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Original article

Effects of 12-week high-intensity interval training on plasma visfatin concentration and insulin resistance in overweight men

Hasan Matinhomaee [a], Jamshid Banaei [a,*], Mohammad Ali Azarbayjani [a], Vahid Zolaktaf [b]

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

[b] *Department of Exercise Physiology, Isfahan University, Isfahan, Iran*

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Abstract

The purpose of this study was to determine the effects of 12 weeks of high-intensity interval training (HIIT) on visfatin and insulin resistance (IR) in overweight adult men during a weight-loss program. Eighteen overweight men (age = 31.8 ± 9.2 years; body mass index = 28.6 ± 1.4 kg/m^2) were randomly recruited into one of the two groups, namely, HIIT (3 days/week, 20 minutes/day; 85–95% peak oxygen uptake) and diet-induced weight-loss combined (DHIIT; $n = 10$) and diet-induced weight loss only (DIO; $n = 8$). The DHIIT and DIO groups undertook a 12-week weight-loss intervention using a moderate isocaloric energy-deficit diet. Both DHIIT and DIO groups demonstrated a significant reduction in body weight ($p < 0.01$). Total fat mass ($p < 0.05$) and lean body mass ($p < 0.05$) were decreased in the DIO group with no significant changes in abdominal fat mass, plasma insulin concentration, homeostasis model assessment-estimated IR (HOMA-IR), blood glucose level, and plasma visfatin. In the DHIIT group, total fat mass ($p < 0.01$), abdominal fat mass ($p < 0.05$), plasma insulin concentration ($p < 0.05$), plasma visfatin ($p < 0.01$), and HOMA-IR ($p < 0.05$) were reduced and lean body mass remained unchanged. In conclusion, adding a low-volume 20-minute HIIT (three times/week) to an energy-deficit diet not only can improve the efficiency of weight-loss program in the reduction of body fat, plasma visfatin levels, and HOMA-IR, but also has a reservation effect on lean body mass.

Keywords: High-intensity interval training; Homeostasis model assessment-estimated insulin resistance; Visfatin; Weight loss

Introduction

Visfatin is a new obesity-related adipokine that is isolated from the visceral adipose tissue.[1] However, some subsequent studies were unable to find differences in visfatin messenger RNA expression between visceral and subcutaneous adipose tissues in humans.[2,3] There are conflicting results regarding the changes in plasma visfatin levels during the development of obesity, with some reporting an increase[1,2] and some reporting a decrease in levels.[4] It is primarily supposed that visfatin exerts an insulin-mimetic effect by binding to and stimulating the insulin receptor as well as by lowering plasma glucose levels.[1] Nevertheless, several studies have revealed a negative association between plasma visfatin level and insulin sensitivity.[3,5] According to Haider et al[6] hyperglycemia enhanced circulating visfatin levels in humans, suggesting that visfatin release may be associated with plasma glucose concentration. Finally, some studies suggest that visfatin may be involved in a mechanism that induces insulin secretion in isolated pancreatic islets.[7]

Hypocaloric diet and exercise are the most common strategies for weight-loss programs and controlling obesity, suggesting improvements in insulin sensitivity and changes in plasma visfatin concentration. Several studies advocate the decreasing effect of gastric surgery or hypocaloric diet on

* Corresponding author. Department of Exercise Physiology, Faculty of Physical Education and Sports Science, Islamic Azad University, Central Tehran Branch, Iranzamin Avenue, San'at Square, Shahrak-E-Gharb, Tehran, Iran.

E-mail address: jamshid.banaii@gmail.com (J. Banaei).

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circulating serum concentrations of visfatin in obese individuals (e.g., Manco et al[8] Haider et al[9] De Luis et al[10]); by contrast, a previous study reported that weight loss after gastroplastic surgery is associated with an increase in circulating concentrations of visfatin, which correlated with the decrease in insulin resistance (IR).[11] De Luis et al[12] in a study conducted on morbidly obese patients, found out that weight reduction after a hypocaloric diet is not accompanied by a change in circulating visfatin levels; however, fat mass, fat-free mass, serum glucose, insulin, and homeostasis model assessment (HOMA) decreased. Agueda et al's[13] findings demonstrated that lean mass changes due to weight loss might be more effective than fat mass changes in serum visfatin concentration. Only limited studies that reported the effects of exercise on circulating visfatin are available. Several studies suggest that exercise training with weight loss induces reduction of plasma visfatin concentration that is accompanied by benefits to body composition, metabolic syndrome factors, and IR.[14–16] Nevertheless, Seo et al[17] did not find any changes in plasma visfatin levels after combined exercise training in healthy women.

Most recent studies have examined the effects of aerobic exercise training or a combination of resistance training and aerobic exercise training on plasma visfatin level, IR, and body composition in overweight or obese individuals.[14–17] Increasing evidence suggests that high-intensity interval training (HIIT) through positive changes in hormone secretion and enzymatic adaptation can effectively improve abdominal and subcutaneous fat loss, IR, fat oxidation, appetite regulation, and aerobic capacity.[18–20] In addition, HIIT involves noticeably lesser training volume, making it a time-efficient approach with increased health benefits compared with aerobic exercise training.[21,22] Consequently, it is possible that visfatin would respond to low-volume HIIT. To the best of our knowledge, there is no study that has investigated the effects of HIIT on circulating visfatin in overweight and obese men during the weight-loss program. Thus, the purpose of our study is to define the effects of 12 weeks of HIIT on visfatin and IR in overweight and obese adult men during a weight-loss program.

Methods

Participants

A total of 18 healthy men (age = 31.8 ± 9.2 years) were recruited for this study. The participants had been registered for a weight-loss program by Iranian Health Clinic of Isfahan, Iran. All participants underwent a complete medical examination, filled up the physical activity questionnaire, and had their weight and height measured before inclusion. We omitted the participants who were smokers, had any severe illness (e.g., diabetes, cardiovascular disease), or were taking medication that could affect laboratory test results. All participants were overweight [body mass index (BMI) = 28.6 ± 1.4 kg/m^2] with a sedentary lifestyle (less than 20-minute exercise two times/week). Participants were randomly assigned to either an HIIT and diet-induced weight-loss combined (i.e., DHIIT; $n = 10$) or diet-induced weight loss only (DIO; $n = 8$) group. For each participant, both pretests and post-tests were executed at the same time of the day. There was no significant difference between the two groups with respect to age, weight, height, or BMI. The Sport Science Department of the Central Branch of Tehran Azad University approved the study protocol. The participants signed an informed consent document before participation.

Training program

Each high-intensity interval exercise session involved repeated 60-second running at a high intensity (85–95% heart rate reserve), which was alternated by 60-second running at a low intensity (55–60% heart rate reserve) for recovery.[23] Participants finished six high-intensity intervals during the 1st week, eight intervals during the 2nd week, 10 intervals during the 3rd–8th weeks, and 12 intervals on the final 4 weeks. A 5-minute low-intensity running was performed as a warm up in the beginning and 3-minute recovery period was provided at the end of each training session. Therefore, each main exercise lasted between 20 and 24 minutes approximately. The total training program was carried out for 12 weeks, three times/week (Saturday, Monday, and Wednesday) under the supervision of an exercise physiologist. To assess the peak oxygen uptake (VO_{2peak}), all participants performed an incremental graded exercise test to exhaustion (Balk protocol) on a programmable treadmill, while using an online gas analyzer system (PowerCube, GANSHORN, Germany). To indicate the attainment of VO_{2peak}, the following criteria were fulfilled: oxygen uptake plateaus with a further increase in workload, a respiratory exchange ratio (RER) more than 1.15, ratings of perceived exertion (RPE) more than 17, volitional exhaustion, and an heart rate (HR) greater than or equal to age-predicted maximum. The energy expenditure of each exercise session totaled to about 300–400 kcal that was calculated by the VO_2 consumption corresponding of heart rate during exercise.[24] All participants used a heart rate monitor device during every exercise session to control the targeted heart rate.

Dietary intervention

Daily caloric requirements were predicted using body weight, height, age, gender, and physical activity level. The weight-loss diet consisted of an energy-deficit diet by 2000–3000 kcal/week in the DHIIT group and 3000–4000 kcal/week in the DIO group. The dietary protocol was a balanced healthy diet that included the six categories of foods. The balanced diet comprised 50–55% carbohydrate, 20–25% protein, and 25–30% fat. All participants visited the nutritionist once a week to assess their dietary intake, obtain dietary recommendations, and calculating reduction in weight.

Body composition

Body composition was measured using a dual-energy X-ray absorptiometry (DEXA) scanning device (Discovery-A,