Effects of High Intensity Interval Training (HIIT) on Interleukin 6 (IL-6) in Young Inactive Women

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ABSTRACT

Background: High intensity interval training (HIIT) enhances the capacity for fat oxidation and mitochondrial enzyme activity, but the effect of HIIT on plasma interleukin 6 levels is not yet clear. The aim of this study was to determine the effects of the eight week HIIT on resting plasma levels of interleukin 6 and fat loss in sedentary young women. Objective: The aim of present study was to evaluate the changes in IL-6 following 8 week high intensity interval training. Results: Statistical analysis of the data showed no significant decrease in resting Interleukin 6 levels post-intervention in the experimental group (P=0.357). Significant improvements (P<0.05) were found in body fat percentage, body mass index (BMI) and VO2max post-intervention (experimental group). The findings of present study demonstrated that high-intensity interval training is an appropriate method to reduce body fat and improve VO2max in sedentary young women. Also, the intensity and duration of exercise as an important factor in the changes in interleukine 6 levels could be noted.

INTRODUCTION

The relationship between physical activities and health has a long history. Sedentary lifestyle leads to a dramatic reduction in physical activities that increases the risk of chronic diseases in women and men. In sedentary people, obesity and weight gain are strongly related to development of chronic [1] and inflammatory diseases that are major causes of mortality [2]. On the other hand, anti-inflammatory effects of exercise have been confirmed [3-4] and its effect has been shown on pro and anti-inflammatory cytokines [5,6], and thus, the protective effect of exercise against mortality is quite plausible. One study has demonstrated a strong and consistent inverse relationship between physical fitness and leukocyte count and markers of inflammation such as serum IL-6 [3]. Fischer et al. have shown that mRNA expression content of exercise-induced IL-6 is markedly reduced in human skeletal muscle after 10 wk endurance training [7], but Robson-Ansley et al. have shown that plasma level IL-6 content is significantly elevated following intensified training [8].

Although current recommendations for physical fitness involve performing aerobic and resistance exercise with moderate to vigorous intensity for several hours per week, people generally fail to follow such regimes due to lack of time [9]. Nowadays, experts have focused on interval training program with high intensity and low volume [10]. Previous studies have shown that this training induces fat oxidation during training in women [11], and improves muscle oxidative capacity [10,12,13] and it is superior to moderate intensity exercise in rats [14]. Rakobowchuk et al. have also confirmed that 6-week sprint interval training with low volume is a time-efficient strategy to elicit improvements in peripheral vascular structure and function [15]. While there is considerable knowledge regarding moderate-intensity exercise and the response of the IL-6 system, there is now increasing evidence that high-intensity exercise may have a greater cardioprotective effect [16]. This is in parallel to evidence indicating that IL-6 release is intensity-dependent [17,18] and that over 50% of the variation can be contributed to the duration of exercise. Intermittent exercise offers a solution to both these criteria in that it combines periods of high-intensity exercise intervened with rest periods, allowing the duration to be extended.
beyond that of continuous high-intensity exercise. Although intermittent exercise is normally the domain of athletes, there is evidence that this form of exercise can be accomplished by recreationally active and sedentary women [19]. While both intensity and duration of exercise appear to be major factors in determining the magnitude of the inflammatory response, the mode of exercise also needs to be examined. Nieman et al. (1998) reported that 2.5 hours of cycling induced significantly lower post-exercise concentrations of IL-6, compared to 2.5 hours of running [20]. These previous findings suggest that intensity, duration, and mode of exercise may potentially modulate the inflammatory cytokine response to exercise; however, the contribution of each variable is still unclear. These studies demonstrate that different modes of exercise can induce various inflammatory responses, depending on volume, duration, and intensity of exercise. The lack of studies investigating the inflammatory response to HIIT in sedentary individuals, demonstrates the need for further investigation. Very few studies have examined how HIIT can affect the inflammatory response over a prolonged training period. So, if IL-6 is considered a mediating factor for health, then it is important to investigate the response of the IL-6 system to this type of exercise. Our hypothesis is that IL-6 will decrease after high-intensity interval training.

MATERIALS AND METHODS

In this quasi-experimental study, 22 sedentary female students voluntarily participated. At first, the necessary knowledge about the research conditions and its stages were given to the subjects. Then, information about the physical activity level and health condition of the subjects was obtained by questionnaires and finally they gave their written consent to participate in the research. Subjects were randomly divided into two experimental and control groups of 11 people. None of the subjects had done high intensity interval trainings at least in the past three months. Two weeks before the start of training, initial assessments including height, weight, body fat, waist to hip ratio (WHR) and body mass index (BMI) were measured. Harpenden skinfold caliper and three-site method (triceps, suprailliac, and thigh) were used to measure body fat percentage. The subjects of experimental group performed the training protocol at a distance of 20 meters which was marked by three cones in three sessions per week for six weeks as follows (Figure 1). In the exercise protocol of 40-meter maximal shuttle run test, subjects at first sprinted from starting point (cone 1) toward cone 2 on route A, then returned in the opposite direction on route B, sprinted 20 meters to the third cone and then finally sprinted back on route C to the starting point (cone 1) sprinted again so that distance of 40 meters was completed. The subjects continued to do so with maximum speed so that the exercise protocol time period of 30 seconds was completed and after 30 seconds of recovery, they repeated the exercise protocol. The exercises progressed by increasing the number of exercise repetitions for 30 seconds from four times in the first and second weeks to five times in the third and fourth weeks, six times in the fifth and sixth weeks and then seven times in the seventh and eighth weeks. Before starting the exercise protocol, the subjects in each session warmed themselves for five minutes and at the end of each workout session, they cooled down themselves for five minutes, as well. This protocol is a valid test to assess anaerobic performance [21]. In the six weeks of performing the workout protocol, subjects in the control group had no regular exercise.

![Fig. 1: Schematic design of exercise protocol.](image)

Fasting blood samples (10cc) were drawn from the antecubital veins of all subjects in both groups 24 hours before the first workout session and 48 hours after the last session (at 8:30 am). Blood samples were poured into tubes containing EDTA anticoagulant immediately and then they were centrifuged at 3000 rpm for 10 minutes at a temperature of 4 °C. The plasma obtained was maintained at -80°C for subsequent measurements. Blood samples was centrifuged at 4C for 5 minutes at 3000 g. After centrifugation, serum was stored at –70°C for subsequent analyses. IL-6 were measured by ELISA kit.

The data were analyzed by SPSS-16 statistical software. Kolmogorov Smirnov test was used to determine normality of data and given that the results of this test showed normality in distribution of data, parametric statistical tests were used. First, independent t-test was used to ensure consistency of both groups before starting workout and then intragroup comparison was performed by paired t-test and intergroup comparison was performed by independent t-test. In all statistical tests the significance level was considered α = 0.05.
Results:

The results showed that after exercise intervention, resting Interleukin 6 concentration decreased but not significantly in the experimental group (P=0.357). Also a significant decrease was observed in BMI and body fat percentage after exercise intervention (P=0.000 and P=0.016 respectively).

Discussion:

The results of the current study showed that eight-week high intensity interval training led to a significant decrease in body fat percentage and BMI in sedentary young women. Although, after eight weeks of high intensity interval training, the interleukin concentration were decreased in all experiment subjects but this decrease were not statistically significant. The effect of exercise on plasma interleukin concentration is unknown. Some researchers have reported the increase, and others have reported no changes and decrease of interleukin levels in response to exercise. These inconsistencies may be due to the differences in the severity, duration, exercise type, presence or absence of diabetes and cardiovascular disease, weight, age and gender of the subjects.

Table 1: Subjects’ anthropometric variables (mean ± standard deviation) before and after exercise intervention.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean ± Standard Deviation before HIIT</th>
<th>Mean ± Standard Deviation after HIIT</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Height</td>
<td>162.9 ± 2.183</td>
<td>162.9 ± 2.183</td>
<td>1.000</td>
</tr>
<tr>
<td>Weight</td>
<td>57.8 ± 3.155</td>
<td>57.47 ± 3.248</td>
<td>0.089</td>
</tr>
<tr>
<td>BMI</td>
<td>21.1 ± 1.197</td>
<td>19 ± 1.154</td>
<td>0.000</td>
</tr>
<tr>
<td>Fat%</td>
<td>31.8 ± 3.552</td>
<td>30.7 ± 3.497</td>
<td>0.017</td>
</tr>
<tr>
<td>Vo2max</td>
<td>47.8 ± 2.945</td>
<td>51.8 ± 3.224</td>
<td>0.000</td>
</tr>
</tbody>
</table>

Table 2: Descriptive statistics of experiment and control groups.

<table>
<thead>
<tr>
<th>Group</th>
<th>N</th>
<th>Mean</th>
<th>Std. Deviation</th>
<th>Std. Error Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experiment</td>
<td>10</td>
<td>-1.200</td>
<td>.29766</td>
<td>.09413</td>
</tr>
<tr>
<td>Control</td>
<td>10</td>
<td>-0.0210</td>
<td>.13638</td>
<td>.04319</td>
</tr>
</tbody>
</table>

Table 3: T test for equality of Interleukin 6 changes in experiment and control groups.

<table>
<thead>
<tr>
<th>IL-6</th>
<th>Levene's Test for Equality of Variances</th>
<th>t-test for Equality of Means</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>F</td>
<td>Sig.</td>
</tr>
<tr>
<td>Equal variances assumed</td>
<td>13.521</td>
<td>.002</td>
</tr>
<tr>
<td>Equal variances not assumed</td>
<td>-</td>
<td>.956</td>
</tr>
</tbody>
</table>

Our results are consistent with results reported by Hovanloo et al. that showed no difference in IL-6 level after HIIT. However, Croft et al. examined whether 6 weeks of HIIT running training (5 x 3 min) had an effect on plasma cytokine levels after an acute bout of exercise. The authors reported that 6 weeks of HIIT training significantly attenuated the post-exercise IL-6 (30-65% decrease) response [22]. Furthermore, Nieman et al. reported an attenuation of the systemic cytokine response in trained cyclists after 3 consecutive days of cycling 3 hours per day at ~57% VO2max [20]. The attenuation of the cytokine response suggests a possible training effect. Tejona et al. had reported that interval training is more efficient than continuous training in improving metabolic parameters in patients with metabolic syndrome [23]. However; the results may have been biased by differences between subjects, protocol and time (16 weeks). Most studies have showed improvements in these cytokines by 12 to 24 weeks of training [2] therefore, the time required for these changes should be more than 8 weeks. Such that this particular exercise stimulus is less stressful to the subject after 8 weeks of exercise training.

The inflammatory response seems to be influenced by rest during the exercise bout. Our study and previous HIIT studies have shown that high intensity, intermittent exercise for relatively brief overall exercise time elicits a modest inflammatory cytokine response [24, 22]. This study and the previous studies suggest rest can have a large effect on the inflammatory response. Muscles are sources of IL-6 in during exercise [2]. In the present study; we have not taken biopsies from muscles. Muscles are sources of IL-6 in during exercise [2]. In the present study; we have not taken biopsies from muscles. Gibala et al. and Burgomaster et al. (2005) reported that HIIT can increase glycogen content and muscle oxidative capacity [10, 13], for this reason mussels didn’t rely on to IL-6 and its effects about provided substrate from liver and fat tissue and decreased levels IL-6 in this research. Increased oxidative capacity of muscles, decreased requirement of the body to glucose in blood, and
increased sensitivity to IL-6, leads to less dependence of body on IL-6 [2]. Although most studies have shown that decreased circulating IL-6 is associated with weight loss or fat loss and there is some evidence that IL-6 concentration has an inverse relationship with adipocytes size and body weight(16), in present study there wasn’t any significant relationship between IL-6 and body fat percentage(P=0.742). It is feasible that the change in body fat percentage that occurred in HIIE may have been influenced by unreported changes in diet. Indeed, HIIE induced suppressed diet intake may be one of a number of possible factors underlying the fat loss effect of HIIE. For example, HIIE may have suppressed appetite or decreased attraction for energy-dense foods. Another explanation for the HIIE fat loss effects is that this type of exercise may result in enhanced lipid utilization [25].

Therefore, 48h blood sampling has been too late for this measurement. The main limitation of this study is low sample size which decrease power of current study. The decrease in IL-6 serum levels after HIIT requires studies with longer follow-up (more than 8 weeks) in order to improve health status of people by means of shorter but more efficient training.


c**Conclusion:**

In summary, based on findings of the present research, it seems that high intensity interval training is a good workout method to reduce body fat percentage and improve BMI in sedentary young women with normal weight range. Also, the time of training protocol can be noted as the crucial factor in decreasing IL-6 concentration in response to exercise. Consequently, it seems that high intensity interval training in terms of time effect can be an efficient factor to controlling body composition and prevent and improve risk factors for chronic diseases such as obesity and inflammatory disease in sedentary young women.


c**REFERENCES**


