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Effects of exercise training intervention without weight loss on glucose and insulin resistance in obese women

Zahedmanesh Forouzan[1*], Yousefi Soheila[1], Pishkar Leila[2], Zahedmanesh Farnaz[1]

[1]*Department of Physical Education and Sport Science, Islamic Azad University, Islamshahr Branch, Islamshahr, Iran*

[2]*Department of Biology, Islamic Azad University, Islamshahr Branch, Islamshahr, Iran*

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Abstract

Growing bodies of literature have indicated an association of obesity with insulin resistance. In this study, Thirty two sedentary adult obese women (age, 38 ± 4.3 yr, BMI, 32.42 ± 3.3 kg/m2) were divided into exercise (aerobic training, 6 weeks/3 times per week) or control (without exercise) group. Fasting venous blood samples were obtained before and after exercise program for measuring insulin and glucose and insulin resistance. Student's paired 't' test was applied to compare the pre and post training values. Aerobic training decreased fasting glucose concentration in exercise group but not in the control group. Insulin resistance tended to (borderline) be decrease by aerobic training in exercise group, but did not reach statistical significance. Insulin concentration did not change with aerobic training program. Based on these data, we can say the changes in glucose concentration in response to aerobic training does not affect by insulin action only, and Can be attributed to the changes in other hormonal changes.

* **Corresponding Author:** Zahedmanesh Forouzan ✉ foruzanzahedmanesh@yahoo.com

Introduction

Although the molecular mechanisms for type II diabetes are less understood, accumulating evidence indicates that obesity and overweight have a important role in that prevalence (Lazar, 2005), a progressive increase in peripheral insulin sensitivity, and corresponding decrements in glucose disposal in skeletal muscle, fat, and the liver (Defronzo *et al.,* 1982). Insulin resistance is typically defined as decreased sensitivity to these metabolic actions of insulin (Kim *et al.,* 2008). Obesity is associated with excess storage of fat in the body leading to cardiovascular morbidities, insulin resistance and even the development of type 2 diabetes (Biswajit *et al.,* 2013).

In this area, recent study on non diabetes obese subjects with insulin resistance have revealed that the initial physiological response to increased body weight and its associated increase in insulin demand is a compensatory period marked by expansion of ß-cell mass (Bonner-Weir *et al.,* 1994; Butler *et al.,* 2003; Kloppel *et al.,* 1997) and ß-cell function (Kahn *et al.,* 2000), which together allow for the increased production and/or secretion of insulin. This situation continued for a long time uninterrupted in obese insulin-resistant hyperinsulinemic individuals.

It has been demonstrated that insulin resistance and dysfunction of pancreatic islet β-cells is associated with lack of control blood glucose level due to insulin release impairment (Biswajit *et al.,* 2013).

Accumulating evidence indicates that obesity and overweight are associated with insulin resistance and high glucose concentration. Therefore, It seems that loss weight following diet of other intervention improve insulin resistance or hyperglycemia in obese individuals. In present study, based on this hypothesis, we investigated the effect of a relatively long term aerobic training program on insulin resistance and fasting glucose in adult obese men.

Materials and methods

Thirty two sedentary healthy obese women (age, 38 ± 4.3 yr, BMI, 32.42 ± 3.3 kg/m^2) were enrolled to participate in this semi-experimental study and divided into exercise and control groups. The purpose of this investigation was to determine the effects of 6 wk (aerobic training, 3 times per week) of aerobic training on fasting glucose and insulin resistance. Written informed consent was signed by all participants. The ethics approval was taken from Islamic Azad University of Iran ethical committee.
A main inclusion criterion was BMI between 30 – 36 kg/m^2. Subjects with a history or clinical evidence of impaired fasting glucose or diabetes, recent heart failure, active liver or kidney disease, or who were on medications known to alter insulin sensitivity were excluded. Neither the control nor experimental subjects had participated in regular exercise for the preceding 6 months, nor did all subjects have stable body weight. All subjects were non-smokers. In addition, exclusion criteria included supplementatio ns that alter carbohydrate metabolism.

At first, anthropometrical measurements was performed. Body weight and height were measured with the subject wearing light clothes. Waist circumference (WC) was measured with a non-elastic tape at a point midway between the lower border of the rib cage and the iliac crest at the end of normal expiration. Body mass index (BMI) was calculated as weight (kg) divided by squared height (m).

Blood sampling and exercise program: After anthropometrical measurements, resting blood samples were drawn at weeks 0 and 12 (48 hour after lasted session) after 12 h of fasting at rest between 8:00 and 9:00 am from the antecubital vein. In exercise group, aerobic training program lasted for 12 weeks, three times per week at intensity range between 60 – 80 percentages of maximal heart rate involved running on Smooth surface without slope or Kick pedal on a stationary bicycle for 30-45 min. Blood samples were dispensed into EDTA-coated tubes and centrifuged for 10 minutes in order to

separate serum. The samples were subsequently stored at - 80°C until assayed. Fasting blood glucose concentration was measured by the glucose oxidase method (Pars Azmun. Tehran, Iran). To estimate insulin resistance, the homeostasis model assessment (HOMA) index was calculated as fasting insulin concentration (μU/ml) × fasting glucose concentration (mmol/l)/22.5 (Duncan *et al.,* 1995).
Statistical analysis: Statistical analysis was performed with the SPSS software version 14.0 using an independent paired t-test. For the descriptive statistics after having checked the normality of the variables using the Kolmogorov-Smirnov test. A p-value < 0.05 was considered to be statistically significant.

Results

Based on what was mentioned, the present study was performed with aim to evaluate to effect of 6 weeks aerobic training on glucose and insulin resistance in adult obese women. Baseline anthropometrical characteristics such as age, body weight and body mass index did not differ between the weight loss and exercise groups (Table 2). Baseline Anthropometric characteristics of the study participants such as age, body weight and body mass index are described in Table 1. Significant differences were not found in body weight and other anthropometrical markers between two groups at baseline ($p \geq 0.05$). In addition, all anthropometrical markers did not change in response to exercise program in exercise group ($p \geq 0.05$).

Table 1. anthropometrical characteristics of the study subjects.

parameter	Exercise (n = 15)	Control (n = 15)
Age (years)	37.5 ± 4.3	41 ± 3.9
Height (cm)	161 ± 11	162 ± 4.9
Body weight (kg)	80.9 ± 9.8	80.6 ± 7.6
Body mass index (kg/m2)	31.2 ± 3.3	30.7 ± 4.1
Abdominal (cm)	108 ± 14.3	109 ± 12.2
Body fat (%)	44.7 ± 7.3	40.1 ± 5.5

Baseline and post training fasting glucose, serum insulin and insulin resistance of two groups are shown in Table 2. The data of Student's paired 't' test showed that fasting glucose concentration decreased significantly by exercise program in exercise group ($p = 0.021$), but not to control group. In contrast, we did not change in serum insulin and insulin resistance after exercise program when compared to baseline values ($p \geq 0.05$).

Table 2. Biochemical characteristics in the baseline and follow by interventions of two studied groups.

Parameters	Experimental		Control	
	Baseline	Exercise Intervention	Baseline	No intervention
Glucose (mm/L)	*91 ± 7.9 **	*77 ± 11.4 **	*85.25 ± 9.7*	*83.3 ± 11*
Insulin (μIU/ml)	*7.7 ± 2.07*	*7.52 ± 1.14*	*7.68 ± 1.23*	*7.81 ± 1.34*
Insulin resistance (HOMA-IR)	*1.72 ± 0.68*	*1.41 ± 0.36*	*1.67 ± 0.33*	*1.61 ± 0.31*

Data represent mean ± standard deviation.

* represent significant changes compared to baseline levels.

Discussion

In this study, insulin resistance and fasting glucose concentration measured in response to six week aerobic exercise training in adult obese women. The major finding of this investigation was significant decrease in fasting glucose following exercise training. On the other hand, aerobic program was associated with a decrease in insulin resistance, but no-significantly from statistically perspective.

Many studies have shown that physical inactivity is associated with insulin resistance, often leading to type 2 diabetes. On the other hand a large body of evidence suggests that exercise training has been considered a cornerstone of diabetes management, along with diet and medication (Sigal *et al.,* 2004).

It has been long known that more glucose is used by muscle than other tissues. Normally, active muscles burn their stored glucose for energy and refill their reserves with glucose taken from the bloodstream, keeping blood glucose levels in balance. In this regard, several studies have reported that lifestyle interventions including 150 min/week of physical activity and diet-induced weight loss of 5–7% reduced the risk of progression from impaired glucose tolerance (IGT) to type 2 diabetes (Tuomilehto *et al.,* 2001).

With increasing age, a tendency has been demonstrated for progressive declines in muscle mass, leading to decreased functional capacity, decreased resting metabolic rate, increased adiposity, and increased insulin resistance, and exercise training involved short or long term program can have a major positive role on above mentioned parameters (ACSM, 1998). In present study, aerobic program was not associated with weight loss in studied subjects, nevertheless fasting glucose concentration decreased significantly. Based on these data, it seems that improving in glucose profile by exercise training can be independent of changes in body weight. In accordance with these observations, It has been previously reported that structured exercise programs had a statistically and clinically significant beneficial effect on glycemic control, and this effect was not primarily mediated by weight loss (Sigal *et al.,* 2004). In present study, although decrease in insulin resistance was not significant but it seems that this decrease (18%) is important from clinical perspective. Of course, no significant decrease in insulin resistance may be attributing to insulin values. Because, Regardless a significant decrease in fasting insulin and borderline significant decrease in insulin resistance but we observed no change in serum insulin in response to exercise program. On the other hand, exercise or repeated muscle contraction also stimulates the glucose consumption, promoting higher amount of GLUT4 glucose transporters in the sarcolema by the increase of translocation, regardless of the insulin presence (Teran-Garcia *et al.,* 2005). A number of studies have demonstrated that there are different GLUT4 intracellular compartments; one stimulated by insulin and the other stimulated by exercise, and the combination of the two results in additional effects concerning the glucose transportation (Ropelle *et al.,* 2005; Gomes et al., 2005).

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