Original Article

Comparing the Effect of Resistance, Aerobic, and Concurrent Exercise Program on the Level of Resistin and High Reactive Protein C of Overweight and Obese Women

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Abstract

History and Objective: Obesity is one of the health risks factors, and aerobic exercise is one of the means to prevent and control obesity. The research was designed to compare methods of resistance, aerobic, and concurrent exercises on resistin and C-reactive protein (CRP) serum level of overweight and obese women. **Research Methodology:** In this semi-experimental research, 36 voluntary overweight or obese women were randomly assigned into three groups ($n = 12$) of aerobic, resistance, and concurrent exercise programs. The training included 8 weeks of exercise performed with 55%–75% of 1-repetition maximum weight lifting. The aerobic exercise was performed at 55%–75% of maximum oxygen consumption and concurrent training included both programs for 3 days/week. The resistin and CRP serum level of the participant was measured 48 h before the start and again 48 h after the termination of the exercise protocol. The statistical analysis was performed on data using SPSS 22.0 (Chicago, USA). One-way analysis of variance and paired *t*-test was employed to test the hypothesis at significance level set to 0.05. **Results:** The result indicated that exercise program significantly decreased CRP level of blood serum ($P < 0.05$) in all exercise groups. Such effect was present in aerobic and concurrent exercise group but not on the resistance group for resistin level ($P > 0.05$). **Discussion:** Aerobic exercise regardless of types has a beneficiary effect on CPR, but resistin level needs different types of exercise to change in overweight and obese women. **Conclusion:** Some aerobic exercises are beneficiary for overweight and obese women health.

Keywords: Aerobic, C-reactive protein, exercise, obese, resistance, resistin

Introduction

Industrialization led to the development of sedentary life style. One of the consequences of this type of life style was obesity and overweightness that are the major risk factor for various diseases including cardiovascular and diabetes. Obesity alters mitochondria function and is a risk factor for diabetes type 2, heart disease, blood pressure, and cancer to name a few.[1] Fat tissue functions as a secreting organ. In addition, it is a rich source of energy, isolator, protector of internal organs versus impacts, and releases an active biological substance called adiponectin.[2] Overweightness is a condition associated with the accumulation of excessive fat in the fat tissues. An indirect but valid index of overweightness is the calculation of body mass index (BMI).[3] This index (BMI) is calculated by dividing the weight in kilogram to the square of height in meter. The World Health Organization considers the ratio of 25–29.9 as overweigh; above the 30 ratio is considered as fat for the individual over the age twenty.[4]

Among the various types of adiponectin, resistin known primarily as the factor leading to resistance to insulin is considered as a significant mediator between obesity and inflammation process.[5] Resistin is a peptide-like hormone that belongs to proteins family with enriched carboxyl ending from systein called resistin-Like molecules found in inflammatory zones and contains 109 amino acids and is involved in resistance to insulin, inflammation, and atherosclerosis.[6] By interfering in glucose and fat metabolism, resistin increases the risk of atherosclerosis. In addition, by activating preinflammatory

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agents, it increases the risk of susceptibility to atherosclerosis plaque.[7] This substance has a direct association with the level of C-reactive protein (CRP). CRP is a member of pentroxy family that is built in response to accumulation of inflammatory cytokines (another name for adipokine) by the liver and fat tissue.[8,9] It is also an index of sensitivity and nonspecific inflammation index, and in causing chronic inflammatory diseases, it plays a role. CRP is one of the plasma proteins that is produced in the liver, and its increase is a response to infectious diseases, inflammation, or tissues damages.[10] The presence of 1 mg/l CRP in blood is an indication of low risk, whereas the level of I to 3 mg/l indicated moderate and above 3 mg/l is considered as high risk in adults.[11]

One of the most significant causes of CRP production is obesity. The level of CRP serum in healthy individuals is low, but it can increase up to 100 times in acute diseases.[12] Despite the fact that this substance is produced in liver, the result of new research indicates that it can be produced in the blood vessels intima layers too.[13] In general, there are strong evidence that indicate the level of inflammatory factors is positively related with fat tissue probably due to the higher level of cytokines secretion in obese individuals.[14]

Lowering the level of fat tissue brought about by participation in physical activities is the most preferred way of preventing the incidence of fat-related diseases. Regular physical activities result in metabolic changes within the muscle and fat tissue and consequently uses fat stored in fat tissue instead of storing it.[15] The result of research in this regard indicates that change of physical activity pattern is associated with a change in the serum level of inflammatory agents.[16] Aerobic activities are usually employed to evaluate the effect of physical activity on fat decrease. Recently, it has been demonstrated that combining aerobic training with resisting training program results in improvement of endothelial function and blood flow in active muscle.[17] Thus, the concurrent training program (resistance and endurance) leads to dual benefits of aerobic exercise as well as resistance training.[18] Resistance training programs are the type of program in which muscles contract against a resisting force including dumbly, weights or an object and results in increase of power and muscle mass.

The result of a study demonstrated that regular training has a significant anti-inflammatory effect and results in a decrease of the inflammatory level.[19] An effective training program needs to be adequate in intensity, duration and frequency and type of activity to induce overloading effect on different body systems and cause adaptation.[20] Since physical activity results in fat losses, adopting an active life style may results in decrease the level of inflammatory markers released from fat tissue. The research result about the relationship between exercise and resistin and glycemic index have not produced unanimous results while Giannopoulou showed that 14 weeks of aerobic training program did not result in significant alteration of resistin and sensitivity to insulin;[21] Jones showed that participation in 8 months of aerobic exercise program resulted in significant decrease of blood resistin level and no significant change in resistance to insulin in overweight young adolescents.[22] In addition, Tofighei *et al.* concluded that 3 months of aerobic exercise resulted in an increase of resistin level.[23] Prestes showed that 16 weeks of resistance training program resulted in a decrease of resistin level,[24] Donges compared the effect of 10 weeks of aerobic versus resistance training program and reported a significant decrease of CRP level in sedentary individuals only for the resistance training program.[25] Jorge reported that 12 weeks of aerobic, resistance, and concurrent training programs resulted in significant decrease of CRP in all three groups.[26]

Considering the controversial findings in regard to the effect of aerobic and resistance training on inflammatory markers, it seems necessary to conduct more carefully designed research in regard to the effect of endurance and resistance training programs concurrent or separately. Therefore, this research was designed to examine the effect of 8 weeks of concurrent endurance and endurance training on the level of inflammatory markers of resistin and CRP in sedentary, overweight women.

Research Methodology

This was a semi-experimental research in which 36 healthy women with no history of smoking, alcohol use or chronic disease including metabolic syndrome, diabetes, or cardiovascular complaints with BMI over 25 were randomly assigned into three equal groups ($n = 12$) of aerobic, resistance, and concurrent exercise groups. The participants were volunteers and signed human consent forms. All the procedure and objectives of the research protocol were explained to them. The training program included 8 weeks of exercise performed with 55%–75% of 1-repetition maximum weight lifting, aerobic exercise performed at 55%–75% of maximum oxygen consumption and combination of the two programs for 3 days/week. The exercise programs were performed on Sadi gymnasium of Shahr-e Kord every other day under the supervision of qualified coaches. The resistin and CRP serum blood level of the participant was measured 48 h before the start and again 48 h after the termination of the exercise protocol. Physical Activity Readiness Questionnaire form was employed to assess the health status of the participants. Weight and height measures recorded by employing digital scales; weight and hip circumferences were measured by flexible tape.

Body fat percentage was measured by Harpenden caliper while serum resistin level was assessed by BOSTER kit made in U. S. A. designed for human sample. Immunotronic method was employed to measure CRP blood level with BIONIK kit for human sample manufacture in U. S. A. and immunometric assay method. All the blood samples were collected in pathology laboratory 48 h before the start of the exercise protocol and 48 h after the termination of the program. Ten cubic centimeters of blood from left-hand ulnar vein was centrifuged and following serum isolation, the sample was kept at −30°C for final analysis.

BMI was calculated by dividing the weight in kilogram to the square of height in centimeter. All the weights were measure bare footed.

For the start of the exercise programs to control the intensity of training, maximum oxygen consumption (VO_{2max}) and maximum muscle force were calculated by Cooper 12 min run[27] and using the formula:

$VO_{2max} = -11.2872 \times (\text{distance covered [mile]} \times 35.9712)$.[28]

For selecting the proper weights, maximum repetition weight, Bursisky formula was employed:

$$1 - RM = \frac{(\text{moved weights}) \text{ kg}}{(1.0278 - \text{reptitition to exhustion} \times 0.0278)}$$

Exercise protocol

All the exercise activities were performed every other day between the 15:30 pm and 17 three times per week for 8 consecutive weeks.

- A primary resistance training program of 1-RM including one barbell bench press, leg press, seated row, knee extension, lateral raise, knee flexion, arm extension, hip abduction and adduction, arm curls, and standing calf raise, overall 10 exercises.[24] The participant started the exercise programs with 55% 1-RM. Every 2 weeks, they were tested with the percentage 1-RM and accordingly the new 1-RM was determined. Finally, at the end of the training program, the participants performed with 75% 1-RM. The time per session included 10 min of warm-up, 55 min of workout, in the beginning, increased to 62 min in the final session and 10 min of cool down exercises
- The aerobic exercise program included 10 min of warm-up followed by the main part of the aerobic exercise and 10 min of cool down activities. The first exercise session lasted 30 min of walking with 55% of maximum oxygen consumption and increased 1-min/session performed at higher intensity to approach 75% of maximum oxygen consumption in the last session of the exercise protocol[29] 12 min Cooper test was employed to determine VO_{2max}
- The concurrent training program was made up of aerobic and resistance training exercises. The intensity of the exercise programs was similar to the other two groups, but the volume of the activities was adjusted in sets and aerobic activities.[26]

The statistical analysis was performed using SPSS: Pc version 22 and Kolmogorov–Smirnov test was used to check the normality of the distribution. The entire hypothesis was tested at alpha level set to 0.05. The analysis of variance (ANOVA) and paired as well as independent *t*-tests was used to test between and within group differences.

Results

Mean and standard deviations of some of the general and physiological characteristics of the participants including age, height, weight, BMI, waist to hip ratio, and VO_{2max} at the base line is presented in Table 1. In addition, mean and standard deviations of resistin and CRP of the resistance, aerobic, and concurrent training groups in pre- and post-test conditions are presented in Table 2.

The result of ANOVA test for the physiological characteristics of the participants including age, height, weight, BMI, waist to hip ratio, and VO_{2max} at the base line showed that there was no significant difference among the three exercise groups ($P > 0.05$).

The result of one-way ANOVA indicated that there was also no significant difference between the level of CRP or resistin of the three exercise group at the base line ($P = 0.93$ and 0.63).

For testing the within group difference of resistin, paired *t*-test was employed. The result of the analysis indicated that the level of blood serum resistin significantly decreased in aerobic and concurrent training groups ($P = 0.05$, $P = 0.03$) but not in the resistance training group ($P = 0.17$). The percentage of decrease is shown in Table 3. The concurrent training group showed the highest percentage of decrease (19.89%) followed by aerobic training group (18.50%). There was a percentage of decrease in the resistance training (16.57%), but it was not significant statistically.

The result of one-way ANOVA test on pretest-posttest difference in resistin level indicated that there was no

Table 1: General and physiological characteristics age, height, weight, body mass index, waist to hip ratio and VO_{2max} of the participants at the base line

Variable	Group		
	Aerobic	Resistance	Concurrent
Age (years)	33.27±6.82	34.9±5.22	33.72±5.29
Height (cm)	156.18±5.21	155.68±6.01	157.09±7.72
Weight (kg)	76.11±9.73	76.86±9.85	76.20±9.94
BMI (kg/m^2)	31.34±4.82	31.83±4.62	31.04±5.03
Body fat percent	38.61±3.48	36.81±4.02	39.17±2.72
Waist/hip ratio (cm)	0.98±0.03	0.97±0.03	0.99±0.02
Vo_{2max} (mm/kg/min)	17.64±3.1	16.98±3.77	18.80±3.76

VO_{2max}: Maximum oxygen consumption, BMI: Body mass index

Table 2: Mean and standard deviations of resistance, aerobic and concurrent training groups resistin and C-reactive protein in pre- and post-test conditions

Variable	Group	Stage	
		Pretest	Posttest
Resistin (ng/ml)	Aerobic	7.50±2.04	6.11±1.39
	Resistance	7.66±2.69	6.39±1.64
	Concurrent	7.59±3.81	6.08±2.52
CRP (ng/ml)	Aerobic	4.81±1.07	3.78±1.05
	Resistance	4.72±1.27	3.81±1.40
	Concurrent	4.90±2.84	3.54±2.23

CRP: C-reactive protein

significant differences in the level of plasma resistin of aerobic, resistance, and concurrent training groups after 8 weeks of participation in the exercise program ($P = 0.97$). These results are shown in Table 4.

A similar procedure was used to test the within group difference of CRP level in by comparing pretest–posttest measures. The result of analysis indicated that the level of blood serum CRP significantly decreased in aerobic, resistance, and concurrent training groups ($P = 0.04$, $P = 0.005$, $P = 0.05$). The percentage of decrease is shown in Table 3. The concurrent training group showed the highest percentage of decrease (27.75%) followed by the aerobic training (21.24%) and resistance training group (19.27%), respectively. These results are presented in Table 5.

The result of one-way ANOVA test on pretest-posttest difference in CRP level indicated that there was no significant differences in the level of plasma resistin of aerobic, resistance, and concurrent training groups after 8 weeks of participation in the exercise program ($P = 0.81$). These results are shown in Table 6.

The result of one-way ANOVA test on pretest-posttest difference in CRP level indicated that there was no significant differences in the level of plasma resistin of aerobic, resistance, and concurrent training groups after 8 weeks of participation in the exercise program ($P = 0.81$). These results are shown in Table 5.

Discussion

The purpose of this research was to examine the effect of 8 weeks of aerobic, resistance, and concurrent training program on the decrease of resistin and CRP level of overweight and obese women. The result of study showed a significant decrease in resistin level; this finding was in agreement with the result of studies reported by Botero *et al.*, Buyukyazı *et al.*, Prestes *et al.* and Kadoglou *et al.*,[24,29,30,31] however, the findings was contrary with what was reported by Tofighei *et al.*, Samedian *et al.*, Jorge *et al.* and Jamurtas *et al.*[23,26,32,33] The discrepancy if the findings may be attributed to the differences of time exercise protocol including time, gender, and physiological adaptation due to the participation in the exercise protocol. Prestes *et al.* stated that the change of resistin level after 24 and 48 h of exercise occurs because of 16 weeks of systematic resistance training program.[24] The authors concluded that resistin may decrease under the influence of type and intensity of aerobic or resistance training program. In such condition, there is a decrease in pre-inflammatory cytokine production through the inherited immune response, decrease in production of preinflammatory mediators by fat and liver tissue and increase of anti-inflammatory mediators released by fat tissue. This decrease in systemic preinflammatory markers is associated with decrease in chronic disease related to menopause. The researcher in this research acknowledged their limitation by the lack of large sample and control group in addition to the 16 weeks of training as too short a period.

Table 3: Paired T-test of resistin in aerobic, resistance and concurrent training groups

Variables	Statistical index					
	Mean±SD		df	Change (%)	*t*	*P*
	Pretest	Posttest				
Aerobic	7.50±2.04	6.11±1.39	10	18/50	2.13	0.05*
Resistance	7.66±2.69	6.39±1.64	10	16/57	1.47	0.17
Concurrent	7.59±3.81	6.08±2.52	10	19/89	2.64	0.03*

*Significant at $P = 0.05$. SD: Standard deviation

Table 4: One-way analysis of variance test on pre- and post-test difference in resistin level of aerobic, resistance and concurrent training groups after 8 weeks

Sources of variations	Sum of squares	df	Mean squares	*F*	*P*
Between group	0.308	2	0.154	0.027	0.97
Within group	169.358	30	5.645		

Table 5: Paired T-test of C-reactive protein in aerobic, resistance and concurrent training groups

Variables	Statistical index					
	Mean±SD		df	Change (%)	*t*	*P*
	Pretest	Posttest				
Aerobic	4.81±1.07	3.78±1.05	10	21.24	2.23	0.04*
Resistance	4.72±1.27	3.81±1.40	10	19.27	3.62	0.005*
Concurrent	4.90±2.84	3.54±2.23	10	27.75	1.86	0.05*

*Significant at $P = 0.05$. SD: Standard deviation

Table 6: One-way analysis of variance test on pre- and post-test difference in C-reactive protein level of aerobic, resistance and concurrent training groups after 8 weeks

Sources of variations	Sum of squares	df	Mean squares	*F*	*P*
Between group	1.210	2	0.605	0.024	0.81
Within group	5.350	56	0.09		

Kadoglou *et al.* and Jorge *et al.* purpose that the lack of significant resistin level change after 12 weeks of concurrent training in menopaused adult women suffering from type 2 diabetes was due to the small sample size and lack of control over the metabolic condition of the participants.[31,26] They claimed that since resistin level is controlled by the diet type and food restrictions result in decrease of Messenger genes expression, it is likely that the lack of change in this index is mediated by the diet of the participants. Jamurtas *et al.* stated that the lack of change in resistin level after submaximal aerobic exercise id due to the fact that the level of this hormone changes after several month if exercise.[33] They concluded that acute aerobic exercise regimes do not lead to prolonged change level of resistin in healthy over weight individuals, therefore, exercise does not cause a significant change in resistin level up

to 48 h post-exercise state. The result of this research in regard to the changes of CRP level was in agreement with the findings of Dastani *et al.*, Jorge *et al.*, Olson *et al.* and Mogharnasi *et al.*,[19,26,34,35] but did not support the findings of Schulze and Busse, Hemmatinafar *et al.* and Tartibian *et al.*[11,36,37] The discrepancy of findings may be attributed to the differences among the groups in the protocol, basic level of the factor and the study design and other factors including type, duration, and the intensity of the training program.

In regard to the mechanism leading to the change of CRP due to exercise, controversy remains. It is likely that the adaptation to aerobic exercise is due to the improvement of heart and vessels. This process is directly linked to the increase in nitric oxide released from endothelial tissue that causes improvement in endothelial function and rise of antioxidant factors. The result of this event is the decrease in systemic as well as local inflammation and consequently decreases of inflammatory cytokines from the smooth muscles of endothelial tract. The final product of such changes is the likely decrease of CRP in liver as the index of inflammation.

In the other hand, because of improvement in cardiovascular system due to the participation in aerobic exercise, change of metabolic, and improvement of lipolysis process follows. These changes are reflected in weight reduction, body mass, particularly in a decrease of body fat percentage. This later factor is one of the main producers of inflammatory cytokines. The end result of these changes is direct and indirect production of CRP in liver.[38] In addition, a potentially major pathway contributing to these changes may include interleukins. Based on some evidence, considerable the amount of tumor necrosis factor-alpha (TNF-α) and interleukin-6 are released from the fat tissue, specifically from the visceral fats.

The release of these factors is increased by the activity of sympathetic pathway and since regular physical activity decreases sympathetic activity, it is likely that it leads to the decrease in secretion of TNF-α and interleukin-6. Dastani *et al.* conducted a research on 30 menopaused women and concluded that participation in 8 weeks of aerobic exercise three times per week with 50%–60% of maximum heart rate resulted in decrease of CRP.[34] Based on the available evidence reported earlier, they stated that decrease of CRP is directly related with obesity, BMI, waist to hip ratio. Every kilogram of weight loss is associated with 13% decrease in CRP. In addition, fat cells produce interleukin 6 that are responsible for the release of CRP by liver. Therefore, weight loss in addition to decrease in fat percent and interleukin production result in decrease of CRP. These authors also considered the loss of BMI because of decrease in CRP level and concluded that in obese individuals with resistance to insulin, the level of CRP is high and it decreases as they lose weight. Jorge *et al.* claimed that decrease in the level of CRP is an indication of depression in systemic inflammation induced by physical activity and diet.[26]

Conclusion

The result of this study showed that all type of exercise regardless of being aerobic or resistance are effective in decreasing health risk factors and there is no significant differences in regard to their effectiveness. It needs to be mentioned that despite the effort to control the research environment and factors that may interfere with the findings of this research, there were limitations beyond the control of the researcher. To name a few, the daily activities and diet of the participants was not possible to monitor during the 8 weeks of exercises. In addition, personal characteristics of the participants including their motivation to engage in the activities were not matched.

Considering the fact that the entire exercising group significantly showed a decrease in the resistin and CRP level of their blood after completing the exercise program, it may be concluded that these types of exercise are appropriate to use in exercise in weight control clubs, rehabilitation center, and diabetic community for their clients. However, further research with larger sample including both gender and controlling diet and daily activities of the type of participants is necessary to make a firm recommendation.

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Conflicts of interest

There are no conflicts of interest.

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