another possible reason may be individual differences in the two studies. And Nutrition plays an important role in the research or the research limitations noted.

Blood pressure in diabetic patients is beneficial. High blood pressure, especially systolic blood pressure, diabetic nephropathy, retinopathy, neuropathy and cardiovascular disease (Figueira et al., 2014). Type 2 diabetes is associated with hypertension leads to abnormalities in the central and peripheral parameters of cardiovascular function(Yan et al., 2014; Marwick et al., 2009). This systematic review and meta-analysis by Figueira and colleagues have examined were performed the effect of combined aerobic and resistance exercises. Aerobic exercise, resistance exercise combined with high intensity as effective methods and Reduce blood pressure in patients with type 2 diabetes have been introduced, particularly if more than 150 minutes of exercise per week(Figueira et al., 2014). As a non-drug treatments and regular exercise to improve blood pressure is introduced(Weibert, 2000). Maintain a systolic blood pressure of 140 mmHg, depending on the age of the patient, resulting in a reduction of 44-28 percent and 35-20 percent of strokes are ischemic heart disease(Choudhury and Lip, 2005). Credible evidence is about the benefits of exercise in improving endothelial function, expandable vascular ventricular diastolic function and left ventricular stroke volume(Yavari et al., 2012; Marwick et al., 2009) which can have a beneficial effect on blood pressure reduction, In the present study, although no significant reduction in diastolic blood pressure. But the slight decrease of about 3 mm Hg and The diastolic blood pressure, reduce the risk of stroke by 25 percent and the risk of coronary heart disease by 17 percent(Yan et al., 2014).

5. Conclusion

In general the findings of this study indicate that the effects positive of aerobic exercise on glycemic control and (significant decrease in FBS and fructosamine) and improves blood pressure (systolic blood pressure decreased) in men with type 2 diabetes. Diabetic patients can consult with a physician or under the supervision of experts in sports and they can use the positive benefits of exercise on glycemic control and blood pressure as a non-pharmacological treatment in addition to their drug benefit.

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