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The effect of resistance training on the levels of glucose, insulin and insulin resistance index among untrained academic women

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ABSTRACT

Sedentary lifestyle means that the lack of physical activity and increased caloric intake, leads to the accumulation of body fat and metabolic disorders including type-2 diabetes, hypertension and cardiovascular disease. The purpose of present study was the comparison of upper body, lower body and concurrent training on the levels of glucose, insulin and insulin resistance index among untrained academic women. 56 sedentary women (aged: 21± 3 yr, Body Mass Index: 21.5± 3.5 kg/m^2, N=14) were randomly assigned to one of four groups (upper body training, lower body training, concurrent training and control group). Three sessions in a week training groups performed a 6 resistance movements for the upper body, lower body and concurrent trainings. After 4 and 8 weeks, blood samples were taken in order to measure glucose, insulin and insulin resistance index. Results of the present study showed that glucose levels had a significant reduction in the measured times. Also, insulin levels had a significant decrease in the measured times and there was a significant reduction of insulin levels among groups. The insulin resistance index changes had a significant reduction in the measured times. Although an upper body (20%) and lower body (21%) and concurrent (19%) resistance training caused an increase in and improving strength (1RM) and performance, it seems that different types of resistance training applied in this study caused a significant decrease in the levels of glucose, insulin and insulin resistance index among training groups compared to the control group.

Key words: Resistance training, glucose, insulin, resistant index to insulin, untrained women

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INTRODUCTION

Unsuitable diet, accompanied with sedentary life style leads to an increase in the prevalence of obesity in world. The high percentage of body fat is a sign of insulin resistance syndrome which is accompanied by insulin level increase, lipid disorder, hypertension increase and also with slight inflammation [8]. Nonexistence of therapy compared to insulin resistance leads to the danger increase affection to diabetes type 2 and cardiovascular disease and finally, leads to the enhancement in death toll [33]. It has been proved that obesity is a strong factor to the insulin resistance, diabetes, dyslipidemia and hypertension [3]. While in past researches, the relationship among obesity, insulin resistance and the high risk of cardiovascular, mostly caused disorder in the operation and it was attributed to endocrine fat tissue like excretion of adipokines such as leptin, resistin, adiponectin and inflammation factors such as TNF-α [18, 31].

But according to the recent documents, skeletal muscle plays an important role in making resistance against insulin in fat people via some cytokines excretion [2]. On the other hand, it has proven that an increase in body fat is the main factor in metabolic disorders divulge such as extra insulin and resistance to insulin among women [37]. Theses metabolic disorders are mainly one of the basic factors in appearing dangerous disease like, hypertension, cardiovascular, heart disease and diabetes type 2 [34, 37]. So that removing free fats serum were delayed in fat

people in the insulin situation and blood glucose removing in these people were minimized [9]. Meanwhile, insulin hormone changes and tissues sensitivity enhuncement to these hormones is known as a phenomenon were signified in therapy treatment and metabolic disorders. Then, proper solutions for keeping serum insulin's natural level highly scrutinized for all people particularly obese women [9, 37]. Research based findings declared positive impacts of body activities on prohibition regarded to insulin resistance and keeping insulin's natural level [13, 35]. So, in recent years exercise use for curing or prevention of insulin resistance increase was the main focus of lots of researchers. But among various sports, the least survey was devoted to the resistance training influence on the resistance insulin changes [13]. In this case, resistance training employed properly to individuals' need based on 1RM forced the necessary stress on the body and it caused to engaging of both upper and lower body with suitable movement range. Furthermore, women compared to men and according to high fat tissues are exposed to more cardiovascular problems and chronic inflammation, additionally estrogen physiologic reduction during life especially subsequent menopause in this context causes to fats distribution change from genoid pattern to android pattern, glucose tolerance reduction, unusual serum fat level changes, hypertension increase, sympathetic tone increase and cardiovascular inflammation [14], that the probability of disordering in endothelium performance and finally it intensifies the appearance of inflammation in big arteries and atherosclerosis.

Results of some studies showed that by doing regular resistance training programs in this field may be a proper therapy style [1]. So, data related to the effects of resistance training programs on insulin resistance index level is limited and past study results in this field are contradictory [16, 24]. In this field Khalili, et al (2013) by taking a survey to the effects of 8 week resistance training (includes: bench press, leg press, stretching by machine, leg extension, leg flexion, biceps curl with 60-70 percent, 1RM) on insulin resistance index among fat girls did not manifest a significant decrease in insulin level and insulin resistance index [25]. Sarami et al (2010) after 10 weeks resistant exercise, 3 days a week (leg press, leg extension, leg flexion, bench press, biceps curl exercises and stretching to downsides) found a significant reduction in insulin resistance index ($P \leq 0.05$) [3] While Atlantis et al (2009) found that there is a positive relation between strength and muscular mass with insulin sensitivity in obese people [5]. Dipietro et al (2006) viewed that, in an equal energy cost, physical activity with high intensity compared to physical activity with medium intensity is more beneficial in its effects on insulin sensitivity [12]. Assarzadeh Noushabadi (2012) after 12 weeks concurrent exercises (aerobic and resistance) viewed a significant reduction in insulin level and insulin resistance index [4]. Tabeiee, R. et al. (2012) in a study in order to find the effects of 6 weeks resistance training and resistance index representation to the overweight girls' insulin showed that insulin resistance index in two experimental groups had a significant decrease ($P<0.05$) but the type of resistance training didn't have any effect on this index [21].

By passing over gradually in the literature review, few studies have paid attention to compare upper, lower body and concurrent resistance training among women and their insulin resistance index. The ever increasing use of resistant training among women or training with weight or dumbbell, changes to a popular shape of sport to improve fitness and losing weight in order to increase the performance to prohibit injury, hypertrophy muscle and decrease fat mass. Each of the variables in this study has been done in a separately body training, while results of the past studies with different training protocols were in a way that there were not any unique interpretation related to measured variables. One of the particular specialties of this research was to survey about the effect of upper, lower body resistance training and cocurrent resistance training compared to resistance insulin index among university women. So, the present study pays attention to 3 types of resistance training, to study and do a research in physiologic and biochemistry reactions in insulin resistance index.

MATERIALS AND METHODS

Subjects

After research recall proclamation at Islamic Azad University Tabriz Branch and Tabriz University, 56 healthy women, were informed about the details and aims of this research, voluntarily accepted to take part in this research. This research approved in the sciences research ethics committee of the post graduate physical education and sports science of Islamic Azad University of central Tehran branch.

Subjects according to the entrance and selection criteria to this study: age range 20/35$\pm$ 2/27 years old, weight 60/1$\pm$ 3/27kg, body mass index 20/1$\pm$1/6 kg/m^2, non-existence of regular exercises in the last 2 years, non-existence of pregnancy, non-existence of surgery in the last year, non-smoking and not using any drugs, also the volunteers of this research were chosen and after completing the satisfaction form, randomly were determined to four groups of upper body resistance group(N=14), lower body resistance group (N=14), concurrent resistance group (N=14) and control group (N=14). Table 1 describes the characteristics of all four groups.

Table 1: subjects' characteristics in all four groups (values presented to mean and standard deviation ±)

	Upper group			Lower group			Concurrent group			Control group		
	Pre	mid	post	Pre	mid	post	Pre	mid	post	Pre	mid	post
Age(years)	20.35±2.27			21.07±2.27			22.71±1.27			22.60±1.72		
Weight(kg)	60.1(3.27)	-	59.3(3.2)	53.3(8.27)	-	53.0(7.6)	59.3(4.46)	-	59.1(4.3)	60.3(3.15)	-	62.3(4.1)
BMI ($kg \cdot m^{-2}$)	20.1(1.6)	-	20.2 (1.7)	28.07(2.7)	–	21.0(2.7)	20.4(1.5)	-	20.4(1.4)	21.1(2.3)	-	21.1(2.1)
PBF(%)	24.1(3.8)	-	23.9(4.0)	27.4(3.4)	-	26.9(3.9)	26.8(3.5)	-	26.0(4.0)	29.2(3.3)	-	29.5(3.1)
BFM (kg)	13.6(2.9)	-	13.6(3.3)	14.7(3.7)	-	14.5(3.7)	14.6(2.8)	-	14.1(2.9)	17.2(3.4)	–	17.3(3.2)
Gl($mg.dl^{-1}$)	70.2(6.2)	67/0(8.7)	64.7(4.9)	69.3(12.7)	62.9(6.3)	58.9(11.4)	69.0(4.3)	66.0(6.5)	60.0(6.3)	74.4(7.8)	75.5(5.5)	79.6(7.2)
Ins($\mu U.dl^{-1}$)	33.2(18.3)	23.3(11.2)	19.3(9.3)	25.7(12.8)	20.0(8.5)	12.8(4.6)	22.8(7.2)	18.5(6.2)	10.7(2.6)	23.5(10.8)	30.7(12.4)	43.5(15.4)
HOMA IR	5.7(3.02)	3.8(2.2)	3.02(1.4)	4.4(2.6)	3.1(1.5)	1.8(0.88)	3.8(1.36)	2.9(0.96)	1.5(0.54)	4.2(1.8)	5.6(2.4)	8.2(3.03)

Training protocol

The used training program in this study was in 8 weeks and each week 3 sessions and exercises for an hour which includes upper body and lowers body and concurrent resistant training. The training program includes: warm up (10 minutes), main training protocol operations (40 minutes), stretching exercises and recovery (10 minutes). Physical activities with 50% intensity 1RM starts and once in every two weeks 5% weight was added with new 1RM (Figure 1).

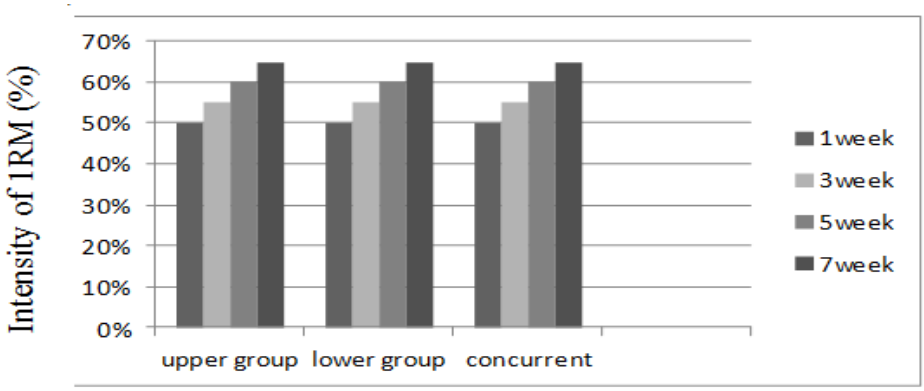

Figure1. Training protocol in 8 weeks. Exercise protocol in three resistance training groups: upper body, lower body, concurrent.

The training program with the machines and free dumbbells or weights group of upper body resistance training that includes bench press, pull down, stretching from front side (rowing), smith bench press, shoulders press, cable pushdown, lower body resistant training group includes Hack squat, dumbbell deadlift, leg extension, leg press and leg curl, standing calf raise, concurrent training includes bench press, pull down, stretching from front side (rowing), leg press, Hack squat and leg curl in 3 sets, 1 minute rest in each set was done.

Study Design:

The present study was carried out for 8 weeks and participants were evaluated in 3 stages: pre-test, mid-test and post-test. A week before the first day of the test and from 8 a.m. to 10 a.m. in the morning, participants referred to the laboratory for the measurement of preliminary testing, including the determination of the body composition (body mass index (BMI), body fat percentage and body fat mass using 220 In Body device (made in Korea), body weight, height. In order to remove an error, all measurements were performed by a single person.

Then, within 2 sessions and in order to learn about training, training location, sports equipment and determining one repetition maximum (1RM) and according to the formula $1RM = \frac{Amount\ of\ Weightsts}{1.0278 - (0.0278 \times repeated\ weights)}$ subjects referred to the gym. Proper techniques of how to use weights and weight machines were instructed to subjects and they started working to be familiar with machines and determining the 1RM. Then three groups performed their own specific and 8-weeks exercise protocol regarding the designed principle of 2 weeks overload for 8 weeks.

Data was registered related to diet of subjects by employing a 24 hours reminding questioner in three days (2 days in early and one day in the late week), also three times (first week, fourth week and sixth week) during body activity program by participants in the special diet sheet.(32)

Blood collection and biochemical analyses

One day before training at 8 am and in a fasting condition, all four groups were referred to the laboratory to take blood samples. Blood samples were obtained at the same time and temperature conditions by a qualified person at the rate of 5 cc. from subjects' right arm anticubital vessel while they were sitting. After one day, they began to

implement physical activities and after four and eight weeks of relevant resistance training, all four groups of subjects were transferred back to the lab to take blood samples. With an identical before workout protocol and with the same conditions blood samples were obtained for measurement of glucose, insulin and insulin resistance index. Immediately after sampling, the samples were centrifuged at 3000 rpm for 10 minutes then the separated plasma was frozen at a temperature of –70 to be used after intermediate and final sampling and when measuring.

Fasting glucose levels were measured using glucose oxide (Pars Azmoon Co. kit) by Ancyon 300 automated analyzer (USA). Serum insulin levels were measured using an insulin ELISA kit (Monobind Inc Company) with a sensitivity of 1U / ml μ.075 with ELISA Reader Awareness of American Manufacturing Co. Model Statfax-2100 and insulitis and resistance to fasting were determined using HOMA - IR method with the formula of glucose (mg / dl) fasting × insulin (μU /dl) fasting / 405 [41].

Statistical analyses:
First, all of the data were studied to determine the normalized using Kolmogorov – Smirnov test. Descriptive data were presented using mean and standard deviation (±) and data were analyzed among the four training groups (upper body, lower body, concurrent and control) using one-way ANOVA with repeated measures (ANOVA). In case of compound symmetry absence in the results of variance analysis with repeated measures using the twining ($P<0.05$), the Greenhouse- Geisser correction was used. Analysis of all data were performed at statistically significant level of $P <0.05$ and with the Spss software version 20.

RESULTS

The results of analysis showed that the glucose which was measured at the time of training, decreased significantly in all three training groups ($P=0.001$ and $F=8.015$) in which there was a 10% reduction in the upper body, 15% lower for lower body and 12% reduction in the concurrent group. In the test between groups the most significant reduction belonged to lower body training group ($P=0.000$) (Figure 2).

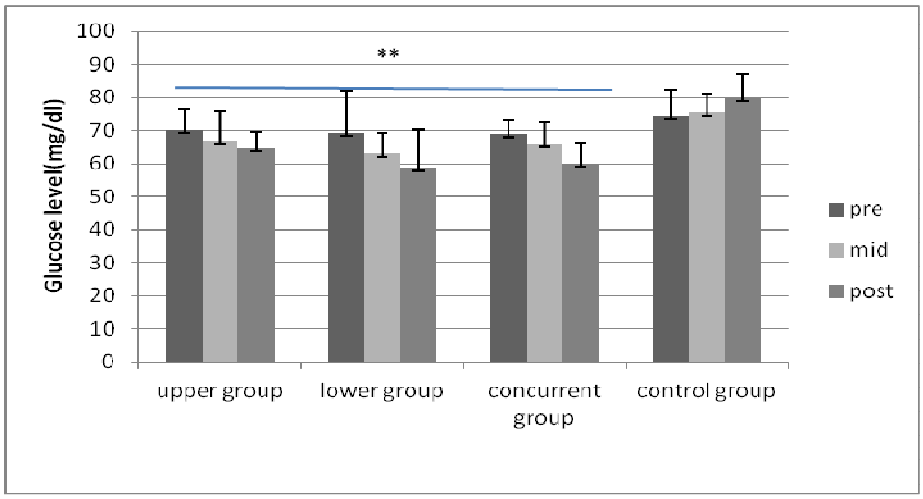

Figure2. Blood glucose levels among the four groups at pre-test, mid-test and post-test.p<0/05 by ANOVA**

Also in the results of the one way ANOVA with repeated measures ($P<0.05$) showed that insulin levels were significantly lower at the time of measurement among the training group ($P=0.022$, and $F=9.45$). Reduction rate was 37% for upper body group, 44% for lower body group and 50% for concurrent group. In the test between groups, insulin levels were reduced in all three groups in which the greatest decrease was in concurrent training group but was not statistically significant ($P>0.05$) and there was not any significant reduction between concurrent and control groups ($P=0.000$) (Figure 2). In the this regard, the results showed that the changes of insulin resistance index at the measurement times had a significant reduction except measurements after 4 and 8 weeks ($P =0.03$ and $P = 0.03$ and $F =14.01$). In the test between groups, in the lower body, upper body and concurrent resisting groups there were respectively 53%, 42% and 57% reductions. Reduction was statistically significant within lower body and cocurrent groups ($P =0.00$) (Figure 4). Thus, considering the significance of group and time, it was found that a resistance training period has a significant effect on the levels of insulin resistance index (Figure 3).

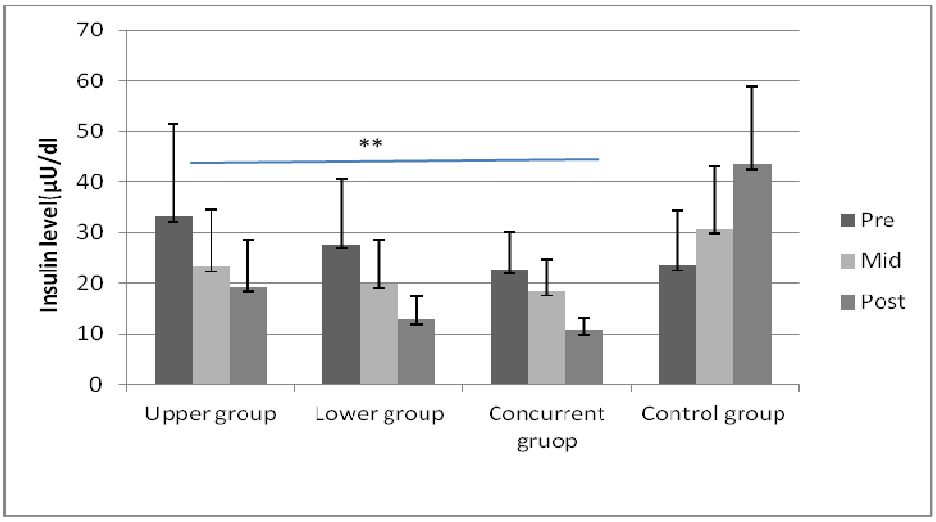

Figure 3: Insulin levels among the four groups at pre-test, mid-test and post-test. .p<0/05 by ANOVA**

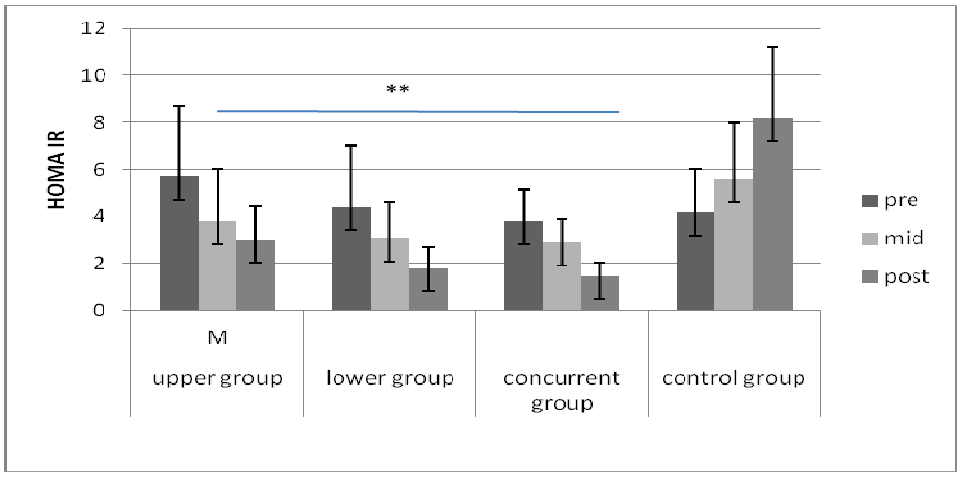

Figure 4: Levels of insulin resistant index among the four groups at pre-test, mid-test and post-test.p<0/05 by ANOVA**

DISCUSSION AND CONCLUSION

Insulin resistance is one of the major complications of obesity which plays a key role in the pathogenesis of obesity-related disorders (including type 2 diabetes) [39]. Thus, identifying interventions that may lead to improve insulin resistance may be necessary in prevention and treatment of exposed individuals (obese people) [39].

In this study, the role of resistance training of upper body, lower body and concurrent were studied on serum concentrations of glucose, insulin and insulin resistance index among academic women. In the this study and in response to resistance training of upper body, lower body and concurrent (lower and upper body resistance training), the results of the analysis of the insulin resistance index indicated a reduction amount of 42%, 53% and 57% that was statistically significant in lower body and concurrent groups (P <0.05). These findings are consistent with the results of Ahmadizad et al [1], Misra et al [28], Di Pietro [12] and Assarzade and Abedi [4].

Research findings in this area indicated that physical fitness is a stronger predictor than fat for insulin resistance. So probably with different mechanisms physical activity helps to improve insulin sensitivity than the change in body fat [27]. Thus consistent with the present study, a hypothesis is proposed that initial changes (at least 10 weeks early) in insulin resistance followed by exercise to improve the quantity and quality of working related to skeletal muscle [23]. Consistent with the present study Atlantis and colleagues (2009) stated that an increase in strength and lean body mass reduces insulin resistance. This finding suggests that the use of more muscle mass by lower body and concurrent resistance training protocol may lead to better the response to insulin to control insulin resistance [17]. Of course, the quantity and quality of the mechanism of muscle is not clearly known to improve insulin sensitivity. Moussa et al [29], Vincent et al [40] After the Wingate test, Jurime et al [22] Bizhe N [7], JD. McDougall [26] after a circular bout of resistance training showed an inconsistence of their study with the present study in increases in

glucose and insulin levels and insulin resistance. It seems that this discrepancy of results is due to the differences in applied training protocols of their study with the present study. Khalili and Nouri (2013) concluded that there was a significant decrease in insulin levels with resistance training (S. [25]. Also, it was reported that there was increase in glucose and insulin level after exhaustion exercises that it was not consistent with the present study [7, 19, 26]. This inconsistency could be the possible reasons such as differences in the study groups, race, training duration, intensity, duration and type of exercise. To explain its mechanism it can be stated that resistance trainings due to the increase in post-messaging receptor for insulin [7], increases in glucose transporter protein Glut4 mRNA [10], increase the activity of glycogen synthase and hexokinase [11, 20], release reduction and increase in clearance of free fatty acids [32], increase in release of glucose from the blood into the muscle due to an increase in muscle capillaries and changes in muscle composition to increase glucose uptake [6] leads to insulin levels reduction and insulin resistance improvement resulted from training [15]. Another reason for insulin reduction could be due to fat mass reduction that did not have a significant reduction in the present study. This finding was not consistent with Pasma et al [32] and Khalili [25], and was consistent with the findings of Bell et al [6] and Nasys et al. [30, 36].

CONCLUSION

Although an upper body (20%) and lower body (21%) and combined (19%) resistance training caused an increase in and improving strength (one repetition maximum) and performance, it seems that different types of resistance training applied in this study caused a significant decrease in the levels of glucose, insulin and insulin resistance index among upper body, lower body and concurrent training groups compared to the control group. At the end it is suggested to perform a similar study with a control of daily calorie and special nutrition program during exercise for lean and obese subjects.

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The present study is a report of research concerning Ph.D. thesis of sporting physiology. I would like to express my cordial thanks to my dearest professors of Islamic Azad University, Central Tehran branch and all those who participated as subjects in this study.

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