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The effects of six weeks moderate-intensity aerobic training on plasma glutathione peroxidase and superoxide dismutase in women with type-2 diabetes

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ABSTRACT

Aim: The aim of this study was to evaluate the effects of six weeks moderate-intensity aerobic exercise on plasma glutathione peroxidase and superoxide dismutase levels in adult women with type-2 diabetes. Methodology: The research population included postmenopausal diabetic women aged from 45 to 60. These women were from the county of Babol and were introduced by the Diabetes Association of this county. From this population, 17 women were selected as subjects and randomly divided into two groups: experimental and control. Experimental group's program consisted of 6 weeks of aerobic exercise training program three sessions a week for at least 45 minutes per session. Two days before and after the training period, blood samples were taken from their brachial veins in a fasting state (12 hours prior to the test) in a sitting position. Results: The results indicated that aerobic exercise significantly increases the levels of glutathione peroxidase and superoxide dismutase in adult women diagnosed with type-2 diabetes compared with the control group. Conclusion: According to the research findings, it can be stated that this aerobic exercise program can have beneficial effects on the antioxidant defense system of the body and reduce oxidative stress in adult women with type-2 diabetes, because it improves the antioxidant defense of the body by increasing the levels of certain plasma antioxidant enzymes.

Keywords: Type-2 diabetes, aerobic exercise, glutathione peroxidase, superoxide dismutase.

INTRODUCTION

Diabetes is one of the common diseases whose rate is highly increasing (1). It is predicted that the number of people diagnosed with this disease would reach 334 million by 2025 (1). Type-2 diabetes that accounts for almost 95% of diabetes cases is caused by muscle cells' inability to properly respond to insulin, while genetic and environmental factors are also effective. As one ages, obesity, physical inactivity, and decrease of body's overall metabolism become more prevalent, especially in postmenopausal women (2). One of the useful solutions for these patients is physical activity, especially aerobic exercise with moderate intensity, which leads to a decrease in the symptoms of this disease (3). Several studies were conducted on the impacts of various exercise methods on markers of diabetes and its effective factors (1). Studies indicate that physical training, as a common way to lower the blood sugar, is effective in the improvement of patients with type-2 diabetes (4). Aerobic exercise with moderate intensity involves the large muscles of our body for a while in a regular and constant way and can adjust insulin's function in any muscle fiber without increasing its size (5). The risk of type-2 diabetes for those involved in regular exercises is twice less than for those who are physically inactive (3, 6).

Free radicals are molecules with high levels of reactivity that are naturally produced during the metabolic reactions of the body. The high levels of free radicals harm cell proteins, membrane lipids, nucleic acids, and eventually lead to cell death. Free radicals play an important role in the pathogenesis of many chronic diseases including atherosclerosis, myocardial failure, autoimmune diseases, cell damages, and diabetes. Under healthy conditions, the antioxidant defense system of the body resists against the production of free radicals and prevents the effects of these harmful substances (7). The substances that have antioxidant activity in the body are divided into two groups: the first group includes non-enzyme antioxidants such as vitamins A, C, E, carotenoids, glutathione, and flavonoids; among other substances in this group are α-lipoic acid, coenzyme Q_{10}, and such materials as copper, zinc, magnesium, and selenium. The second group includes enzyme antioxidants including catalases, superoxide dismutase, glutathione reductase, arylesterase, and paraoxonase (8). In addition to the production of oxidative stress, the antioxidant defense system of the body is also impaired in patients with diabetes. Since the superoxide dismutase enzyme is one of the first defensive barriers of the body against oxidative stress, it can be expected that the activity of this enzyme be impaired more than that of other enzymes. In patients with diabetes, the activity of glutathione peroxidase is more than that of healthy people and it was concluded in these studies that the effect of diabetes on the activity of glutathione peroxidase enzyme in different tissues did not yield similar results. In a patient with diabetes, reducing these changes using physical training with an anti-diabetic and antioxidant function is of a great clinical importance (9). Considering the importance of the issue, this research endeavors to examine whether aerobic training with moderate intensity has any effect on the levels of glutathione peroxidase and superoxide dismutase in patients diagnosed with type-2 diabetes.

MATERIALS AND METHODS

Subjects

The research population included postmenopausal diabetic women aged from 45 to 60 from the city of Babol who were invited with the coordination of the Diabetes Association of this county. Once the volunteers were interviewed and their consents were gained, considering the conditions of volunteers for participating in the training program, 16 persons were randomly selected and divided into two groups. All qualified subjects submitted their letters of consent and the relevant questionnaire one week before the beginning of research and expressed their readiness to start the training program. The subjects also took part in an introductory session to get familiar with the program.

Exercise instruction

The training group participated in the training program for six weeks and three sessions per week. The training program started with 10 minutes of warm-up. The training time started from 25 minutes and each day, two minutes were added to it until the activity time reached 45 minutes. From that point on, the duration was kept constant. The intensity of the activity started from 60% of heart rate reserve and 5% percent was added each week until the time when the intensity reached 75% of heart rate reserve. After that, the intensity of exercise was kept constant. At the end of these training sessions, the participants cooled down for 10 minutes.

Blood samples

Two days before and after the training program blood samples were taken from the participants' brachial veins in a sitting position in a fasting state (12 hours prior to the test). Their physical and physiological measures were also documented. The subjects were asked not to change their diets during the research.

Biochemical Assessment

The activity of glutathione peroxidase and superoxide dismutase was measured through spectrophotometry. The obtained values were stated as units per milligram of protein.

Statistical method

Descriptive statistics was used to classify the data; Kolmogorov-Smirnov test was applied to check the data for being normal; and independent and dependent t-test was adopted to analyze the data. It should be noted that the findings are expressed in the form of mean ± standard deviation. SPSS program (version 16) was used to calculate the data and the significance difference was set up at the level of $p \leq 0.05$.

RESULTS AND DISCUSSION

The descriptive indicators of subjects at the beginning and end of the protocol are provided in Table 1. The results of tables 2 and 3 indicate that aerobic exercises has led to a significant increase in the level of plasma glutathione peroxidase (P=0.006) and superoxide dismutase (P=0.003). A significant difference was also observed between the averages of plasma glutathione peroxidase (P=0.001) and superoxide dismutase (P=0.001) before and after the exercise in the two subject groups.

Table 1: Descriptive indicators of subjects

	N	Control group M±SD		Experimental group M±SD	
		Pre test	post test	Pre test	post test
Height (cm)	8	1.578± .0434	1.578±.0434	1.577±.0585	1.577±.0585
Age	8	49.500±8.0622	49.500±8.0622	50.500±5.6568	50.500±5.6568
Weight (kg)	8	66.142±8.6492	66.785±9.2098	68.611±12.0979	73.388±10.3494
BMI	8	26.512±2.9784	26.776±3.2960	27.441±3.7873	29.456±3.5190
WHR	8	.935±.1695	.937±.1690	.924±.0621	.933±.1188

Table 2: The results of dependent t-test of glutathione peroxidase (GPX) in experimental and control groups

	Group	N	M±SD		Sig
			Pre test	post test	
GPX	Control	8	5.252±1.890	5.152±1.813	0.006
	Experimental	8	4.757±1.110	6.294±7.792	

Table 3: The results of dependent t-test of superoxide dismutase (SOD) in experimental and control groups

	Group	N	M±SD		Sig
			Pre test	post test	
SOD	Control	8	1.784±2.413	1.771±2.078	0.003
	Experimental	8	1.741±1.940	2.138±2.103	

Table 4: The difference between measured variables, before and after the exercise within the two subject groups

	Control group M±SD	Experimental group M±SD	F	Sig
Diff.GPX*	-1.000±2.633	1.537± 4.644	1.155	0.001
Diff.GPX	-1.285±6.447	39.777±1.604	8.769	0.001

**Diff is the difference between variables before and after the exercise*

The results of the present study revealed that aerobic physical activities with moderate intensity increases the levels of antioxidant enzymes significantly; in a way that the level of plasma glutathione peroxidase (GPX) in the aerobic exercise group showed a significant increase compared with the control group after the research protocol. Several mechanisms are provided to justify the response of antioxidant enzymes to exercise. In some studies, an increase in the levels of glutathione peroxidase was observed after the exercises (10), which can imply an increase in glutathione resources as a glutathione peroxidase coenzyme. During the activity of glutathione peroxidase, reduced glutathione is converted into glutathione acid. This acid is again converted into reduced glutathione by the reductase glutathione enzyme using NADPH. Research shows that glutathione peroxidase reduces H_2O_2 by glutathione oxidant (GSH) (11). In fact, exercise conditions (type, intensity, time) are the first mechanism that influences the oxidative stress indices after the training. Interestingly, intense exercise leads to a temporary increase in the production of reactive oxygen and types of nitrogen; however, it also provides the required stimuli for the defense of endogenous antioxidant (12). Long-lasting exercise leads to an increase in the metabolism of the body and thus an increase in the consumed oxygen; in a way that free radicals are increased and this increases antioxidant enzymes (10, 13, 14). In many studies on the impacts of exercise on oxidative stress, it is reported that intense and endurance training diminishes the damage of oxidative stress associated with exercise (15, 16, 17). The findings of the present study are in line with the results of Lionburgho et al., Miyazaki et al., Oztasan, Radack et al., Sherlaksemi et al., Tirumali et al., and Gala et al., who showed that intense and endurance training decreases the damage of oxidative stress resulted from exercise (10, 15, 16, 17, 18, 19, 20, 21). In this study, aerobic physical training with moderate intensity also led to a significant decrease in weight and the sizes of waist and hip. A decrease in appetite and fat absorption from the intestine due to the prevention of pancreatic lipase's activity can account for the weight loss. Another indicator examined in this study is the amount of plasma superoxide dismutase that showed a significant increase after the protocol compared with the control group. It is well obvious that superoxide dismutase is produced during exhaustive physical activity as the front line of defense by antioxidant enzyme system against ROS (22, 23). In fact, superoxide dismutase eliminates the first produced radical, i.e. superoxide radical, or converts it to peroxide hydrogen which is a weaker radical (24). In patients with diabetes, hyperglycemia leads to an increase in CU^{2+} ion release, which is an essential co-factor for the activity of SOD enzyme, and by physical exercise, one can deal with the decrease of this enzyme (25). The results of the present study is in line with the results of studies conducted of superoxide dismutase (22, 23). Further studies are required to discover this mechanism. Tissue over-oxygenation is one of the most important reasons for the rise of oxidative stress factors and the response of oxidative stress to physical exercise is affected by many factors such as one's health conditions, age, gender, race, genetics, level of physical fitness, individual differences, different tissue responses, muscle fibers and its various types, the intensity and time of exercise, and the decrease of anti-oxidative-stress nutrition received in one's daily diet (26). Consequently, the obtained results in this study can be justified. Most importantly, the variety of lipid peroxidation indicators and their measurement methods and sensitivity in different studies can lead to different results. In addition, regular physical exercise with moderate intensity makes a positive change in the oxidative homeostasis of cells and tissues by diminishing the oxidative damage and increasing resistance against oxidative stress. Research findings indicate that physical exercise can increase antioxidant enzymes, decrease the oxidative stress created in pancreatic tissue, prevent the destruction of beta cells, and improve the performance of pancreatic beta cell mass, all of which lead to an improvement in the life quality of patients with diabetes after physical exercise. Therefore, based on the results of previous studies, the increase in the levels of antioxidant glutathione peroxidase and superoxide dismutase in diabetic patients of this study after aerobic exercise with moderate intensity improves the antioxidant condition of these patients.

CONCLUSION

According to the findings of the present study, one can probably say that aerobic exercise with moderate intensity can control free radicals and can have useful effects on the antioxidant defense system of the body and reduce the oxidative stress in adult women with type-2 diabetes, because it improves the antioxidant defense of the body by increasing the serum level of certain plasma antioxidant enzymes. Nevertheless, considering the novelty of this study's area of focus, there still remains several questions worthy of further attention in future research.

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