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Effect of high intensity exercise training (HIIT) and endurance training on weight loss and C- reactive protein in obese men

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Abstract

Obesity and overweight are common epidemic in all of world and increase the risk of disease. C-reactive protein (CRP) is an inflammatory biomarker that its level increases in obese/overweight people. Weight loss can be a useful treatment for reduction law-chronic inflammation and risk of disease. Therefore if we can find a proper method for weight loss, risk of disease reduces. The aim of this study was determined and comparison effect of low- caloric dietary, low-caloric diet + endurance training, low-caloric diet + high intensity interval training (HIIT) on weight loss and CRP levels. For this purpose 32 healthy obese/overweight men randomly assigned in three groups: low-caloric diet (n=10), diet + endurance training (n=11) and diet + HIIT (n=11). Subjects in diet group received a dietary program that its energy was 3500 *kcal/week* less than their routine diet. In two exercise groups dietary program was consist of 2500 *kcal/week* less than ordinary diet and energy expenditure through exercise was about 1000 *kcal/week*. After 12 weeks intervention weight and CRP levels in all groups decreased significantly and there is not significant differences between groups. We did not find any correlation between body weight loss and CRP changes. We concluded that low-caloric diet, diet + endurance training, diet + HIIT can be proper methods to weight loss and decrease risk of disease.

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Introduction

Obesity and overweight are the epidemic in the entire world. Obesity and overweight increase the risk of diseases such as cardiovascular diseases, type 2 diabetes, arthritis, hypertension and certain form of cancers (Mokdad *et al.*, 2003). Adipose tissue expresses and releases pro-inflammatory cytokines such Inter Leukin-6 (IL-6) and Tumor Necrosis Factor α (TNF-α) (Laukkanen *et al.*, 2001; Myera *et al.*, 2002). The main inflammatory molecule associated with obesity is C - reactive protein (CRP), which is synthesized and secreted by the liver in response to IL-6 (Heinrich *et al.*, 1990). CRP is an acute phase reactant which is a marker of low – chronic inflammation (Ridker *et al.*, 1998). Individuals who are obese demonstrated elevated levels of CRP (Escobar-Morreale *et al.*, 2003; Arita *et al.*, 1999). Weight loss through diet and/or exercise training can reduce metabolic disorders (Oreapulos *et al.*, 2010; Sharma *et al.*, 2012). Studies indicated that weight loss might be required to normalize CRP levels (Yang *et al.*, 2001; Yokoyama *et al.*, 2004). It is recommended that combination of dietary and physical activity is the best method to weight loss (Okura *et al.*, 2009). Weight loss via dietary alone decreases lean body tissue (Campbell *et al.*, 2009; Weinheimer *et al.*, 2010). Endurance exercise training increasingly recommended in prevention and treatment of obesity and overweight (Haskell *et al.*, 2007) without the negative influences on body mass. A specific study on the effects of endurance exercise training in obese women shows that endurance-trained women had a higher fat oxidation rate (Stisen *et al.*, 2006). In lean and obese men endurance exercise training hadn't effect on weight and CRP levels (Dekker *et al.*, 2001). In recent years researchers show that high intensity interval training (HIIT) might be a time efficient alternative to achieving similar physiological benefits such endurance training. The role of HIIT in body weight management was demonstrated (Hunter *et al.*, 1998). It seems that the higher the intensity of the exercise, the higher the fat oxidations post exercise (Bahr *et al.*, 1991; Gilette *et al.*, 1994). Researchers demonstrated that HIIT more than endurance exercise training decreased body fat percent (Schjerve *et al.*, 2008).

Although there are some reports about exercise training and CRP responses, but studies about HIIT role and differences between endurance training and HIIT training are unclear. The purpose of this study is comparison of HIIT training and endurance training effects on CRP in obese men.

Material and methods

Subjects

Subjects were 208 obese/overweight men, 30-45 year that were referred to a weight control clinic in Isfahan-Iran at 2011 summer.32 volunteers participated in this study. All subjects were untrained, healthy, no smokers and do not take any medications. They randomly assigned in 3 groups, diet only (n=10), diet + endurance exercise training (n=11), diet + HIIT (n=11).

Experimental design and protocol

Subjects evaluated 3 days before intervention. First day, weight, height, VO_2peak (peak oxygen consumption) were measured and blood samples were collected. After 12 weeks intervention, 48 hours after it all variables measured again.

Variable measurement

Weight

Body weight was measured to the nearest 0.1 kg with using a digital scale (Seca, Germany). Subjects' weight was measured in standing position and with minimum dresses.

Height

Height was measured to the nearest 0.5*cm* using a well-mounted stadiometer. Subjects' height was measured where as they put off their shoes, their heels touched the wall and their head was straight.

VO_2peak

VO_2peak was determined using an incremental exercise test on treadmill (h/p/cos mos Mercury med, Germany). Respiratory and metabolic variables were obtained for each breath by measuring gaseous

respiratory exchanges using a gas analyzer (Powercube, Ganshorn, Germany).

C - reactive protein

Blood samples were collected after 8-10 hours fasting and at 8-9 a.m. from antecubital vein in to sterile cubes containing heparin. The plasma was frozen at -80℃. CRP was assessed by ELISA kit (IBL-International, Germany) with accuracy less than 1*mg/ml*.

Dietary program

All subjects instructed to take a well balanced supplemental food every day. In diet only group energy intake/week was 3500 *kcal* less than their previously energy intake and in training groups was 2500 *kcal* less than previously energy intake. Diet consists of 50-55% carbohydrate, 15-25% protein, 25-30% lipid.

Endurance training program

In addition to energy restriction, subjects in endurance training group performed walking-running exercise with low–moderate intensity or 55-70% V_2peak, 3 days/week, 30-45 min/day. The exercise started with 55% VO_2peak and 30 *min/ session* and finally progressed to 65-70% VO_2peak, 45min/session.

HIIT program

In addition to energy restriction subjects in HIIT group engaged in a HIIT program. The program consisted of 1 *min* running with high intensity or 85-95% VO_2peak and 1 *min* recovery with 50-55% VO_2peak. In the first 2 weeks training program was 4-6 sets with 85% VO_2peak. During 12 weeks progressed to 95% VO_2peak and 10 sets.

Statistical analysis

Statistical analyses were performed using *SPSS* statistical soft ware system (version21).Values was expressed as mean± SD in table 1. Paired sample *t*-test performed for evaluated changes in each group and co-variance analyses were used to test differences in changes between variables in all groups. Bootstrap post hoc analysis was applied when the ANOVA interaction term was significant. *P*-values less that 0.05 were considered statistically significant.

Results

Subjects' characteristics

Subjects' BMI (body mass index) was calculated as the total body mass (*kg*) divided by height (*m*) square. Subject's characteristics descriptive statistics was shown in table 1.

Table 1. Characteristics of participants according to age, height, weight, BMI.

	Diet	Diet + Endurance	Diet + HIIT
Age(year)	32.5±5.80	29.45±6.09	30.82±5.37
Height(cm)	180.5±1.96	180.91±4.95	176.9±5.77
Weight(kg)	94.9±7.25	101.36±14.16	92.56±9.38
BMI(kg/m²)	29.12±2.00	30.90±3.51	29.84±2.59

Weight

Table 2 presents the weight changes after 12 weeks in each group. In all groups weight decreased after 12 weeks (diet only=-5.2%, P<0.001, endurance training=-3.6%, P<0.001, HIIT= -7.9%, P<0.001). Weight decrease in HIIT group was more than two other groups. Weight changes in all groups were significant but there are not any significant differences between groups (P>0.094).

CRP

Statistical analysis reported that after 12 weeks intervention CRP levels in all groups decreased significantly (diet only=-25.4%, *P*<0.003, endurance training=29.0%, *P*<0.026, HIIT= -38.2%, *P*<0.001). Table 3 presents CRP level changes before and after

12 weeks in all groups. Co-variance analysis indicated that there are not significantly differences between groups (P>0.261). We did not find any significant correlation between CRP changes and weight changes (P>0.089).

Discussion and conclusion

Exercise training has been recommended to obesity treatment, but it seems that the amount of weight loss due to exercise has been modest (Ballor *et al.*, 1991). Some investigators have suggested that exercise produced a relatively small energy deficit and needs to be applied long term of at least 1 year to generate weight loss (Bouchard *et al.*, 2001; Garrow *et al.*, 1995). Some investigators suggested that dietary methods for weight loss can result in weight cycling (Kramer *et al.*, 1989). It seems that exercise training impacts on energy metabolism in the post- exercise oxygen consumption that affected by exercise intensity (Bahr *et al.*, 1991). Thus HIIT must increased weight loss. It has commonly be observed that 6-12 weeks of exercise at a moderate intensity can improved substrate oxidation on the other hand high intensity interval training for 6-7 weeks produces similar results (Rodas *et al.*, 2000). Our research shows that energy restriction via diet and increase energy expenditure with exercise can reduce weight although it seems that HIIT decreases weight more than endurance exercise training and di*et al*one methods for weight loss, there is not any significant differences between them.

Table 2. Weight (*kg*) changes before and after intervention.

	before Mean±SD	after Mean±SD	change% Mean±SD	P-value
Diet	94.4±7.2	90.0±7.2	-5.2±1.2	0.001*
Diet + endurance	101.3±14.1	94.9±12.5	-3.6±1.5	0.001*
Diet + HIIT	92.6±9.4	85.2±9.2	-7.9±2.9	0.001*

** Significantly different before and after intervention.*

A close association between adipose tissue synthesis and secretion of inflammatory cytokines has been demonstrated (Pasceri *et al.*, 2000).Investigators shown that obesity is a cause for low-chronic inflammation. Total body fat has been shown to be a predictor of circulatory CRP levels. Adiposity increases releasing CRP, IL-6 and TNF-α from adipose tissue. IL-6 stimulates expression and secretion of CRP from liver.

Table 3. CRP (*mg/l*) changes before and after intervention.

	before Mean±SD	after Mean±SD	changes% Mean±SD	P-value
Diet	2.2±0.5	1.6±0.6	-25.4±20.0	0.003*
Diet + Endurance	1.7±0.8	1.2±0.8	-29.0±26.1	0.026*
Diet + HIIT	1.9±0.4	1.1±0.5	-3.8±19.2	0.001*

** Significantly different before and after intervention.*

These findings suggested that decrease adipose tissue can reduce CRP and other inflammatory markers. Previous investigators that examining the ability of exercise to alter inflammatory markers have demonstrated mixed results (Mattusch *et al.*, 2000; Thomas *et al.*, 2000). These results may be related to the acute and chronic phases of the inflammatory responses to exercise training. Aerobic exercise training interventions studies support the hypothesized long-term training effects on the

inflammatory process, resulting in reduce inflammatory markers. It is reported that long-term engagement in dynamic physical activity results in reduced levels of inflammatory markers (Pischon *et al.*, 2003; Rothenbacher *et al.*, 2003).

Some investigators reported that weight loss via energy restriction with or without exercise decreased IL-6 and CRP levels in obese women (Imayama *et al.*, 2012). Other researchers shown that exercise induced weight loss can decrease CRP levels (Hamedinia *et al.*, 2009). Some other investigators demonstrated that energy restriction dietary reduced IL-6, CRP, TNF-α but exercise alone has not significantly effect on these inflammatory biomarkers (Nicklas *et al.*, 2004). Other researchers reported that weight loss has not significant effect on CRP levels (Wong *et al.*, 2004; Arsenault *et al.*, 2009).

Our research results demonstrated that diet only, diet + endurance exercise and diet + HIIT reduced both weight and CRP levels. Differences between Arsenault *et al.* research result and our results may be related to their subjects that were postmenopausal women and their hormonal changes can affect on CRP responses to weight loss.

Also we do not find any relation between CRP levels and weight, but correlation between CRP and body fat was significant. This finding recommended that fat reduction can decrease CRP levels but weight changes alone cannot be a proper predictor for CRP changes.
So we recommended diet, diet +endurance training and diet +HIIT methods for weight loss and reduce risk of some disease in 30-45 years obese/overweight men.

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