

## Effect of Aerobic Exercise on HbA<sub>1</sub>C, Serum Insulin Level, C-peptide and Insulin Resistance in Middle-Aged Women with Type II Diabetes

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**Abstract: Introduction :**Diabetes is the most common chronic diseases in addition to creating disability and reduced quality of life for many patients, costs to patients and their families and the community to enter .Major disruption in Type II Diabetes: Role of insulin resistance and secretion is abnormal is that the role and importance of the role of insulin resistance in insulin secretion disorder created by the disease and various complications such as cardiovascular complications, diabetic foot, and kidney failure is identified .The present study surveyed the impact aerobic activities selected eight weeks on glycosylated hemoglobin (HbA<sub>1</sub>c), plasma insulin levels, insulin resistance Peltry c and type II diabetes women . **Methods :**Type of applied research and methods, semi-empirical. Among the 800 female patients with diabetes type II, 30 patients with diabetes type II with age range 40 to 60 year range blood sugar between 150 to 250 mg per dL were selected randomly and divided into two group as control and empirical groups. Selected activities include eight weeks of aerobic exercise for three sessions per week and each session for 50 minutes with intensity of 60 to 70 percent maximum heart rate on the bike and the treadmill was power meter .Before exercise after 12 hours fasting subjects of both groups value 10 ml blood was taken from the elbow vein. Bloodletting second time after eight weeks of aerobic activity, such as the first step was taken. In analyzing data from paired t test was used .Significant level in this study  $p \leq 0.05$  is. **Results :**Selected aerobic exercise on glycosylated hemoglobin hba<sub>1</sub>c Peltry plasma insulin concentration c and create meaningful change. But in reducing insulin resistance was not significant . **General conclusions :** Exercise intensity% 60% 70 HRR in type II diabetes increases in plasma insulin concentration and decrease glycosylated hemoglobin Peptide c (HBA<sub>1</sub>C) is. Diabetes experts are so that the exercise as complementary therapy along with drug treatments to use.

[Seyed Mahmoud Hejazi, Mahmoud Soltani, Masoud Zare, Salehe Nornematolahi, Farnaz Aminian. **Effect of Aerobic Exercise on HbA<sub>1</sub>C, Serum Insulin Level, C-peptide and Insulin Resistance in Middle-Aged Women with Type II Diabetes.** *Life Sci J* 2012;9(4):4276-4279]. (ISSN: 1097-8135). <http://www.lifesciencesite.com>. 639

**Keywords:** diabetic women, aerobic power, aerobic exercises selected physiological factors

### Introduction:

Although researchers precisely do not know how diabetes type 2 develops, there are three important related risk factors including hereditary, obesity and age. Controlling factors such as age and race is impossible, but obesity- the third risk factor in diabetes- is partially controllable. Based on World Health Organization and International Diabetes Federation (IDF) reports, diabetic patients across the world are near to 240 million people and in 2025 will increase to more than 3000 million people. In future decades more than  $\frac{3}{4}$  of all cases will be living in developing countries. Based on Iran's statistics there is 2 million diabetic patients between 25-64 years old in our country.

Recent studies in Swiss and England showing considerable increase in diabetes between young people and its reason is not obvious now. Though remarkable progresses in medicine, curing this disease is not possible and its various complications such as cardiovascular complications, diabetic foot, renal failure and impotency put heavy

financial pressure on patients and healthcare system and cause various problems in patients' lives (1). But there is a difference between diabetes type 2 and other diseases; patient's role in recognizing, controlling and preventing from possible complications is more than a professional physician (2).

For healthy living, a diabetic patient should measure his/her blood glucose level continuously, having appropriate nutrition and regular exercise. Exercise cause fitness, body flexibility, increase muscle tone, improving heart and lung function; also help keeping body weight which can relate to beneficial changes in insulin sensitiveness.

Nowadays, we want to know if continuous exercise in long term can prevent from or delay developing diabetes type 2 in high risk people or at least controlling it. The most important disorder in developing diabetes type 2 is insulin resistance and its abnormal secretion, most studies emphasized that the role and importance of insulin resistance in developing this disease is more than abnormal insulin

secretion (1). As few researches have done about effect of aerobic exercises on insulin resistance, serum insulin level, blood glucose level, C-peptide and HbA<sub>1c</sub> in diabetes type 2 in Iran, we are trying to find if selected aerobic exercises for 8 weeks can improve HbA<sub>1c</sub>, serum insulin level, C-peptide and insulin resistance in diabetic type 2 middle-aged women. HbA<sub>1c</sub> showing the percent of combining blood glucose with hemoglobin in last 2-3 months and high level of it indicates blood glucose average in recent 2-3 months was more (1).

C-peptide has no known biological activity, but always its quantitative level of production and secretion is equal to insulin level (3). At first, insulin produces as a one chain peptide calling pre-insulin, in secreting granules of beta cells divides with a 31 amino acid enzymes calling C-peptide and converts to proinsulin (1, 4). Insulin resistance is a significant sign in obese non-independent insulin diabetic patients. Insulin resistance is when blood insulin level is normal or even increased, but body does not response appropriately to insulin; in other word, insulin resistance is the cell disability to responding to insulin and blood glucose reduction (5).

Insulin is an anabolic hormone producing from beta cells of Langerhans Island of pancreas; this hormone is a small protein playing important role in storing excessive energy (1, 4). Bruce et al (2004) assessed insulin sensitiveness after exercise in diabetic type 2 patients. Their findings showed fast blood glucose is reduced but not significant, though the reduction of serum insulin was significant. Frick and Henricson (2005) assessed the effect of exercise and fatty acid antioxidant on treatment of insulin resistance in diabetes type 2 patients; finding showed exercise improved insulin function in transporting glucose into body muscles (6).

Trawani et al (1984) studied the effect of regular exercise on VO<sub>2</sub> Max, blood glucose control, glucose tolerance and insulin sensitiveness in diabetes type 2 patients. Their plan was consisted of 60 minute exercise for 6 weeks with 50-60% VO<sub>2</sub> Max, which improved insulin sensitiveness by 15% (7). Ritman et al (1984) studied the effect of exercise on glucose homeostasis in diabetes type 2 patients. Their plan included 20-40 exercise, 5-6 times per week for 6-10 weeks with 60-90% VO<sub>2</sub> Max. Findings have shown there is an invert relation between aerobic ability and HbA<sub>1c</sub> and Glucose tolerance test (8).

Ronma et al (1986), in their study with the purpose of assessing the effect of long term physical activity on metabolic control in diabetes type 2 patients, have shown there was significant difference between exercise and control group HbA<sub>1c</sub> after 4-5

months (9). Ewin (2000) assessed the relationship between appropriate physical activities level and stability of insulin level in women aged 40-83 years old. Findings showed physical activity induced 6.6% reduction in insulin level (10).

#### Materials and Methods:

The purpose of this study is assessing the effect of selected aerobic activities for 8 weeks on serum insulin level, C-peptide, HbA<sub>1c</sub> and insulin resistance in middle-aged women with diabetes type 2. This is a practical study and considering the study's limitations has designed semi-experimental which includes pre-test and post-test in two control and experimental groups.

From 800 women with diabetes type 2 referring to Shahid Bahonar's diabetes clinic in Kerman, 30 patients 40-60 years old with diabetes type 2 which their blood glucose was between 150-250 mg/dl have chosen and randomly assigned to two control and experimental groups. After physical assessment, patients voluntarily participated in two groups. Based on previous scheduled program and considering necessarily important factors about diet, physical activity and any disease before beginning exercise, patients have gone to laboratory at 8-10 a.m. They should be NPO for 12 hours and didn't have intense physical activity for 24 hours before the blood sampling.

In laboratory 20 ml blood had taken from elbow's vein of each patient in a sample tube containing anticoagulant, for separating serum from the sample, tubes put in a HeHICH-Rotina35 centrifuge made by Germany. Data from blood samples and patients before and after 8 weeks aerobic exercise analyzed. In order to describe data we used descriptive statistics including mean and frequency charts and tables, and as the data were normal we used paired t-test for testing hypothesis. Data analysis and charts were done with SPSS and Excel software and in this study the significant level was p<0.05.

#### Results:

Selected aerobic exercises has significant effect on HbA<sub>1c</sub> (p<0.029), serum insulin concentration (p< 0.005) and C-peptide (p<0.007) of patients with type 2 diabetes. But has no significant effect on insulin resistance in diabetic patients (p= 0.969).

Table 1: Comparisons of HbA<sub>1c</sub> (%) mean differences in patients with diabetes pre and post-test

Groups	Stage	Mean±SD	Mean difference±CV	t-test
Control	Pre-test	8.68±1.53	0.46±232	t=-1.988 p<0.029
	Post-test	8.69±1.48		
Experimental	Pre-test	8.33±1.50		
	Post-test	7.88±1.31		

Table 2: Comparisons of serum insulin (ulu/ml) mean differences in patients with diabetes pre and post-test

Group	Stage	Mean $\pm$ SD	Mean difference $\pm$ CV	It-test
Control	Pre-test	10.26 $\pm$ 8.25	7.46 $\pm$ 2.65	t=2.816 p<0.005
	Post-test	13.66 $\pm$ 9.33		
Experimental	Pre-test	8.77 $\pm$ 5.05		
	Post-test	19.63 $\pm$ 9.92		

Table 3: Comparisons of C-peptide (ng/ml) mean differences in patients with diabetes pre and post-test

Group	Stage	Mean $\pm$ SD	Mean difference $\pm$ CV	t-test
Control	Pre-test	2.22 $\pm$ 0.39	-0.33 $\pm$ 0.128	t=-2.613 p<0.007
	Post-test	2.19 $\pm$ 0.43		
Experimental	Pre-test	2.31 $\pm$ 0.60		
	Post-test	1.95 $\pm$ 0.58		

Table 4: Comparisons of insulin resistance mean in patients with diabetes pre and post-test

Group	Stage	Mean $\pm$ SD	Mean difference $\pm$ CV	t-test
Control	Pre-test	4.86 $\pm$ 2.61	2.26 $\pm$ 1.55	t=1.959 p<0.969
	Post-test	6.30 $\pm$ 3.31		
Experimental	Pre-test	3.80 $\pm$ 1.82		
	Post-test	7.51 $\pm$ 3.51		

### Discussion:

Aerobic exercises induced HbA<sub>1c</sub> decrease and this reduction in exercise group in comparison with the group without exercise was significant. When the level of blood glucose increases, enters into red blood cells easily and binds to hemoglobin in an irreversible, non enzymatic reaction. Due to the real half-life of red blood cells (30-35 days) and theoretical half-life of them (60 days), blood level of glycosylated hemoglobin is the marker of average of blood glucose in last 1-2 months and its level in patients with diabetes could become 2-3 times more than the normal level.

Glycosylation rate of young red blood cells which circulating in blood for a short time is less than older red blood cells and the reaction of glucose with hemoglobin in first 30 days of their lives is more than next 90 days; and more the level of blood glucose, more the glycosylation rate and HbA<sub>1c</sub>.

Findings of this study showed after 2 months aerobic exercise the level of HbA<sub>1c</sub> decreased significantly, as the natural life of red blood cells for carrying glucose is 30-35 days and the blood glucose level of diabetic patients changing, so the level of HbA<sub>1c</sub>, insulin resistance and serum insulin can change. Ronnema et al (1986) declared aerobic exercises with VO<sub>2</sub>Max 70% in a 4 months period could decrease HbA<sub>1c</sub> (9).

Studies showed that HbA<sub>1c</sub> is the main marker of retinopathy progress in diabetic patients and with 10% decrease of its level (8% to 7.2%) the risk of retinopathy progress will decrease 43-45%.

Therefore, exercise can decrease glycosylated hemoglobin and the risk of retinopathy in patients with type 2 diabetes.

In this study, there was significant difference between the decreased level of HbA<sub>1c</sub> in exercise group and control group. Findings of our study is the same as Ronnema et al, Shahlakan et al, Ustiupa et al, Mayorana studies (3, 5, 9, 11). Results showed aerobic exercise has significant effect on C-peptide and insulin concentration and insignificant effect on insulin resistance in patients with type 2 diabetes. Both insulin dysfunction (insulin resistance) and insulin secretion are inducing diabetes type 2. In insulin resistance the ability of up taking blood glucose and restoring it by liver and muscles decrease.

In response to insulin resistance, secretion of insulin increases to save the normal glucose tolerance. Primary the insulin secretion defect is mild and selectively is due to glucose, but it's normal in response to other stimulating factors of insulin secretion like amino acid. The insulin secretion defect progresses and causes insulin insufficiency. Results of our study showed serum insulin concentration after 8 weeks aerobic exercise increased.

Because the exercise intensity was not enough to use the insulin related glucose, it must be taken energy from fat tissue, so the level of serum insulin increased. declared aerobic exercises for 12 weeks caused serum insulin increase and the level of insulin secretion in response to insulin resistance increase to maintain the normal glucose tolerance. By increasing the quantity and function of some hepatic enzymes in glycolysis reactions of liver, insulin increase the usage of glucose and indirectly prevent glucose release in blood. On the other hand, by decreasing the function of hepatic glucose 6-phosphatase, insulin avoids glucose release.

In this study, there was significant difference in the level of serum insulin increase between the exercise group and the group with no activity. Our results is the same as Poirier study and different with Ronnema study (2, 9). At the same time of increasing insulin secretion, the concentration of C-peptide decreased significantly. Decrease of C-peptide concentration which is related to decrease of fat, showing the increase of insulin secretion in beta cells.

### Conclusion:

In this study, insulin resistance increased whereas serum C-peptide decreased. These findings, C-peptide decrease and insulin resistance increase after 8 weeks aerobic exercise, shows the up taking and responding to insulin by cells inclined. In result

insulin resistance increases that could be because of the short period of study and possibly the increase in insulin sensitiveness is related to insulin binding capacity to muscle' cells receptors. Therefore, needs more insulin for up taking excess glucose in blood

### References

- 1- Lango D, Fauci A, Kasper D, Hauser S, Jameson J, Loscalzo J. Harrison's Principles of Internal Medicine: 18th Edition. Philadelphia: The CV Mosby Company. 2008.
- 2- Poirier P, Tremblay A, Broderick T, Catellier C, Tancrède G, Nadeau A. Impact of moderate aerobic exercise training on insulin sensitivity in type 2 diabetic mentrated with oral hypglycemia agents is insulin sensitivity enhanced only in nonobese subjects? *Med Sci Monit.* 2002 Feb;8(2):CR59-65.
- 3- Maiorana A, O driscool G, Goodman C, Taylor R, Green D. Combined aerobic and resistance exercise improves glycemic control and Fitness in type 2 diabetes. *Diabetes research and clinical practice* 2002; 56(2): 115-23.
- 4- Ronald L. Prigeon, Steven E. Kahn and Daniel Porte, Jr .Changes in insulin sensitivity, glucose effectiveness, and B-cell function in regularly exercising subjects. *Metabolism* 1995; 44(10):1259-63.
- 5- Uusitupa MI, Stancáková A, Peltonen M, Eriksson JG, Lindström J, Aunola S, et al. Impact of positive family history and genetic risk variants on the incidence of diabetes: the Finnish Diabetes Prevention Study. *Diabetes Care* 2011 Feb;34(2):418-23.
- 6- Ametov AS, Barinov A, Dyck PJ, Hermann R, Kozlova N, Litchy WJ, et al; SYDNEY Trial Study Group. The sensory symptoms of diabetic polyneuropathy are improved with alpha-lipoic acid: the SYDNEY trial. *Diabetes Care.* 2003 Mar;26(3):770-6.
- 7- Reitman JS, Vasquez B, Klimes I, Nagulesparan M. Improvement of glucose homeostasis after exercise training in non-insulin-dependent diabetes. *Diabetes Care* 1984 Sep-Oct;7(5):434-41.
- 8- Trovati M, Carta Q, Cavalot F, Vitali S, Banaudi C, Lucchina PG, et al. Influence of physical training on blood glucose control, glucose tolerance, insulin secretion, and insulin action in non-insulin-dependent diabetic patients. *Diabetes Care.* 1984 Sep-Oct;7(5):416-20.
- 9- Ronnema T, Mattila K, Lehtonen A, Kallio V. A controlled randomized study on the effect of long-term physical exercise on the metabolic control in type 2 diabetic patients. *Acta Med Scand* 1986;220(3):219-24.
- 10- Irwin ML, Mayer-Davis EJ, Addy CL, Pate RR, Durstine JL, Stolarczyk LM, et al. Moderate-intensity physical activity and fasting insulin levels in women: the Cross-Cultural Activity Participation Study. *Diabetes Care.* 2000 Apr;23(4):449-54.
- 11- Shahlakan JR. The effect of exercise condition, diet and drug therapy on glycosylated hemoglobin levels in types (NIDDM) diabetics : *J sport med. phys. Fitness* 1995; 35: 281-8.

9/6/2012