Research Article

The effect of moderate-intensity interval training on plasma subfatin levels and body composition in sedentary obese middle-aged women

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Abstract

Obesity is a major risk factor for metabolic diseases. Subfatin, an adipokine with potential metabolic benefits, is of increasing interest. This study investigated the effects of eight weeks of Moderate-Intensity Interval Training (MIIT) on plasma subfatin levels and body composition in sedentary, obese, middle-aged women. Thirty sedentary women (aged 50-60 years; BMI>30 kg/m²) were purposively selected and randomly assigned to an experimental (n=15) or a control (n=15) group. The experimental group performed an eight-week MIIT program (three sessions/week) at an intensity of 50-75% of heart rate reserve, following the principle of progressive overload. The control group maintained their usual sedentary routine. Fasting plasma subfatin levels were measured via enzyme-linked immunosorbent assay (ELISA), and body composition indices (BMI, body fat percentage [BFP], waist-to-hip ratio [WHR]) were assessed pre- and post-intervention. The MIIT group exhibited a significant increase in plasma subfatin levels (p=0.016) and a significant decrease in BFP (p=0.01) compared to the control group. While positive trends were observed, no significant inter-group differences were found for BMI (p>0.05) or WHR (p=0.095). An eight-week MIIT program effectively elevated plasma subfatin concentration and reduced body fat percentage in sedentary, obese, middle-aged women. These results suggest that MIIT may be a valuable exercise strategy for improving adipokine profile and body composition in this population.

Key Words: Obesity, MIIT, Body composition, Subfatin

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Introduction

Obesity is a disorder characterized by excessive accumulation of visceral and subcutaneous fat and excess weight. This weight gain results from greater energy intake than energy expenditure. Obesity is a major public health problem in worldwide that associated with the high risk of metabolic diseases such as type 2 diabetes, cardiovascular disease, and metabolic syndrome (Hariharan et al., 2022). The result is that obesity is recognized as one of the serious public health crises of the current century, with its prevalence increasing in all age groups, especially among middle-aged women (Okati-Aliabad et al., 2022). Obesity not only increases the risk of cardiovascular disease, type 2 diabetes, and some types of cancer, but is also associated with numerous hormonal and metabolic changes that disrupt the body's energy balance (Ugur et al., 2022). Middle-aged women, especially those who are inactive, due to the hormonal changes (such as menopause) and decreased physical activity are at risk for the increased body fat and related complications. Adipose tissue, as an active endocrine organ, secretes various adipokines that can have pro-inflammatory or anti-inflammatory roles, depending on the function and condition of the body (Guerreiro et al., 2022). Adipokines are involved in the regulation of numerous physiological functions, including metabolic homeostasis, insulin sensitivity, cardiovascular function, immunity, and inflammation. Increasing evidence suggests that the relationship between obesity and cardiovascular disease is related to the lipid dysfunction, in which an imbalance between beneficial and harmful adipokines plays a key role (Miao, 2011; Miao & Li, 2012).

Recently, a novel adipokine, subfatin, has been identified that is specifically expressed in subcutaneous adipose tissue and is associated with obesity and adipogenesis (Li et al., 2014). Subfatin (meteorin-like protein; METRNL) represents a newly discovered adipokine that is secreted by adipose tissue and skeletal muscle and has insulin-sensitizing and anti-inflammatory function (Zheng et al. 2016). In a study was shown

shown that subfatin to be decreased in white adipose tissue of rats with calorie restriction, while it was significantly increased during white adipocyte differentiation and also in white adipose tissue of rats obese with high-fat diet (Li et al., 2014). As a novel adipokine, subfatin plays an important role in regulating energy metabolism, insulin sensitivity, and counteracting chronic inflammation, and it has been shown that circulating subfatin levels are lower in obese individuals (Pellitero et al., 2018). Recent studies suggest that regular exercise can increase subfatin levels and thereby improve the metabolic status of obese individuals (Majeed et al., 2024). However, information on the effect of exercise interventions, especially interval training, on plasma subfatin levels is limited.

Exercise training is one of the most effective non-pharmacological methods for controlling the obesity (Bengin et al., 2024). Recently, interval training has gained much popularity due to its potential effects on body composition and physical fitness. According to research results, interval training can cause changes in body composition by reducing fat mass (Sultana et al., 2019). Moderate-intensity interval training, due to its enough intensity and strong metabolic effects, has been recognized as an effective strategy for reducing body fat, improving insulin sensitivity, and regulating adipokines in obese individuals. These exercises can affect metabolism by reducing subcutaneous fat and changing the adipokines profile (Horváth et al., 2024). Considering the important role of subfatin as an anti-inflammatory adipokine in obesity, it seems necessary to study the effect of exercise training, especially moderate-intensity interval training, on plasma levels of this adipokine. Therefore, the aim of the present study was to investigate the effect of eight weeks of moderate-intensity interval training on plasma levels of subfatin in inactive obese middle-aged women.

Materials and methods

Study design and participants

The present study was an applied and semi-experimental that studied the effect of eight weeks of moderate-intensity interval training on plasma levels of subfatin in inactive middle-aged obese women. The statistical population of this study included all obese women aged 50 to 60 years in Ahvaz city. After screening, 30 participants were recruited via convenience sampling and were then randomly assigned to two groups. MIIT group: this group included 15 inactive obese women whose blood samples were taken 48 hours before the start of the training period. Body composition evaluation indices were also measured. Then, they performed moderate-intensity interval training for eight weeks and 48 hours after the last training session, blood was taken again to evaluate the effect of training on the research variables. Control group: this group also included 15 inactive obese women who did not do any regular exercise and only had usual daily activities, but at the same time as the other group, blood was taken from them in two pre-test and post-test stages, and body composition evaluation indices were also measured.

Moderate-intensity interval training

The training program included moderate-intensity interval training for eight weeks, with a frequency of three sessions per week. Each training session lasted 60 minutes and included 15 minutes of warm-up (general and specific) and 35 minutes of interval running (in the form of 7 repetitions of 5-minute interval running with 2.5-minute active rest, as per Table 1) at an intensity of 50-75% of the heart rate reserve, followed by a 10-minute cool-down. The warm-up and cool-down of each training session included stretching exercises and slow running. The subjects were advised not to participate in any other exercise activities during the eight weeks of the training program. The initial training intensity for the first week was determined at an intensity of 50% of the heart rate reserve. After measuring the subjects' resting heart rate in the supine position and based on the maximum heart rate formula based on age, the training intensity was calculated using the Karonen formula. Based on the principle of gradual overload, exercise intensity was increased by 5% each week until the exercise intensity reached 70% of heart rate reserve in weeks five and six, and finally, in weeks seven and eight, the exercise intensity ended at 75% of heart rate reserve (Barron-Cabrera et al., 2023). A summary of the moderate-intensity interval training program is given in Table 1.

Measurement of body composition indices

The body composition indices, including height, weight, body mass index (BMI), body fat percentage (BFP), and waist-to-hip ratio (WHR), were measured in two pre-test and post-test stages in both groups by using the In-body 370S model, made in China.

Sampling and measuring biochemical variables

48 hours before the first training session and 48 hours after the last training session, blood samples were taken from the subjects in both groups by a laboratory technician; then the sample was centrifuged at 3000 rpm for 10 minutes and the blood plasma of

Table 1. MIIT program in different weeks

week	Intensity (heart rate reserve)	Number of activity intervals	Active rest (s)	Frequency
1	50	7	150	3
2	55	7	150	3
3	60	7	150	3
4	65	7	150	3
5	70	7	150	3
6	70	7	150	3
7	75	7	150	3
8	75	7	150	3

the samples were separated. The plasma obtained was poured into 1 ml microtubes and transported to the laboratory for the next steps and stored at -80°C (frozen). Blood was taken after 12 hours of overnight fasting and in a resting state, and 5 cc each stage was taken from the anterior vein of the left hand of the subjects in a sitting position. The blood was poured into sterile tubes containing anticoagulant and EDTA. After collecting the samples in the post-test stage, all blood samples were removed from the freezer on the same day and the desired test was performed according to the relevant protocols. To measure the plasma levels of subfatin, was used a ELISA human kit from CUSABIO company with a sensitivity of 0.039 ng/ml. Given that the present study was conducted on human samples with exercise intervention over a relatively long period of time, in full compliance with the ethical principles of research, approval was received from the ethics committee with the ID number IR.IAU.AHVAZ.REC.1404.192 from the Islamic Azad University, Ahvaz Branch.

Statistical analysis

In the present study, the mean ± standard deviation was used to describe the data. Also, the analysis of covariance (ANCOVA) test was used to compare the variables in the two groups. The data were analyzed by SPSS-23 software at a significance level of 0.05.

Results

Descriptive data related to the mean and standard deviation of age, height, weight and body mass index of the subjects in the two groups are shown in table 2.

Also, to evaluate of the difference between plasma levels of subfatin and other variables in the pre-test of the two groups, was used an independent t-test, that the results are shown in Table 3.

As can be seen in Table 3, no significant differences were observed between the two groups in all research variables, including plasma levels of subfatin, body fat percentage (BFP), and waist-to-hip ratio (WHR) in the pre-test ($p>0.5$).

The Analysis of covariance (ANCOVA) was used to investigate the effect of eight weeks of MIIT on body fat percentage (BFP), waist-to-hip ratio (WHR), and plasma levels of subfatin in inactive obese middle-aged women. The results showed that eight weeks of MIIT significantly reduced body fat percentage (BFP) ($p=0.01$) and significantly increased plasma levels of subfatin in inactive obese women ($p=0.016$). However, although eight weeks of MIIT reduced waist-to-hip ratio (WHR) in inactive obese women, but this change was not significant ($p=0.095$). The results of the analysis of covariance test are presented in Figures 1(A, B, C).

Discussion

In the present study, it was shown that eight weeks of moderate-intensity interval training resulted in a significant increase in plasma levels of subfatin in inactive, obese middle-aged women. The increase in subfatin caused by exercise leads to increased glucose metabolism, increased brown adipose tissue stimulation, increased fatty acid oxidation, inhibition of inflammation, and improved insulin sensitivity (Alizadeh et al., 2025).

A previous study also reported that increased subfatin in adipose tissue improves insulin sensitivity through upregulation of PPAR-γ (Farhan & Salman, 2023). However, previous studies have shown that increased subfatin affects lipid oxidation by upregulating beta-oxidation and brown fat-related factors. Decreased abdominal visceral fat mass and increased beta-oxidation factors and lipolysis have been reported with increased subfatin. Therefore, even in the case of chronic obesity caused by a high-fat diet, regular exercise appears to be effective in lipid metabolism in adipose tissue through increased subfatin and could potentially be considered as a non-pharmacological and non-invasive strategy for the treatment of obesity (Bae, 2018).

Physical activity significantly changes body composition. Exercise, especially interval training, increases the use of body fat stores and is considered the best way to lose weight and body

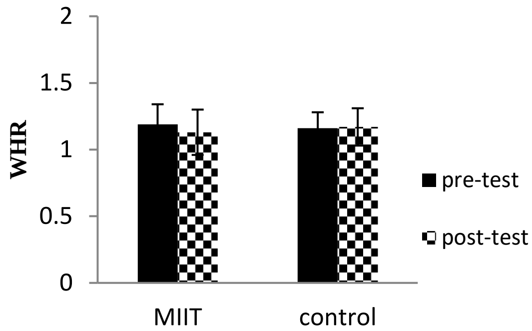
Tale 2. Distribution of age, height, weight and BMI of the subjects in the two groups

Group	N	age (year)	height (cm)	weight (kg)	Body mass index(BMI)
MIIT	15	3.53±52.71	7.29±165.45	10.14±82.45	2.08±32.15
control	15	4.19±54.37	5.44±163.23	8.21±79.38	1.53±31.24

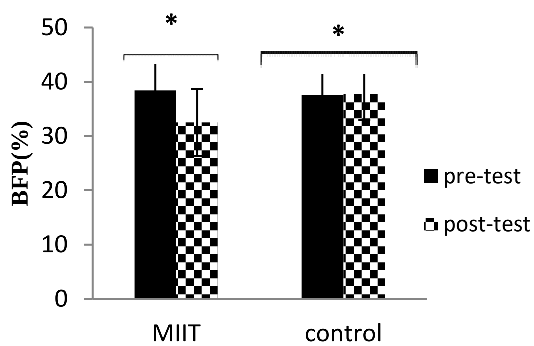
Table 3. Results of the independent t-test for pre-test comparison of two groups

Variable	Groups	Mean ± S.D	Difference of Means	t	Sig
Subfatin (ng/ml)	MIIT	0.96±5.83	0.41	2.36	0.257
	control	1.13±6.24			
body fat percentage (BFP)	MIIT	5.26±38.41	0.87	2.39	0.253
	control	4.37±37.54			
waist-to-hip ratio (WHR)	MIIT	0.15±1.19	0.03	0.84	0.538
	control	0.12±1.16			

A)



B)



C)

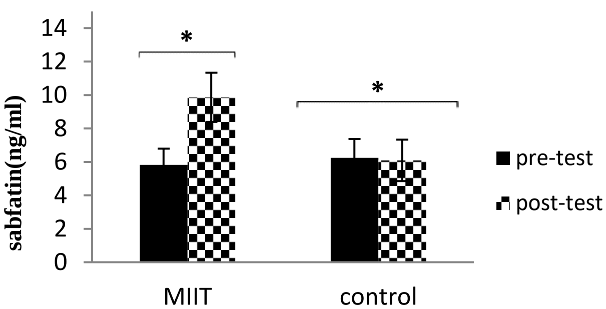


Figure 1. Adjusted pre and post-intervention means (±SD) for (A) waist-to-hip ratio (WHR), (B) body fat percentage (BFP), and (C) plasma subfatin levels in the control and MIIT groups, following analysis of covariance. * Indicates significant differences between and within groups., p<0.05.

fat percentage (Westerterp, 2018). As a result of exercise, the ability to absorb and oxidize fat in trained muscles increases. In MIIT, by increasing the activity of the lipoprotein lipase enzyme, the capacity for fat beta oxidation increases, and its important eff-ect is to increase the share of fat and, as a result, a proportional decrease in the share of glucose in creating energy following exercise (Yang et al., 2018). Studies have shown that gene expression and plasma levels of subfatin are influenced by factors such as obesity and overweight, diabetes, blood glucose and insulin levels, and blood lipid levels. It has been reported that there is a negative and significant correlation between serum subfatin levels and body fat percentage (Majeed et al., 2024). In the present study, eight weeks of MIIT resulted in a significant increase in subfatin levels in inactive obese women, which was associated with a significant decrease in weight, BMI, and body fat percentage. Therefore, the increase in serum subfatin levels resulting from MIIT in the present study may be attributed to the improvement in measured body composition indices such as weight, body mass index, and body fat percentage. Although waist-to-hip ratio was not statistically significantly reduced in the present study, it was reduced in the MIIT group compared to the control group, and given the association of this index with visceral fat, longer periods of training are likely required to reduce this body composition index.

The results of the present study indicate the role of moderate-intensity interval training on weight control and body composition indices in obese middle-aged women. Of course, the type, intensity, and duration of physical activity are important variables that can interfere with the extent of the effect of physical activity on these indices (Tarp et al., 2018).

Prolonged exercise increases the rate of lipolysis in adipose tissue. This has been confirmed by microdialysis of the extracellular space of subcutaneous adipose tissue (Laurens et al., 2020). During exercise, the main activator of lipolysis is the sympathetic system. Verboven et al. (2018) showed that an alpha-adrenergic inhibitory mechanism regulates resting lipolysis, while during exercise the stimulatory effect of beta-adrenergic is important. This beta-adrenergic effect originates from sympathetic nerve stimulation or epinephrine. The hormone epinephrine is the main activator of hormone-sensitive lipase (Verboven et al., 2018). By increasing lipolytic activity in adipose tissue, body composition values, including BMI, fat percentage and weight, are ultimately reduced.

Conclusion

Obesity is a complex and multifactorial process and is associated with the occurrence of many diseases and metabolic disorders. Several inflammatory and anti-inflammatory adipokines are secreted and activated by adipose tissue. Subfatin is one of these anti-inflammatory factors that is reduced in obesity. Exercise activities, especially moderate-intensity interval training through the increasing anti-inflammatory factors such as subfatin, play an important role in controlling obesity and, consequently, reducing the complications caused by obesity.

What is already known on this subject?

Obesity is a disorder characterized by excessive accumulation of visceral and subcutaneous fat and excess weight. This weight gain results from greater energy intake than energy expenditure.

What this study adds?

Exercise activities, especially moderate-intensity interval training through the increasing anti-inflammatory factors such as subfatin, play an important role in controlling obesity and, consequently, reducing the complications caused by obesity.

Organ Cross-Talk Tips:

- Exercise signals from skeletal muscle to fat tissue led to a beneficial change, increasing the secretion of subfatin, an adipokine with metabolic benefits.
- The training elevated plasma subfatin, suggesting that improved fat tissue health can release factors into the bloodstream to positively influence other metabolic organs like the liver and muscles.

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Data availability

The data that support the findings of this study are available from the corresponding author upon reasonable request.

Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

Ethical approval Given that the present study was conducted on human samples with exercise intervention over a relatively long period of time, in full compliance with the ethical principles of research, approval was received from the ethics committee with the ID number IR.IAU.AHVAZ.REC.1404.192 from the Islamic Azad University, Ahvaz Branch.

Informed consent Participants signed an informed consent form prior to participation in the study

Author contributions

Conceptualization: Z.M.A., M.B.,; Methodology: Z.M.A., M.B.,; Software: Z.M.A., M.B.; Validation: Z.M.A., M.B.; Formal analysis: Z.M.A., M.B.; Investigation: Z.M.A., M.B.; Resources: Z.M.A., M.B.; Data curation: Z.M.A., M.B.; Writing - original draft: Z.M.A., M.B.; Writing–review & editing: Z.M.A., M.B.; Visualization: Z.M.A., M.B.; Supervision: M.B.; Project administration: Z.M.A., M.B.; Funding acquisition: M.B.

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