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The Effect of a Short Period of Aerobic Training on Serum Asprosin, Glycemic Control, and Lipid Profile in Women with Type 2 Diabetes

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Abstract

Introduction: Asprosin is an adipokine related to glucose homeostasis and type 2 diabetes (T2D). It has also been stated that exercise is one of the main pillars in the management of T2D, along with drug therapy. The aim of this study was to determine the effect of a short period of aerobic exercise on serum asprosin, glycemic control, and lipid profile in women with T2D.

Methods: In this semi-experimental study, 30 women with T2D from Zabol were selected by purposive sampling and divided into the training (3 weeks of aerobic exercises, 3 sessions per week) and control (no training) groups. Fasting blood sugar (FBS), fructosamine, asprosin, and lipid profiles were measured at the beginning of the intervention and 48 hours after the last session of the intervention.

Results: The findings of the present study showed that after 3 weeks of intervention, there was a significant decrease in FBS ($P=0.011$), fructosamine ($P<0.001$), and serum asprosin ($P=0.038$) and a significant increase in the high-density lipoprotein level ($P=0.002$) in the training group compared to the control group. However, no significant difference was observed in triglyceride, total cholesterol, or low-density lipoprotein ($P>0.05$).

Conclusion: Based on the findings, 3 weeks of aerobic training had positive effects on the adjustment of serum asprosin, which was related to glycemic control and the improvement of the lipid profile.

Keywords: Type 2 diabetes, Exercise training, Asprosin, Metabolic disorders

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Introduction

Type 2 diabetes (T2D) is one of the most common metabolic disorders in the world, which, in addition to genetic factors, is influenced by environmental factors such as inactivity, nutrition, stress, and other factors.[1] Studies have been conducted on molecular and signaling factors affecting insulin resistance as the main cause of T2D. New research shows the connection between obesity and insulin resistance.[2] Adipose tissue is currently considered a dynamic endocrine organ that exerts its effects on different tissues by secreting pleiotropic factors collectively called adipokines. The amount of secretion or function of adipokines changes in obesity and metabolic disorders.[1,3] The release of hepatic glucose into the circulation is critical for brain function and survival during periods of fasting and is regulated by a series of hormones that precisely regulate plasma glucose levels.[4] Asprosin stimulates a cyclic adenosine monophosphate-dependent mechanism that leads to the rapid release of glucose in the liver.[1] It has been reported that serum asprosin levels are increased in obesity and T2D and are associated with insulin resistance and dyslipidemia.[5] It has been suggested that targeting asprosin therapeutically may be beneficial in T2D and metabolic syndrome.[6]

Insulin resistance is often associated with metabolically unhealthy obesity, which leads to metabolic disorders.[2] Therapeutic approaches aimed at improving insulin sensitivity are believed to prevent and treat metabolic disorders.[2,7] One of the non-drug therapeutic interventions in T2D is exercise, which has been introduced as one

of the pillars of treatment in this disease, along with drug therapy,[7] highlighting the practical importance of exercise in reducing complications related to T2D. There is limited research on the effect of regular exercise on asprosin as a biomarker related to glucose homeostasis and a metabotropic factor, which indicates the need for more research in this regard. Therefore, the present study sought to determine the effects of three weeks of aerobic exercises on serum asprosin level, insulin resistance, and lipid profile in women with T2D.

Materials and Methods

Population

In the current study, 30 women with T2D were selected through a simple random sampling method from patients who referred to Zabul health centers, who met the conditions to enter the study and completed a questionnaire about their physical condition, disease, and lifestyle. The inclusion of women was based on the examination and issuance of sports licenses by a specialist doctor, ensuring that there were no problems prohibiting exercise. During a meeting, the volunteers to participate in this plan were familiarized with the type of plan, its goals, and its implementation method, both formally and verbally. After examination by a specialist doctor (if it is determined that there is no obstacle to exercise) and physical fitness tests, they were selected and randomly placed in one of the 2 experimental and control groups. The exclusion criteria included being absent during the training sessions two times, performing any intervention except for the interventions considered based on grouping, changing the medication plan of the patients by the doctor, and having any injury or illness that affects the training intervention or the results.

Sample Size

In this research, according to the previous studies and the formula below, 10 people were considered in each group, and according to the recommendation of the statistical consultant, a total of 30 people were taken into account (two groups of 15 people).

$$n = \frac{(z_{1-\frac{\alpha}{2}} + z_{1-\beta})^2 (s_1^2 + s_2^2)}{(\overline{x}_1 - \overline{x}_2)^2}$$

Measurements

In the present study, baseline variables were measured 24 hours before the start of the interventions. In the post-test, the measured variables determined fasting 48 hours after the last training session, at 8–9 in the morning. Glucose, total cholesterol, triglycerides, and high-density lipoprotein (HDL) were assayed using standard enzymatic procedures. Low-density lipoprotein (LDL) levels were obtained by the Friedewald formula.[8] The serum obtained from blood sampling was used to measure the desired indicators with special kits. All biochemical tests were measured in serum on a BT 3000 automatic analyzer by commercial kits (Pars Azmoon, Iran). The level of fructosamine was also estimated with the calorimetric method. The concentration of serum asprosin was determined with the WUHAN EIAAB SCIENCE human sample kit (China) with a sensitivity of 0.8 ng/mL by the enzyme-linked immunosorbent assay. A Rockport walking test was also performed to estimate aerobic capacity (VO_2max).

Interventions

After measuring the basic variables, the participants were randomly divided into two experimental groups (aerobic exercise and drug treatment) and one control group (only drug treatment). Aerobic training consisted of three weeks of training, three sessions per week with one day in between, and each training session included aerobic exercises for 45–60 minutes and with a 60%–70% reserve heart rate under the supervision of the relevant coach, the sports physiologist, and the nurse to avoid possible dangers.

In this research, the patients were instructed to stop the exercise if they felt any pain in the limbs, chest, shoulders, and body, or if they were too tired. In this research, to prevent hypoglycemia during and after exercise, patients were advised to use the snacks recommended by the nutritionist before and after exercise, as well as a sweet food to be used in cases of hypoglycemia. To control yogism, the blood sugar of the patients was checked by a glucometer device (Ecocheck model, GC model, Germany). In addition, to control blood pressure fluctuations, a digital sphygmomanometer was used to measure blood pressure, and if it was out of the recommended range, they were prevented from exercising.

The control group did not practice regular exercise during these three weeks of intervention and only used the usual medical recommendations. Participants utilized the same drug treatment and nutritional recommendations throughout the study period and were prohibited from taking supplements and other drugs.

Statistical Analysis

In this research, descriptive statistical methods, including means and standard deviations, were employed for reporting the results. To compare the difference between the pre-test and the third week, a paired sample t-test and the analysis of covariance test were used to compare the control and training groups. All statistical analyses were performed at a significance level of $P < 0.05$ by SPSS software, version 22.

Results

Table 1 presents the means and standard deviations

related to age, height, body mass index, VO_{2max}, and history of T2D in both experimental and control groups.

According to the results obtained from the dependent t-test (Table 2), a significant decrease in the levels of fasting blood sugar (FBS) ($P=0.003$), fructosamine ($P=0.002$), and LDL ($P=0.014$) and a significant increase in HDL levels ($P<0.001$) were observed in the training group compared to the baseline values. However, no significant change was found in any of the variables studied in the control group ($P>0.05$). In the examination of intergroup changes, the results of the analysis of covariance (Table 2) revealed that the decrease in FBS ($P=0.011$) and fructosamine ($P<0.001$) and the increase in HDL ($P=0.002$) in the training group were significant compared to the control group.

In addition, the results demonstrated that there was a significant decrease in the fasting serum asprosin level in the training group compared to the pre-test ($P=0.013$), but no significant change was observed in the control group ($P=0.128$). In the intergroup comparison, a significant difference ($P=0.038$) was found between changes in the training group in comparison to the control group (Figure 1).

Table 1. Table of Demographic Characteristics of the Subjects

Variables	Experimental	Control	Sig.
Age (y)	40.3±3.8	39.1±3.8	NS
Height (cm)	169.5±6.6	171.5±7.7	NS
Weight (kg)	77.2±9.4	78.5±11.4	NS
BMI (kg/m^2)	26.8±2.1	26.6±2.3	NS
VO_2max (mL.kg^{-1}.min^{-1})	33.8±2.0	34.5±1.5	NS
Time of diabetes (year)	3.7±2.0	4.1±1.4	NS

Note. NS: No significant; Significant level ($P\leq0.05$); BMI: Body mass index; VO_2max: Maximal oxygen consumption.

Table 2. Comparison of Pre- and Post-test Means of Research Variables

Variables	Group	Within-Group Changes				Between-Group Changes	
		Pre-test	Post-test	t	*P*	Δ	*P*
TG (mg/dL)	Experimental	166.87±21.98	150.80±24.24	2.107	0.054	-16.02±29.53	0.103
	Control	172.27±60.57	182.47±58.99	-0.749	0.466	+10.20±52.73	
TC (mg/dL)	Experimental	148.80±17.79	143.00±9.61	1.909	0.077	-5.80±11.77	0.354
	Control	154.00±11.89	152.73±13.27	0.339	0.740	-1.27±14.46	
HDL (mg/dL)	Experimental	37.87±5.41	41.73±5.34	-5.254	<0.001*	+3.87±2.85	0.002#
	Control	42.67±6.42	42.47±6.82	0.205	0.841	-0.20±3.78	
LDL (mg/dL)	Experimental	77.56±13.35	71.11±8.85	2.816	0.014*	-6.45±8.89	0.340
	Control	76.88±6.03	73.77±12.47	1.280	0.247	-3.11±9.96	
FBS (mg/dL)	Experimental	136.93±33.94	121.00±23.19	3.520	0.003*	-15.93±17.53	0.011#
	Control	133.47±17.13	134.40±19.02	-0.219	0.830	+0.93±16.48	
Fructosamine (μmol/L)	Experimental	352.10±54.48	299.70±52.26	4.298	0.002*	-52.40±38.56	<0.001#
	Control	227.70±61.45	334.80±58.83	-1.297	0.227	+12.10±29.51	

Abbreviations: FBS, Fasting blood sugar; TG, Triglycerides; TC, Total cholesterol; HDL, High-density lipoprotein; LDL, Low-density lipoprotein.
* Significant change from baseline values; # Significant change compared to the control group.

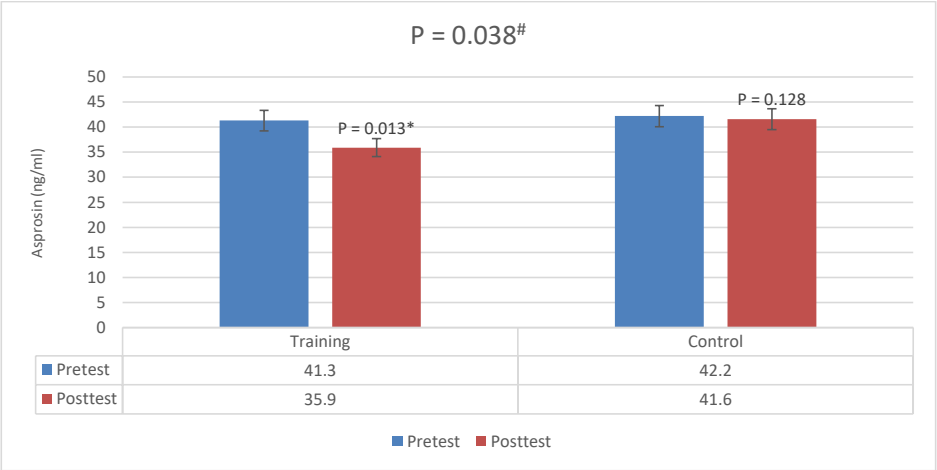

Figure 1. Changes in Fasting Serum Asprosin in Training and Control Groups. *Note*. * Significant change from baseline values; # Significant change compared to the control group

Discussion

Based on the results of the present study, after three weeks of intervention, a significant decrease in the levels of serum asprosin, FBS, and fructosamine was observed in the training group compared to the control group. One of the important findings of the present study was a significant decrease in asprosin after the training intervention period. One of the humoral agents that is effective in blood sugar control is asprosin, which can justify the positive effects of aerobic exercises on glycemic control in the current research. The results of the present research confirmed the positive effects of aerobic exercises on asprosin modulation despite the short intervention period compared to previous findings.[1,9,10] It has been stated that asprosin is a glucogenic agent that increases the release of glucose from the liver.[6] After secretion, asprosin travels to the liver, where it exerts its glucogenic effect through OR4M1, a G protein-coupled receptor.[11] Asprosin plays an important role in regulating glucose homeostasis and lipid metabolism through the cyclic adenosine monophosphate-*protein kinase A* pathway in the liver and hypothalamus.[1,6] Plasma asprosin levels have been reported to be positively correlated with waist circumference, fasting plasma glucose, post-challenge plasma glucose (2hPG), hemoglobin A1c (HbA1c), triglycerides, and homeostasis model assessment for insulin resistance.[12] The results of our research also indicated a decrease in variables related to glycemic control after the intervention period. It has been reported that physical activity as a non-drug treatment method is effective in controlling blood glucose in diabetics because it increases insulin sensitivity and glucose tolerance while reducing blood glucose in these patients.[13,14] In the review conducted by Shah et al, it was found that exercises for more than eight weeks lead to glycemic control and a reduction of HbA1c in patients with T2D.[14] In our research, fructosamine was used for a short period (3 weeks), and the results showed a significant reduction in fructosamine, emphasizing the positive effects of aerobic exercises on glycemic control. The fructosamine test replaces the traditional HbA1c assessment in the glucose assessment of type 2 diabetic patients during a short exercise program.[15] During exercise, muscle contraction-induced improvements in insulin sensitivity are associated with increased adenosine monophosphate-activated protein kinase activity, which promotes the translocation of GLUT4 to the cell membrane, thereby enhancing glucose uptake. After exercise, increased protein kinase B inactivates TCB1D4, thereby increasing GLUT4 translocation to the cell membrane.[13] It has been reported that exercise increases GLUT4 and improves insulin signaling, which can lead to better glucose uptake by muscles and prevent hyperglycemia in diabetics.[7] It has also been stated that exercise is effective in maintaining the health of beta cells and plays a role in preventing or slowing down the progression of diabetes through the humoral communication between muscle and beta cells.[16] It is possible to mention the reduction of asprosin in adaptation to regular exercise as one of these communication factors that causes glycemic control in patients with T2D.[1] It has been reported that asprosin, by binding to unknown receptors expressed in mouse skeletal muscle cells, impairs insulin sensitivity by activating endoplasmic reticulum stress or inflammation pathways mediated by PKCδ/SERCA2.[17]

In examining the effect of aerobic exercises on lipid profile, after the intervention, a significant increase in the HDL level was observed in the training group compared to the control group. In addition, aerobic exercises could reduce the LDL level compared to the pre-test, But these changes were not significant compared to the control group. In patients with T2D, insulin resistance is characterized by atherogenic dyslipidemia, a specific lipid pattern that includes hypertriglyceridemia, decreased HDL levels, and elevated LDL.[18] In their study, Hong et al reported that asprosin was independently and positively correlated with the occurrence of metabolic syndrome and insulin resistance, even after controlling for anthropometric variables, lipid profiles, and inflammatory markers.[19] Based on the relationship of asprosin with metabolic syndrome, by reducing asprosin and subsequently reducing insulin resistance, lipid metabolism has improved, leading to an increase in HDL. Apart from being involved in reverse transport, HDL cholesterol exerts various effects, including anti-inflammatory, antioxidant, anti-diabetic, anti-thrombotic, and many other activities.[20] HDL concentrations have been shown to increase with regular endurance exercise and, therefore, may help reduce the risk of coronary heart disease in physically active individuals compared to sedentary individuals.[8,21] Despite producing small changes in serum lipids, exercise has beneficial effects on HDL particle maturation, composition, and function.[21] The effects of regular exercise on HDL function are variable and depend on several factors, including exercise dose and participant characteristics.[22] Probably, these positive changes in the lipid profile are more likely with the increase in the duration of the exercises and other variables such as the intensity of the exercise, the type of exercises, or the time of exercise sessions.

Limitations of the Study

The limitations of the current research include the small size of the research sample and the use of women alone as the research sample. In addition, patients participating in the current research were patients whose blood sugar levels were clinically less than 200 mg/dL; thus, the results of this research may not be generalizable to all diabetic patients.

Conclusion

In total, the results of the present study revealed that three weeks of aerobic exercises reduced serum asprosin, controlled glycemia, and improved the lipid profile in the form of an increase in HDL. This improvement in the metabolism of patients with T2D can be attributed to the adjustment of serum asprosin and its effect on improving glucose homeostasis and dyslipidemia.

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Authors' Contribution

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Competing Interests

The authors declare that they have no conflict of interests regarding the publication of this article.

Ethical Approval

This study was approved by the ethics committee of Zabul University of Medical Sciences (ethics code: zbmu.1.REC.1394.94).

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