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

Hasan Matin Homaee, Lida Moradi*, Mohammad Ali Azarbajani, Maghsoud Peer

Department of Exercise Physiology, Faculty of Physical Education and Sports Science, Islamic Azad University, Central Tehran Branch, Tehran, Iran

Key words: Obesity, endurance training, HIIT.

http://dx.doi.org/10.12692/ijb/4.9.190-196 Article published on May 10, 2014

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.

*Corresponding Author: Lida Moradi ☺ Lida_moradi @ hotmail.com
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 (Bahrt et al., 1991; Gillette 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, VO₂peak (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.

VO₂peak

VO₂peak 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°C. 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% V2peak, 3 days/week, 30-45 min/day. The exercise started with 55% VO2peak and 30 min/ session and finally progressed to 65-70% VO2peak, 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% VO2peak and 1 min recovery with 50-55% VO2peak. In the first 2 weeks training program was 4-6 sets with 85% VO2peak. During 12 weeks progressed to 95% VO2peak 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.

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

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=-29.6%, 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 diet alone methods for weight loss, there is not any significant differences between them.

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

<table>
<thead>
<tr>
<th></th>
<th>before Mean±SD</th>
<th>after Mean±SD</th>
<th>change% Mean±SD</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diet</td>
<td>94.4±7.2</td>
<td>90.0±7.2</td>
<td>-5.2±1.2</td>
<td>0.001†</td>
</tr>
<tr>
<td>Diet + endurance</td>
<td>101.3±14.1</td>
<td>94.9±12.5</td>
<td>-3.6±1.5</td>
<td>0.001†</td>
</tr>
<tr>
<td>Diet + HIIT</td>
<td>92.6±9.4</td>
<td>85.2±9.2</td>
<td>-7.9±2.9</td>
<td>0.001†</td>
</tr>
</tbody>
</table>

*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.**

<table>
<thead>
<tr>
<th></th>
<th>before Mean±SD</th>
<th>after Mean±SD</th>
<th>change% Mean±SD</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diet</td>
<td>2.2±0.5</td>
<td>1.6±0.6</td>
<td>-25.4±20.0</td>
<td>0.003†</td>
</tr>
<tr>
<td>Diet + Endurance</td>
<td>1.7±0.8</td>
<td>1.2±0.8</td>
<td>-29.0±26.1</td>
<td>0.026†</td>
</tr>
<tr>
<td>Diet + HIIT</td>
<td>1.9±0.4</td>
<td>1.1±0.5</td>
<td>-3.8±19.2</td>
<td>0.001†</td>
</tr>
</tbody>
</table>

*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 reduced 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 showed 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.

References
http://dx.doi.org/10.1006/bbrc.1999.0255

http://dx.doi.org/10.1016/j.atherosclerosis.2009.05.009


http://dx.doi.org/10.1038/oby.2009.2

http://dx.doi.org/10.1016/j.metabol.2006.10.015


Sharma AM, Padwal R. 2010. Obesity is a sign over-eating is a syndrome: an etiological framework for the assessment and management of obesity.

Obesity 11, 362-70. http://dx.doi.org/10.1111/j.1467-789X.2009.00689.x


