

## Evaluating the Effect of Standard Nutrition-Exercise on Glucose and Lipids Level on Type 2 Diabetic Patients: An Intervention Study

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**Background:** Diabetes was one of the most important metabolic and public health diseases all over the world. It was the most common endocrine disease caused by metabolic disorders. Type 2 diabetes is rapidly progressing in world. The incidence of diabetes is predicted to double in the following 20 years.

**Objectives:** The current study was aims to evaluate the effect of standard nutrition and exercise on glucose and lipid levels in diabetic patients.

**Patients and Methods:** It was an intervention study whose target population is consisting of 120 diabetic patients who had referred to PARSIAN Diabetes Research Center. Sampling size has been non-randomly selected. Mean and standard deviation are quantitative data applied in this study. T-test and independent sample T-test have been respectively utilized to compare changes within and between the groups. The amount of p-value has been calculated less than 0.05 which indicates statistical significance.

**Results:** The achieved findings shows that glucose level has significantly decreased in experiment group using a pretest-posttest design ( $P < 0.05$ ).

**Conclusions:** Eight-week standard nutrition and regular exercise have significant effect on decrease of glucose level, insulin resistance and plasma lipoproteins. It is suggested to apply these programs in diabetes centers.

**Keywords:** Standard; Exercise-Nutrition; Glucose; Lipids; Diabetes; Intervention Study; Diabetes

### 1. Background

Diabetes was one of the most important metabolic and public health diseases all over the world (1). It is the most common endocrine disease caused by metabolic disorders (2). Type 2 diabetes was rapidly progressing in world. The incidence of diabetes was predicted to double in the following 20 years (3). In 2000, 5.7% of Iranians suffered from diabetes, while this population will increased to 6.8% by 2025 (4). The percentage of type 2 diabetes was about 7.7 (2,000,000 people) among 25-64-year old Iranians, half of whom have not recognized their disease (5). Insulin injection, standard nutrition and regular exercise were three main factors in the treatment of diabetes. Regular aerobic exercise, like changing the patterns of diet, is another part of the course of treatment for diabetes. Type 2 diabetes was increasingly common due to aging, obesity, sedentary lifestyle, higher consumption of simple sugar and high calories food (6). Although genetic factors have been also affective in type 2 diabetes, lifestyle was known as the main cause of this disease (7). 66% of diabetic patients also suffers from cardiovascular diseases which was the leading cause of death among

diabetic patients twice as high (8). Cardiovascular diseases could endanger diabetic patients about 66% more due to hyperlipidemia and cholesterol increase in blood. Furthermore, owing to the fact that diabetics were at risk of cardiovascular diseases, they need to be more accurately diagnosed with these diseases (5). Nowadays the incidence of diabetes can be epidemically seen all over the world, since more than 24,000,000 people were diagnosed with type 2 diabetes by the Centers for Disease Control and Prevention in 2007, while still 6,000 patients have not been known (8). The incidence of diabetes is predicted by the World Health Organization (WHO) to increase to 300,000,000 adults in 2025 (1).

Today, it is estimated that one in three people are affected by diabetes. Diabetes is considered as a significant cause of premature death and a major cause of cardiovascular diseases. It also causes kidney diseases, blindness and amputations (2). Type 2 diabetes brings about cardiovascular diseases, blindness, kidney diseases and amputations. Regular exercise can delay diabetes complications (6, 8). In the current study, diabetic patients got aerobic

exercises during the research period to assess whether their glucose and lipids levels change or not before and after the exercise, and find the most appropriate pattern of exercising in order to control and treat the complications of diabetes and decrease the costs and disabilities.

## 2. Objectives

The current study was aims to evaluate the effect of standard nutrition and exercise on glucose and lipid levels in diabetic patients.

## 3. Patients and Methods

The present study is an intervention research whose target population includes 120 diabetic women non-randomly chosen among diabetic patients of persian Diabetes Research Center. Having selected the sample based on their age and drug use, first the research aim and methodology have been determined and then, the participants filled the questionnaire and signed it. The participants have been classified into two groups: intervention group (3 sessions each week during 8 weeks of standard exercise-nutrition; first sessions were about 35 minutes while the final sessions were 50 minutes), and control group (without any exercise during the research period). A diagnostic test was used for all patients and it was found that none of them suffered from chronic kidney diseases, thyroid disorders, Iron deficiency anemia, and blood pressure and coronary artery diseases. The participants' diet and drug use have been suggested and controlled by nutritionists of PARSIAN Diabetes Research Center. The patients have only used glucose-lowering tablets of metformin. Anthropometric parameters such as height and weight and body mass index (BMI) and body fat percent-

age have been calculated at the beginning and end of the research. BMI and fat percentage have been measured by in body 720 Body Composition Analyzer made in South Korea. ELISA and Immune tech kit (Austria) have been applied in order to measure ferritin (9). Fasting blood sugar (FBS) measurement has been conducted through the application of Colorimetric technique which is based on enzyme glucose oxidase measurement (Parsazmoon, Iran). Five cc blood has been gotten from the patients brachial vein before and 24 hours after finishing the exercise, and before eating anything for 12 hours, and before using glucose-lowering tablets (in order to make the same condition), when resting.

Before starting each session, the patients made themselves ready and had 5 to 10-minute warm ups of stretching movements. Then, they began aerobic exercises with %60 of maximum heart rate reserve (heart rate was measured by stethoscope made in Finland) and at last finished their exercise accompanied by 5 to 10 minutes of stretching movements. Statistical analysis was carried out through SPSS software (version 16.0). Mean and standard deviation were quantitative data applied in this study. Pared sample T-test and independent sample T-test were respectively utilized to compare changes within and between the groups. The amount of p-value was calculated less than 0.05 which indicated statistical significance.

## 4. Results

Epidemiological and demographic data are shown in the following table. Mean age in this study was considered 50 years for the control group and 51 years for the experimental group. Mean weight was also 69 kg for the control group and 70 kg for the experimental group (Table 1-3).

**Table 1.** Results of Kolmogorov-Smirnov Test for Pretests and Post-Tests of two Control and Experimental Groups (the Status of Body Composition)<sup>a</sup>

Variable	Control group		Experimental Group		Significant
	Pre-Test	Post-Test	Pre-Test	Post-Test	
<b>Weight, kg</b>	0.97	0.95	0.81	0.78	0.001
<b>Body mass index, kg/m<sup>2</sup></b>	0.31	0.32	0.30	0.29	0.0003
<b>Waist-hip ratio, WHR</b>	0.82	0.8	0.79	0.63	0.004

<sup>a</sup> Dependent T-test indicated that glucose level had a significant decrease from pretest to post-test stage in experimental group ( $P < 0.05$ ), while such a significant change was not observed in control group ( $P > 0.05$ ).

**Table 2.** The Participants' Age and Body Composition, and Results of Test in Order to Examine the Homogeneity and Variance Among Control and Experimental Groups Before Starting the Research<sup>a</sup>

Variable	Control Group	Experimental Group	P Value
<b>Age, y</b>	$50.11 \pm 8.78$	$51.18 \pm 8.09$	0.78
<b>Height, cm</b>	$154.72 \pm 4.42$	$157.69 \pm 3.2$	0.1
<b>Weight, kg</b>	$69.76 \pm 8.7$	$70.65 \pm 11.59$	0.85
<b>Body mass index, kg/m<sup>2</sup></b>	$29.05 \pm 3.26$	$28.47 \pm 4.85$	0.76
<b>Waist-hip ratio, WHR</b>	$0.92 \pm 0.07$	$0.96 \pm 0.70$	0.24

<sup>a</sup> The experimental group also experienced a significant decrease in insulin resistance from pretest to post-test stage ( $P < 0.05$ ), while such a significant change was not observed in the control group ( $P > 0.05$ ). Significant increase in high density lipoprotein (HDL) levels was seen in the experimental group after 8 weeks of aerobic exercise, while this increase was not significant in the control group.

**Table 3.** Results of Mean Test for Pretests and Post-Tests of two Control and Experimental Groups (the status of blood variables)<sup>a</sup>

Variable	Control group		Experimental group	
	Pre-Test	Post-Test	Pre-Test	Post-Test
HDL, mg/dL	0.65	0.53	0.83	0.63
LDL, mg/dL	0.7	1	0.97	0.61
Triglycerides, mg/dL	0.87	0.89	0.44	0.9
Total Cholesterol, mg/dL	0.86	0.86	0.73	0.71
Glucose, mg/dL	0.96	0.32	0.93	0.5

<sup>a</sup> Eight weeks of aerobic exercise do not significantly affect total cholesterol of type 2 diabetics ( $P > 0.05$ ). Total cholesterol significantly decreased from pretest to post-test period in the experimental group ( $P < 0.05$ ), while no significant change was observed in the control group ( $P > 0.05$ ).

**Table 4.** Results of Dependent T-Test for Means of Glucose in two Control and Experimental Groups

Variable	Group	Pre-Test	Post-Test	P Value
Glucose, mg/dL	Experimental	127.09 ± 43.86	110.72 ± 35.74	0.04
	Control	134.88 ± 30.73	136.35 55 ± 0.35	0.85

**Table 5.** Results of Dependent T-Test for Means of High Density Lipoprotein HDL in two Control and Experimental Groups

Variable	Group	Pre-Test	Post-Test	P Value
HDL, Mg/dL	Experimental	47.72 ± 2.76	50.36 ± 1.6	0.012
	Control	48.77 ± 2.63	51.11 ± 1.76	0.53

## 5. Discussion

The achieved findings of this study demonstrate that glucose level has significantly decreased among participants of the experimental group ( $P < 0.05$ ). Furthermore, the difference between pretest and post-test of two experimental and control groups indicates insignificant changes of glucose level. These findings are inconsistent with the obtained findings of Kadoglou et al. (2010) (10). Muscle tissues do not rely on glucose for gaining energy most of the day, and obtain their needed energy from fatty acids, since the muscle membrane is partially permeable to glucose when being at rest, unless they are stimulated with insulin. However, the amount of insulin secreted between the meals is so low that cannot make a large amount of glucose into the cells. But the muscles in the two conditions consume large amounts of glucose, one of which is moderate-to-vigorous physical activity. In this condition, although there is a small amount of insulin, muscle cells consume too much glucose, since muscle fibers are permeable to glucose when working, in the absence of insulin due to the contracting process (11). Considering the abovementioned issues, it can be stated that muscle contraction has an insulin-like effect and sends much glucose into the cells to produce energy. Active muscle fibers are also allowed to have a low glycogen concentration for a relatively long period. On the other hand, with the completion of the exercise the muscle cells try to rebuild their glycogen stores, thus the blood glucose concentration lessens after a few hours of exercise (12).

Findings of this study also indicate a significant de-

crease in insulin resistance among participants of the experimental group after 8 weeks of aerobic exercise. Changes between the groups have also demonstrated a significant decrease in insulin resistance in the experimental group in comparison to the control group. These findings are consistent with the findings of Shahab et al. (2012) and inconsistent with the findings of Kadoglou et al. (2010) and Izadi et al. who have reported unchanged insulin resistance against aerobic exercises among diabetics (12-14).

In fact, aerobic exercises can supply type 2 diabetics with the increased muscle vascular density as well as improvements in maximal oxygen consumption and oxidative enzyme activity in skeletal muscle. Aerobic exercises could also enhance the participants' sensitivity to insulin level. Thus, less insulin is required after exercising to adjust glucose level in proportion to the time before exercising. Insulin sensitivity improvement is probably associated with the capacity of each muscle cell to receive insulin. There is also an increase in hepatic insulin sensitivity (15). Therefore, less insulin is required to absorb the excess insulin from the bloodstream. Fitness of diabetic patients (no matter when they are at rest or exercising) brings about minimum requirements for insulin. In such occasions, aerobic exercise can often decrease plasma insulin level when resting and insulin level when testing glucose resistance, thus insulin sensitivity will increase and insulin level will decrease in type 2 diabetics. Moreover, aerobic exercises can enhance insulin

performance through decreasing the accumulation of intracellular TG and increasing fatty acid oxidation and mitochondrial biogenesis (16). The obtained findings show a significant decrease and increase respectively in total cholesterol and high density lipoprotein (HDL) of participants in the experimental group after 8 weeks of aerobic exercises ( $P < 0.05$ ). The average concentration of serum triglyceride and low density lipoprotein (LDL) has an insignificant decrease in the experimental group. It has been also proved that after 8 weeks of aerobic exercise, changes between the groups in all lipids indexes have been insignificant in participants of the experimental group in comparison to the control group. These findings are consistent with the findings of research accomplished by Pan and Hu et al. (2007), while inconsistent with Pan and Hu et al. (2012) (17, 18). Aerobic exercises can also enhance mitochondrial size and the activity of lipolysis enzymes which increase the ability of lipids catabolism (19). Evidences suggest that catecholamine hormones, growth hormone and lipolysis rate increase during physical activities. Furthermore, in women, the hormone 17-beta-estradiol increases when exercising, and subsequently lipids are used as the source of energy during physical activities (20). Mean of (HDL) changes in the first and second groups has had a significant increase ( $P < 0.05$ ). This increase could be derived from the increased activity of lipoprotein lipase enzyme (LPL). LPL enzyme also affects transforming very low density lipoprotein VLDL into (HDL) and increasing HDL-C level. On the other hand, lecithin cholesterol acyl transferases (LCAT) transforms cholesterol and (LDL) into (HDL); this enzyme increase may be responsible for (HDL) increase rooted in aerobic exercises (21). A significant increased LCAT has been observed during some exercises. Some other mechanisms could probably occur in this field such as insulin sensitivity decrease which brings about changes in lipids and lipoprotein levels (22). Regular endurance trainings increase gene expression of lipolysis enzyme (23). Triglyceride (TG) is the most important source of energy in endurance physical activities. Lipoprotein lipase enzyme (LPL) degrades (TG) upon free fatty acids in order to supply needed energy during aerobic exercises; therefore, there is a significant relationship between (LPL) enzyme and (TG) and this conclusion can be drawn that aerobic exercises can increase (LPL) enzyme while increase (TG). The obtained findings show a significant decrease in weight, body mass index and waist-hip ratio of participants in the experimental group, while no significant change has been observed in lipids percentage ( $p = 0.05$ ). These findings are consistent with the findings of researches carried out by Oberbach et al. (2006), Pan and Hu et al. (2007), Shondi et al. (2011), and Izadi et al. (2012) (9, 24-26).

Regular exercises enhance the expression of lipolysis enzymes, beta-oxidation, Krebs, electron transport chain, and mitochondrial density, and also cause more usage of lipids instead of carbohydrates for energy (27, 28). As a

result, lipids and body mass index decrease and patients lose weight.

Eight weeks of standard nutrition and physical activity can decrease body mass index, lipids, ferritin, glucose, insulin resistance, and lipoprotein plasma, and increase cardiorespiratory fitness among diabetic patients.

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## References

1. Sigal RJ, Kenny GP, Wasserman DH, Castaneda-Sceppa C. Physical activity/exercise and type 2 diabetes. *Diabetes Care*. 2004;27(10):2518-39.
2. The American Diabetes Association's (ADA) evidence-based practice guidelines, standards, and related recommendations and documents for diabetes care. *Diabetes Care*. 2012;35 Suppl 1:S1-2.
3. Steinmetz A. Treatment of diabetic dyslipoproteinemia. *Exp Clin Endocrinol Diabetes*. 2003;111(5):239-45.
4. Grundy SM, Balady GJ, Criqui MH, Fletcher G, Greenland P, Hiratzka LF, et al. Primary prevention of coronary heart disease: guidance from Framingham: a statement for healthcare professionals from the AHA Task Force on Risk Reduction. American Heart Association. *Circulation*. 1998;97(18):1876-87.
5. Verma S, Li SH, Badiwala MV, Weisel RD, Fedak PW, Li RK, et al. Endothelin antagonist and interleukin-6 inhibition attenuate the proatherogenic effects of C-reactive protein. *Circulation*. 2002;105(16):1890-6.
6. Thomas MC, MacIsaac RJ, Tsalamandris C, Jerums G. Elevated iron indices in patients with diabetes. *Diabet Med*. 2004;21(7):798-802.
7. Salonen JT, Tuomainen TP, Nyysönen K, Lakka HM, Punnonen K. Relation between iron stores and non-insulin dependent diabetes in men: case-control study. *BMJ*. 1998;317(7160):727.
8. Cade JE, Moreton JA, O'Hara B, Greenwood DC, Moor J, Burley VJ, et al. Diet and genetic factors associated with iron status in middle-aged women. *Am J Clin Nutr*. 2005;82(4):813-20.
9. Pollock ML, Gaesser GA, Butcher JD, Després JP, Dishman RK, Franklin BA, et al. American College of Sports Medicine Position Stand. The recommended quantity and quality of exercise for developing and maintaining cardiorespiratory and muscular fitness, and flexibility in healthy adults. *Med Sci Sports Exerc*. 1998;30(6):975-91.
10. Kadoglou , Piperno A, Trombini P, Gelosa M, Mauri V, Pecci V, Vergani A, et al. Increased serum ferritin is common in men with essential hypertension. *J Hypertens*. 2002;20(8):1513-8.
11. Minamiyama Y, Takemura S, Kodai S, Shinkawa H, Tsukioka T, Ichikawa H, et al. Iron restriction improves type 2 diabetes mellitus in Otsuka Long-Evans Tokushima fatty rats. *Am J Physiol Endocrinol Metab*. 2010;298(6):E1140-9.
12. Fumeron F, Pean F, Driss F, Balkau B, Tichet J, Marre M, et al. Ferritin and transferrin are both predictive of the onset of hyperglycemia in men and women over 3 years: the data from an epidemiological study on the Insulin Resistance Syndrome (DESIR) study. *Diabetes Care*. 2006;29(9):2090-4.
13. Wrede CE, Buettner R, Bollheimer LC, Scholmerich J, Palitzsch KD, Hellerbrand C. Association between serum ferritin and the insulin resistance syndrome in a representative population. *Eur J Endocrinol*. 2006;154(2):333-40.
14. Lao TT, Ho LF. Impact of iron deficiency anemia on prevalence of gestational diabetes mellitus. *Diabetes Care*. 2004;27(3):650-6.
15. Ashourpour M, Jalali M, Jazayeri A, Saedi A, Taghdir M, Zaeri M. The relationship between ferritin and glycemic status in type 2 diabetics and healthy people. *Tehran Uni Med Sci*. 2010;12(3).

16. Tuomilehto J, Lindström J, Eriksson JG, Valle TT, Hämäläinen H, Ilanne-Parikka P, et al. Prevention of type 2 diabetes mellitus by changes in lifestyle among subjects with impaired glucose tolerance. *New England J Med.* 2001;344(18):1343-50.
17. Hu FB, Stampfer MJ, Solomon C, Liu S, Colditz GA, Speizer FE, et al. Physical activity and risk for cardiovascular events in diabetic women. *Ann Intern Med.* 2001;134(2):96-105.
18. Pan XR, Li GW, Hu YH, Wang JX, Yang WY, An ZX, et al. Effects of diet and exercise in preventing NIDDM in people with impaired glucose tolerance. The Da Qing IGT and Diabetes Study. *Diabetes Care.* 1997;20(4):537-44.
19. Boule NG, Haddad E, Kenny GP, Wells GA, Sigal RJ. Effects of exercise on glycemic control and body mass in type 2 diabetes mellitus: a meta-analysis of controlled clinical trials. *JAMA.* 2001;286(10):1218-27.
20. Boule NG, Kenny GP, Haddad E, Wells GA, Sigal RJ. Meta-analysis of the effect of structured exercise training on cardiorespiratory fitness in Type 2 diabetes mellitus. *Diabetologia.* 2003;46(8):1071-81.
21. Albright A, Franz M, Hornsby G, Kriska A, Marrero D, Ullrich I, et al. American College of Sports Medicine position stand. Exercise and type 2 diabetes. *Med Sci Sports Exerc.* 2000;32(7):1345-60.
22. Stofan JR, DiPietro L, Davis D, Kohl HW, 3rd., Blair SN. Physical activity patterns associated with cardiorespiratory fitness and reduced mortality: the Aerobics Center Longitudinal Study. *Am J Public Health.* 1998;88(12):1807-13.
23. Department of Health . *Physical activity and health: a report of the Surgeon General.* United States: DIANE Publishing; 1996.
24. Pate RR, Pratt M, Blair SN, Haskell WL, Macera CA, Bouchard C, et al. Physical activity and public health. A recommendation from the Centers for Disease Control and Prevention and the American College of Sports Medicine. *JAMA.* 1995;273(5):402-7.
25. Sigal RJ, Kenny GP, Wasserman DH, Castaneda-Sceppa C, White RD. Physical activity/exercise and type 2 diabetes: a consensus statement from the American Diabetes Association. *Diabetes Care.* 2006;29(6):1433-8.
26. Mostahfezian M. The effect of aerobic exercise on iron and ferritin level and absorption capacity of serum iron among athletic students. (3):55-64.
27. Theil EC. Iron, ferritin, and nutrition. *Annu Rev Nutr.* 2004; 24:327-43.
28. American Heart Association . *The New American Heart Association Cookbook.*: Clarkson Potter; 2010.