The Effect of Aerobic Exercise on Cardiovascular Risk Factors in Women with Type 2 Diabetes

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Abstract

Objective: Cardiovascular complications are the major cause of reduced lifetime in diabetic patients. Given that physical activity can play an effective role in reducing these complications, the current study was conducted with the aim of examining the effects of 8 weeks of aerobic exercise on some cardiovascular risk factors in women with type 2 diabetes.

Materials and Methods: Twenty women with Type 2 Diabetes were selected by convenience sampling method and were randomly divided into two experimental (n=11) and control (n=9) groups. The exercise protocol included aerobic exercise training for eight weeks and 3 sessions per week; every session lasted for 60 minutes and with intensity of 60-70 percent of maximum heart rate reserve. Blood samples were taken to measure serum high-sensitivity C-reactive protein (hs-CRP), glycemia and serum lipids before and after aerobic training period.

Results: The obtained results indicated a significant decrease in the levels of hs-CRP, fasting glucose and total cholesterol, and a significant increase of HDL in the experimental group than controls ($p<0.05$). Mean serum concentration of triglycerides and LDL reduced in the experimental group; however, this reduction was not statistically significant. None of the changes in the control group were significant except for increase in the plasma triglycerides levels.

Conclusion: According to the results of this study, 8 weeks of aerobic exercise can reduce inflammatory causes as well as glycemia and lipid profile in women with type 2 diabetes that these changes can have a desired effect on reducing the risk of cardiovascular disease in these patients.

Keywords: Aerobic exercise, hs-CRP, Type 2 diabetes

Introduction

Diabetes mellitus (DM) is one of the most common metabolic diseases in the world which is caused by impaired insulin secretion and insulin resistance (1-3). According to the International Diabetes Federation (IDF) currently more than 246 million people around the world are affected by this disease and by 2025 this figure is expected to increase to more than 380 million people (4). Studies have shown that Iran is among the countries that are at the increased risk of diabetes (5). In type 2 DM, high blood glucose level can cause complications such as cardiovascular disease and damages to kidneys and eyes (6). Cardiovascular risk factors can be divided into two categories. The first set including hyperlipidemia, diabetes, smoking and family history of heart disease which have been studied over the years; The second set of factors including C-reactive protein (CRP), homocysteine and fibrinogen which in recent years have drawn attention to themselves (7-9). CRP is a plasma component which is made in liver and its increase is a sign of infectious diseases or different tissue damages. A trace amount of this protein has been reported in the serum and body fluids of healthy people (its normal level in the serum is 3.5 mg/L). But in inflammatory reactions, the level of high-sensitivity CRP (hs-CRP) will be suddenly increased up to 30,000 times than normal level within 6 to 48 hours (10).

Lipid metabolism disorder caused by inadequate control of hyperglycemia in diabetic patients is involved in the development of cardiovascular complications (11-13). Plasma fatty acids cause dyslipidemia in diabetes through increasing hepatic very low-density lipoprotein (VLDL) synthesis, cholesteryl ester transfer protein, and low-density Lipoprotein (LDL-c), as well as decreasing high-density lipoprotein (HDL-c). The function of atherogenic lipoproteins, i.e. increasing triglyceride (TG), increasing LDL-c, and decreasing HDL-c) causes atherosclerosis and increases the risk of cardiovascular events (14). Presently, experts believe that diet and medications are not sufficient alone to treat and control blood glucose in diabetic patients, and physical activity and exercise also have to be added to the daily program of the diabetic patients (15). Aerobic exercise is intended to be an essential part in the medical management of type 2 diabetic patients in order to improve cardiovascular health in these individuals (16). Kadoglou, in his study on 50 diabetic women showed that 16 weeks of aerobic exercise has led to reductions in the levels of lipids and hs-CRP in the aerobic exercise group compared to the control group (17). Since diabetic patients are at risk for cardiovascular disease, the identification of markers that can be helpful in diagnosing this disease seems to be essential in the human societies (18). Considering the important role of physical activities in reducing the risk factors of cardiovascular disease in diabetic patients, and given the fact that in Iran no research has been conducted to show the relationship between the new cardiovascular markers (hs-CRP) and physical activities in diabetic patients, this study was done to investigate the effects of aerobic exercise on some cardiovascular risk factors in women with type 2 DM.

Materials and Methods

This study was semi-experimental. Furthermore, its plan was confirmed by Research Assembly of Physical Education and Sport Sciences Faculty of Ferdowsi University of Mashhad (Iran). During the first stage, the subjects of this study were twenty women with type II diabetes who were selected by convenience sampling method and were randomly divided into two experimental (n=11) and control (n=9) groups. Before starting the program, written informed consents were taken from all subjects. During the second stage, their height was measured in centimeters using a stadiometer and their weight was measured using a Beurer PS07-PS06 digital scale model. The body composition was determined by bioelectric impedance using In Body-720 (Biospace, Dogok-dong, South Korea) to study the percent of body fat (PBF). All of these measurements were carried out while the volunteers had stopped eating or drinking 4 hours prior to their test, and their bladder, stomach, and bowels were empty.The exercise protocol included aerobic exercise training lasted for 6 months and 3 sessions per week and every session lasted for 60 minutes and with intensity of 60-70 percent of maximum heart rate reserve (MHRR). MHRR was respectively calculated for every single athlete calculated based on Karvonen equation as follows: Target heart rate= [(220-age) − HR_{rest}) × %60 or %70] + HR_{rest} (19). It was also controlled during exercise by a heart rate monitor (Finland–Polar) . Blood samples were collected by venepuncture from forearm vein after at least 15 minutes of sitting at rest or in the supine position. After centrifuging samples in plastic capillary tubes using Haematospin centrifuge, serum CRP concentration was determined using an auto-analyzer spectrophotometer and different kits in various wavelengths as follows. Serum CRP concentration was determined by using Pars-Azmun kits with Immunoturbidometric method. Glucose was measured by an auto-analyzer using enzymatic method. Serum total cholesterol, TG and HDL-c were measured by an auto-analyzer using enzymatic method (Pars-Azmun kits), and LDL-c was then calculated using Friedewald equation (20). All statistical analyses were performed with SPSS version 16. The mean and standard deviation of data were calculated after checking the data distribution normalcy using Kolmogorov-Smirnov and homogeneity of variance tests. The comparison between mean values of the groups and homogeneity of the groups were examined using independent samples t-test. $P<0.05$ was considered significant.

Results

Twenty diabetic women, with the mean age of 50.7±8.2 years, participated in this study. Descriptive information concerning the age, height, weight, body mass index (BMI) and percent fat among the different groups is given in Table 1. The level of hs-CRP in experimental group was significantly reduced from 1.11±0.21mg/dl to 0.8±0.2mg/dl (p=0.02). According to the Table 2, the levels of fasting glucose and total cholesterol in experimental group were decreased and HDL-c was increased significantly compared with control group ($p<0.05$). Although serum levels of TG and LDL-c were reduced in the experimental group, this reduction was not statistically significant. None of the changes in the control group were significant except for an increase in TG level.

Table 1. Descriptive values of basic measurements in the study groups.

Variables	Experimental	Control
Age (year)	51.18± 8.09	51.11± 8.78
Height (M)	157.69± 3.26	154.72± 4.42
Weight (Kg)	70.65± 11.59	69.76± 8.7
BMI (Kg/m^2)	28.47± 4.85	29.05± 3.2
Fat percent (%)	39.86± 6.53	39.12± 5.96

***Data are presented as mean±SD.**

Discussion

The aim of this study was to investigate the effect of an eight week aerobic exercise on women with Type 2 Diabetes. This study showed significant reduction of hs-CRP level following eight weeks of aerobic exercise in the experimental group. Comparison of the groups showed no significant changes after eight weeks. It is important to note that the intensity, type, and the length of the exercise along with muscular vulnerability, and the number of the used muscles are influential on CRP response to physical activities. In intense and short exercises, in which the use of different muscular tissues is almost rare, CRP response happens late. Therefore, the results of the study are in agreement with the results of the studies done by Kadoglou et al. and Roberts et al. (17,21,22). Overall, researchers have concluded that any change in the concentration of hs-CRP depends on several factors; in this regard different mechanisms have been suggested to explain the change in hs-CRP concentration that can be referred to here. One of these mechanisms is through reducing cytokine productions from adipose tissue, skeletal muscle, endothelium and blood mononuclear cells; improvement of endothelial function, increasing anti-oxidative effects, reducing the level of fat and leptin and increasing the expression of adiponectin which in turn decreases the level of CRP; which all of them are possible by regular physical

Table 2. Comparison of pre-test and post-test variables in the two groups.

Variable	Groups	Pre-test	Post-test	p*	p**
hs-CRP (mg/dl)	Aerobic training	1.11±0.21	0.8±0.2	0.02†	0.7
	Control	1.06±0.29	0.83±0.28	0.06	
FBS (mg/dl)	Aerobic training	127.09±43.86	110.72±35.74	0.04†	0.01†
	Control	134.88±30.73	136.55±35.35	0.85	
Total Cholesterol (mg/dl)	Aerobic training	164.72±32.37	149.09±23.61	0.04†	0.02†
	Control	159.77±19.97	166.66±19.95	0.31	
TG (mg/dl)	Aerobic training	131.09±50.66	122.63±55.34	0.46	0.15
	Control	143.77±42.94	168.33±65.24	0.03†	
LDL-C (mg/dl)	Aerobic training	93.09±13.19	84.09±23.61	0.058	0.08
	Control	95.11±10.87	94.77±12.99	0.92	
HDL-C (mg/dl)	Aerobic training	47.72±2.76	50.36±1.6	0.01†	0.03†
	Control	48.77±2.63	51.11±11.76	0.53	

***Within groups changes**
****Between groups changes**
Significant (p<0.05)
Data are presented as mean±SD.

activities and exercising (23). The results of this study showed that mean serum concentration of fasting glucose was significantly decreased in experimental group compared with the control group ($p<0.05$); these results are in agreement with some previous studies (17,21,24,25,26,27). In diabetic patients, impaired glucose uptake is usually caused by dysfunction of glucose transport protein 4 (GLUT-4) or impairment of insulin signaling (28). Physical activity stimulates and changes GLUT-4 and transforms it into the cell membrane (29) and increases the rapid uptake of glucose done by active skeletal muscles through protein carriers (29,30). Another reason for improved glycemic control in experimental group compared with the control group is that after aerobic exercise, the protein content of insulin receptors as well as the activity of protein kinase B which has an essential role in insulin signal transmission is increased which may lead to lower blood sugar (29). Also, based on the results, it was found that in the experimental group compared with the control group, the levels of total cholesterol were significantly decreased and HDL-c level was increased. Also, TG and LDL-c levels were reduced in the experimental group, but this reduction was not statistically significant which may be due to the intensity of the exercises. These results also are concordant with the results of Kadoglou et al (17), Roberts et al (21), and Gordon et al (24). An effective adaptation after aerobic activities is mitochondrial volume increase followed by lipolysis enzymes' activity which enhances the fats' catabolism ability during the exercise (30). Furthermore, in women, during the physical activities the secretion of 17-beta estradiol will be increased and therefore fat reserves as an energy source are more used during the exercise (31). The reason for increasing HDL-c can be the increased activity of lipoprotein lipase (LPL). LPL is effective in VLDL conversion into HDL-c; increased LPL activity results the higher levels of HDL-c. On the other hand, lecithin-cholesterol acyltransferase (LCAT) converts cholesterol as well as LDL-c into HDL-c. Probably the increase of this enzyme is responsible for the exercise-related increase of HDL-c (32). It has shown that physical activities increase LCAT greatly. In this regard, other mechanisms such as lowering insulin sensitivity which changes the levels of blood lipids and lipoproteins are noteworthy (32,33). In conclusion, the results of this study showed that two months of regular aerobic exercise reduces the levels of hs-CRP, glycemia and lipid profiles in women with type 2 diabetes. These changes have favorable effects on heart health of diabetic patients and will reduce the risk of cardiovascular disease in these patients.

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The authors declare that there is no conflict of interests.

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