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The effect of high- intensity interval swimming training on irisin and metabolic syndrome in postmenopausal overweight women

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Abstract

Background: Transmembrane protein fibronectin type III domain-containing protein 5 (FNDC5) is as a myokine, metabolic regulator and potential therapeutic agent which is known as a potential trait for metabolism and obesity.

Aim: The purpose of this study was to evaluate the effect of high intensity interval swimming training on circulating irisin and some metabolic syndrome in postmenopausal overweight women.

Materials and Methods: Thirty postmenopausal overweight women (55.73 ± 2.66 years, 26.72±2.33 kg/m^2) were randomized into high intensity interval swimming training (n=15; HIIT) and control groups (n=15; CON). HIIT performed 6–10×30 s swimming interspersed by 2 min recovery for an 8-week period completing 24±1 session (average heart rate= 0.89±0.029% HRmax). Fasting blood samples were taken and body mass index was measured pre- and post-intervention.

Results: In CON, there was not significant change in all measured variables before and after the intervention period. Irisin increased (P<0.01) by 0.64±0.27 mg/ml in HIIT group. Insulin decreased (P<0.01) by 0.96±0.36 mg/dl while the blood lipid profile P= 0.78 cholesterol, P=0.14 TG, P=0.10 HDL, P=0.52 LDL, systolic blood pressure (P= 0.51), dyastolic blood pressure (P= 0.75), and BMI (P= 0.87) were unaltered.

Conclusion: The result of present study showed that high intensity interval swimming trainings is an effectual and time-efficient training way for increasing irisin, and it can lead to compensatory irisin increases in postmenopausal overweight women.

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1. Introduction

Transmembrane protein fibronectin type III domain-containing protein 5 (FNDC5) that is encoded by the FNDC5 gene has been discovered in 2012 and it is known as a novel hormone-like myokine irisin [1]. It is as a myokine, metabolic regulator and potential therapeutic agent which is known as a potential trait for metabolism and obesity [1]. Some variables like diet, exercise, body composition, metabolic rate can modulate the circulation irisin [2]. Due to the fact that one of the most important functions of irisin is browning the white adipose tissue, this myokine has been considered by researchers since its discovery in 2012 [2].

However, the effect of exercise on serum irisin is still unclear and the available results are contradictory. While Murawska et al. (2020) [3] and Rashti et al. (2019) [4] founded that exercise could lead to a significant increase in plasma irisin level, Tibana et al. (2017) [5] on the other hand, have doubted any positive or negative association between the two. These inconsistencies in the findings on irisin response to exercise may be related to metabolic conditions, body composition, age, sex as well as type, duration, and intensity of exercise [6]. According to literatures, there is little information about the impact of exercise on irisin and metabolic syndrome in older. It was observed that irisin is negatively correlated with age [7]. Aging reduces muscle mass and function, thereby reducing endocrine muscle function [8], it is more considerable for women due to hormonal changes, less physical activity and less irisin level during menopause [9].

In recent years, high intensity interval training (HIIT) has attracted much attention. The aim of HIIT is to exert repeated maximum efforts with alternating rest breaks [10]. According to evidences, HIIT is time-efficient method that can improve health in sedentary overweight/ obese people [11] and include variety of exercises, that prevents the sessions from becoming boring [12]. According to Jung et al. (2014) [13]. HIIT workouts can be a more enjoyable and attractive than moderate-intensity continuous workouts. Although Some evidence report that HIIT training has led to an increase in irisin compared to low-intensity training, despite the same amount of energy consumed in the two types of training [14], the effect of HIIT training on irisin response remains unclear and it is not very familiar especially among obese, overweight and old people.

Swimming may be a good exercise training for middle-aged and elderly overweight individuals because it contains least weight- bearing stress [15]. Cox et al. (2010) [16] observed that to improve some metabolic syndrome such as insulin resistance, swimming was more efficient than walking at a same intensity in 50- to 70 years old women. According to Connolly et al. (2016) [17], high intensity interval swimming training may be an effective and time-efficient strategy to improve glucose control, insulin sensitivity in inactive, middle-aged women. According to our knowledge, no studies have investigated the effects of high intensity interval swimming training on irisin and metabolic syndrome in postmenopausal.

According to the title, it is assumed that the subjects have metabolic syndrome, but based on the results all the variables even at the baseline are normal and no sign of metabolic syndrome is seen in overweight women. Our first hypothesis was that high intensity interval swimming training would lead to compensatory irisin increases in postmenopausal overweight women. Our secondary hypothesis was that increasing irisin is accompanied with improvement in metabolic syndrome.

2. Materials and Methods

2.1. Participation

Thirty participants were participated in our study according on inclusion criteria: lack of prohibition of sports activities by the physician, body mass index 25-30 kg/m^2, having 3-5 years menopausal history and haven't participated in exercise training regularly for at least 2 years. The participants were postmenopausal women who were familiar with swimming skills. All participants completed the Medical Assessment and Physical Activity Readiness Questionnaire. The participants, according to the Helsinki Declaration [18], were informed about the whole protocol of the study. Then, they completed the informed consent form and were assured that their information would be kept confidential. The participants were randomized into a high-intensity interval swimming training group (HIIT: n=15, age 55.53±2.92 years; BMI 26.90±2.4 kg/m^2), and a control group (CON: n=15, age 55.93±2.46 years, BMI 26.53±2.33 kg/m^2).

The randomization process separated the participants in two groups and then defined the type of intervention. Both stages were carried out in random and blinded conditions. The study was started with preliminary testing and familiarization sessions. Then HIIT group took part in high intensity interval swimming training with 3 training sessions per week for 8 weeks, while CON group had no training or lifestyle changes during the same period.

The participants were asked not to use a special diet during the research and to use a standard daily diet. There were no dropouts from the study.

2.2. Procedure

The HIIT group completed all of 24 experiment design training sessions during the 8 weeks intervention period. Each session consists of 6-10 30s front crawl intervals which disperse by 2 min of passive recovery [19]. The 1st, 2nd and 3rd weeks were included 6 intervals, the 4th, 5th and 6th weeks were included of 8 intervals the 7th and 8th weeks were consisting of 10 intervals. The 24 HIIT training session occurred in an indoor pool. RPE and HR of participant was monitoring during training sessions. Each HIIT training session started with 10 min warm up including: pool walking and jogging, stretching and slow swimming. The training sessions began with 10-min warm-up period that consist of pool walking and jogging, wall stretches and slow swimming (Table 1).

Table 1. The training program for participants during study

Weeks	Days in week	Warm up	Intensity	Cooldown
1 2	3 days in week	10 min	Six repetition of fast 30-sec swimming repetitions, with 2-min intervals of active rest between repetitions	10 min
3 4 5	3 days in week		Eight repetition of fast 30-sec swimming repetitions, with 2-min intervals of active rest between repetitions	
6 7 8	3 days in week		Ten repetition of fast 30-sec swimming repetitions, with 2-min intervals of active rest between repetitions	

All participants were required to complete the training program. Being absent in three HIIT sessions would result in exclusion from the study.

The participants reported their RPE following the 1st, 2nd, 4th, 6th, 8th and 10th intervals in each training sessions. Their heart rates were also monitored using a Polar H10 monitor during one session in 0th, 2nd, 4th, 6th, 8th week at the same intervals of RPE data to determine adequate changes in their heart rate. Also, in each session, the peak heart rate and the swimming distance was noted. Average mean and peak HR in HIIT training session in the 0th and 8th weeks was 143.40±2.19 and 152.13±2.38 bpm, respectively, corresponding to 87.20±.79 and 92.52±1.5% HRmax, respectively (Figure 1). Ten min of cool down which include of stretching and locomotor activities were used at the end of training sessions.

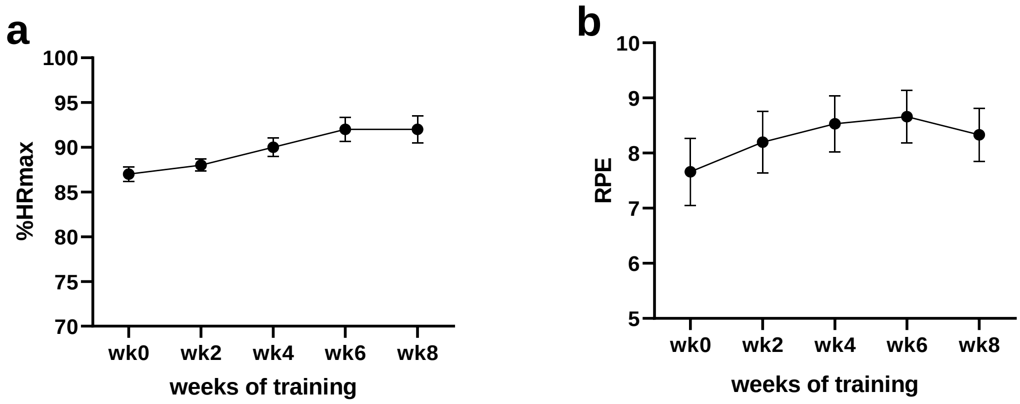


Figure 1. Mean RPE and HRmax% after eight training sessions in 0th, 2nd, 4th, 6th and 8th training weeks; RPE= rating of perceived exertion, HRmax% = percent maximum heart rate**.**

No training was performed 48 hours before testing. resting blood sample were taken from an antecubital vein under standardized conditions between 7 and 8 a.m. after 12 hours overnight fasting. The blood samples were centrifuged for 30 sec to collect the plasma. Irisin was measured by ELISA kit (Hangzhou Eastbiopharm Co, cat number KE90905). Blood samples were also treated to measure insulin and lipid profile level. Serum insulin level was assayed by ELISA technique. Also, TG, TC, LDL-c and HDL-c were assayed using enzymatic method kit (Pars Azmoon, Tehran, Iran) by RA-1000 American biochemical auto analyzer machine. An automatic BP monitor (HEM-709; OMRON, IL, USA) was used to determine systolic and diastolic blood pressure according to standard methods [20] every 30 min during 2 hours rest period.

2.3. Statistic

Data is reported as mean±SD and Shapiro-Wilk test was used to evaluate the normality of data. Also, sample t-test was used to compare baseline and endpoint continuous values within groups. Student's independent t-test was performed to comparison between HIIT and control groups. In addition, two-way ANOVA performed to comparison between and within subjects' factor. P value <0.05 was determined to be statistically significant. SPSS was used to analyses data and graph pad prism software was used to creating graphs.

3. Results

Average mean HR in the first and last weeks of the intervention in HIIT group was 143.40±2.19 and 152.13±2.38 bpm, respectively, corresponding to 87.20±0.79 and 92.52±1.5 HRmax%, respectively. There were significant differences in heart rate between the first and last weeks of intervention within HIIT group (P<0.01). Average mean RPE during HIIT training in the first and last weeks of the intervention was 7.66±0.61 and 8.33±0.48, respectively. There were differences in RPE between the first and last weeks of training within HIIT group (P<0.05). The intensity of workout is shown in Figures 1a, b. The average swim distance per session during the first week was 124±5 m and increased (P<0.05) to 192±10 m during the last training week of intervention. Average swim distance per swimming interval increased (P<0.05) by 25±4% from the first to the last training week.

Irisin was 3.35±0.71 and 3.37±0.70 mg/ml before the training intervention in HIIT and CON, respectively; however, the irisin concentration increased significantly (P<0.01) in the HIIT group and remained unchanged in the CON group (Figurer 2a).

HDL and LDL and TG were 46.53±8.1, 46.4±7.1, 87.3±14.6 and 85.6±14.2, 149.33±32.8, 144.86 ±28.3 mg/dl before training in HIIT and CON, respectively, and was unchanged after the intervention period (Figures 2b, c, d). Total plasma cholesterol was 176.73±21.15 and 179.0±20.71 mg/dl before the training intervention in HIIT and CON, respectively, and was unchanged after the intervention period (Figure 2e).

Insulin was 6.12±1.19 and 5.16± 0.87 mg/ml before the training intervention in HIIT and CON, respectively; however, the insulin concentration decreased significantly (P<0.01) in the HIIT group and remained unchanged in the CON group (Figurer 2f).

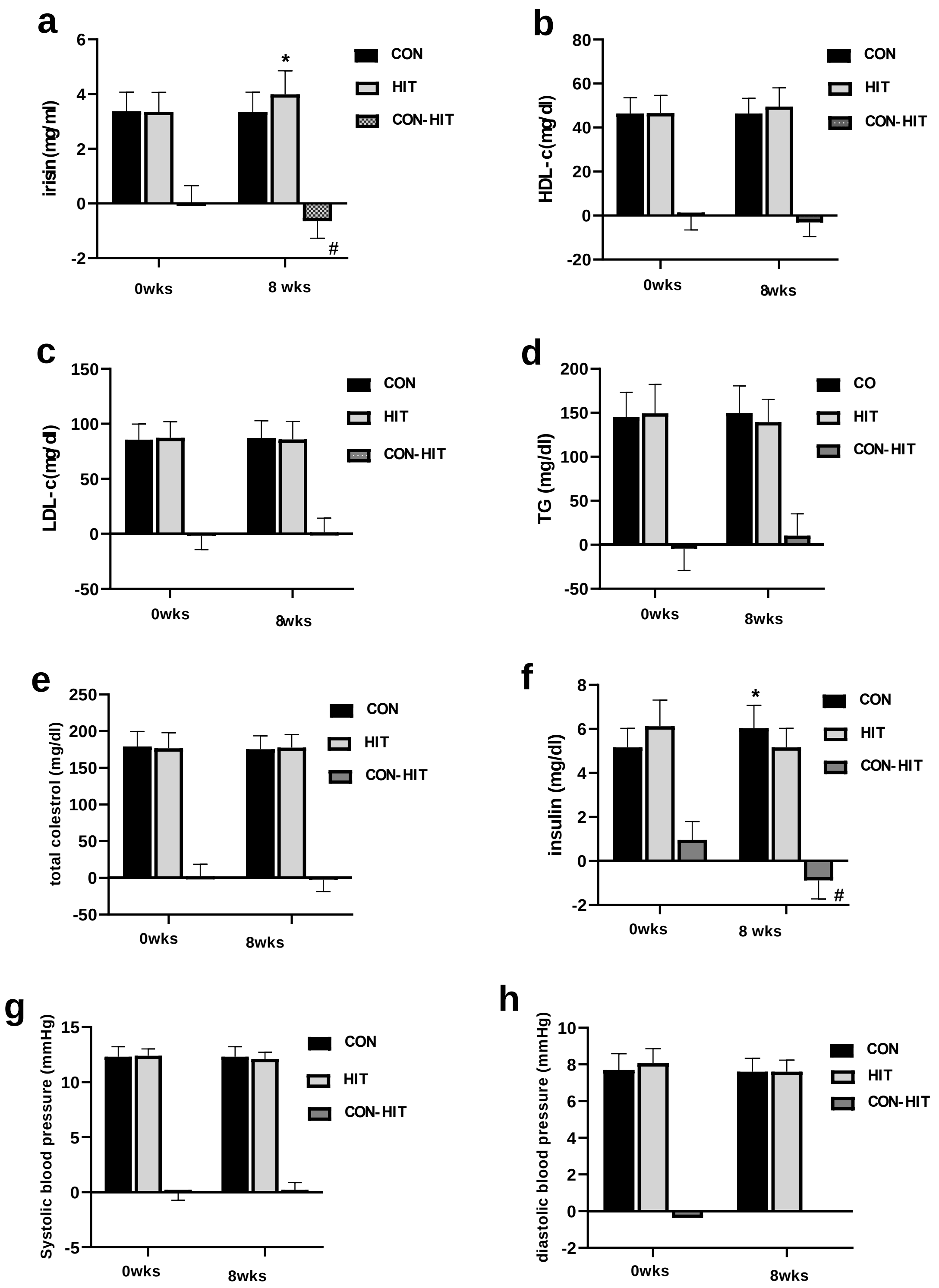
Systolic and diastolic blood pressure were 12.4±0.63, 8.06±0.79 and 12.33±0.89, respectively measured at 7.73±0.88 mmHg before the HIIT and CON training intervention, respectively, and remained similar after the completion of training intervention (Figurer 2g, h).

4. Discussion

For the first time, the effects of high intensity interval swimming training on irisin and some metabolic syndrome have been studied in postmenopausal overweight women. As major findings of our study, high intensity interval swimming training increased irisin and decreased insulin plasma level (P<0.01). In contrast, no changes occurred in fasting lipid profile and blood pressure. Although previous literature on high-intensity swim training is lacking, the effect of high intensity training on the irisin and metabolic syndrome has also been studied.

Murawska-Cialowicz et al. (2020) have implemented 8 weeks of HIIT following the tabata protocol for men in which there were significant improvements in blood irisin concentration (by 29.7%) [3]. Also, Rashti et al. (2019) showed improvement in blood irisin level after 10 weeks of high intensity concurrent training in postmenopausal women [4]. However, no considerable changes [21] or decline [5] in irisin were observed in all studies.

Some studies reported that the secretion of irisin into the circulation during training may be one of the functions of endocrine system to control metabolism. Some studies have shown that exercise training can stimulate the secretion of irisin into skeletal muscle, which in turn leads to the expression of FNDC5 protein, thereby increasing the level of irisin formation [22].



*Significant difference between each group; # Significant differences between HIIT and CON; HIIT= high-intensity interval swimming; CON= control; HIIT-CON= difference between high-intensity interval swimming and control groups.

Figure 2. Changes in irisin, HDL-c, LDL-c, TG, total cholesterol, insulin, systolic and diastolic blood pressure after 8 weeks of HIIT workout in comparison to CON and HIIT. Data is presented as means ± SEM.

In circulation, irisin transforms white adipose tissue into brite (brown in white)/ beige fat cells by upregulating the genes responsible for changing with browning [23]. Brown adipose tissue is responsible for dispersing heat energy, while white adipose tissue is known to be responsible for energy storage. This event makes an elevation in total body energy expenditure [24].

Considering the result of our study, fasting insulin concentration was significantly reduced after 8 weeks of high intensity interval swimming training. Research has shown that exercise can reduce blood glucose levels by reducing insulin resistance and improving insulin sensitivity [25]. During exercise, hormonal regulation and glucose uptake occur completely separately from insulin; During exercise, the required glucose is absorbed from the blood by the muscles involved in the activity without insulin involvement, in which the GLUT4 plays an essential mediating role. However, due to continuous exercise in the long-term, insulin receptors are able to respond more appropriately to lower insulin levels due to upregulation, which ultimately reduces blood sugar and prevents diabetes [25].

There was no significant change in other metabolic syndrome of postmenopausal overweight women after 8 weeks of HIIT in our study. The health benefits of exercise are indubitable in the prevention of many age-related diseases, but according to da Silva et al. (2020), mode and intensity of exercise training may differently impact the metabolic outcomes in older adults. They report that 12 weeks of resistance training + HIIT improved LDL and insulin greater extension than resistance training + moderate-intensity continuous aerobic training in older adults [26]. They didn’t observe significant change in HDL, total cholesterol, systolic and diastolic blood pressure of older adults in both groups.

According to Durstine et al. (2001), the impact of exercise on blood lipid level in individuals with overweight or obesity depend on blood lipid levels before exercise, exercise duration, exercise intensity, metabolic rate, calorie intake, body composition and lifestyle [27]. Su et al. (2019) indicates that these factors should be considered in studies examining the impact of exercise on blood lipid levels [28]. Although they reports in their meta-analysis study, that high-intensity interval training and moderate-intensity continuous training modes resulted in statistically significant reductions in total cholesterol but according to the American College of Sports Medicine, Centers for Disease Control and Prevention, and National Institutes of Health, moderate exercise is recommended for improving the metabolism [29].

The present study has some limitations. First, the sample size was too small for the findings to be generalized. Future researches with a large sample size are needed. Second, since the exercise program lasted only 8 weeks, a longer training duration and higher frequency may result in further improvements in metabolic syndrome risk in postmenopausal overweight women. Third, unfortunately, due to the limited number of volunteers, it was not possible to use people with a higher BMI level.

5. Conclusion

The aim of this study was to assess the influence of high intensity interval swimming training on circulating irisin and some metabolic syndrome in postmenopausal overweight women. The results suggest that high intensity swimming training can be considered as an appropriate training to increase the amount of irisin, as well as decrease insulin in postmenopausal overweight women. Because swimming is safe for and welcomed by the elderly, they can benefit from high-intensity interval swimming training. However, further researches are needed to identify the other effects of these exercises in the elderly.

Conflict of interest

The authors declared no conflicts of interest.

Authors' contributions

ESH performed experiments and collected data; AJ Supervised, directed and managed the study; AJ and ESH wrote and edited manuscript. A.J and E.SH funding acquisition. All authors have read and agreed to the published version of the manuscript.

Ethical considerations

The authors have completely considered ethical issues, including informed consent, plagiarism, data fabrication, misconduct, and/or falsification, double publication and/or redundancy, submission, etc. The present article was adopted from a M.A thesis approved by the Islamic Azad University Shahrekord branch, Iran. This study was approved by the Human Subjects Committee of Islamic Azad University Shahrekord Branch (Ref 2015K067) and by the Ethics Committee of Islamic Azad University, Shahrekord Branch (IR.IAU.SHK.REC.1397.008. the Iranian Registry of Clinical Trials registration IRCT20180822040849N1).

Data availability

The dataset generated and analyzed during the current study is available from the corresponding author on reasonable request.

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