Brief Report

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The Effect of High-Intensity Functional Training on Semaphorin-3E Levels in Obese Men

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Abstract

Objective: The role of inflammation in the pathophysiology of obesity is significant, as a known connection between metabolism and immune function. Lifestyle modification may be a useful strategy to prevent obesity-related complications. To the best of our understanding, there have been no studies conducted to examine the impact of various exercise protocols on the profile of inflammatory factors within the body. The objective of this study was to examine the impact of high-intensity functional training (HIFT) on the levels of semaphorin-3E (Sema-3E) in individuals who are obese.

Materials and Methods: This study examined the effects of a 12-week HIFT program on 22 obese men aged 23 to 32 years old. Participants were divided into two groups: a control group (C) and a HIFT exercise group (H). Body mass index (BMI) and blood levels of Sema-3E were measured before and after the intervention period.

Results: In this study, the results of the ANOVA analysis showed a significant difference of the levels of semaphorin-3E between the studied groups ($P< 0.001$).

Conclusion: The results of the present study show that HIFT reduced the levels of semaphorin-3E in the body and may be effective in reducing systemic inflammation.

Keywords: Obesity, High intensity functional training, Sema-3E, Inflammation

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Introduction

Adipose tissue expands in cases of obesity, and recent research has highlighted its significant role in energy homeostasis, metabolism, inflammation, and immune response (1,2). However, when inflammation is improperly regulated, it can result in the abnormal expression of pro-inflammatory mediators, which may contribute to various diseases, including diabetes, cancer, and cardiovascular conditions (3,4). Research has demonstrated that Sema3s play a role in neuronal and cardiovascular morphogenesis, as well as in the development of pathological conditions in the nervous system and cancer, by influencing processes such as cell growth, survival, migration, and proliferation (5,6). Although research has demonstrated that HIFT can lead to various chronic health benefits, there are few studies examining its acute effects on circulating inflammatory proteins that could influence the early stages of exercise-induced adaptations.

Material and Methods

This research is semi-experimental, employing a pre-test and post-test design carried out in two phases-before and after the intervention-while including a control group in both field and laboratory settings. To directly evaluate the impact of HIFT on SEMA3E levels in obese men, well-structured randomized controlled trials are necessary. The statistical sample (according to the sample size calculation formula) (7) included 22 obese men (BMI≥ 30) aged 23 to 32 years. The samples were selected through a call in administrative and public centres. Following the run-in period, volunteers were randomized into two study groups in a 1:1 ratio using permuted block randomization. All experimental procedures were voluntary, with full consent and approved by the ethics committee. All ethical principles were followed during the training process, and subjects could withdraw from the research at any time during the training period. Inclusion criteria for the study consist of no chronic diseases as determined by the medical history questionnaire (such as cardiovascular disease, diabetes, or any condition that hinders physical activity), no use of dietary supplements, no smoking, no alcohol or drug treatment, no low-calorie diet in the past six months, no regular daily physical activity in the last two years, and a waist-to-height ratio exceeding 0.5. Criteria for exclusion from the study include missing more than one exercise session, experiencing an accident or physical injury, and the emergence of any factors that may interfere with the participants' ability to effectively engage in the exercise sessions. According to the established schedule, the subjects went to the laboratory to complete the personal information, the health questionnaire, the physical activity questionnaire and to check the anthropometric indicators. Fasting blood samples of 7 cc were collected from the subjects 48 hours prior to the initiation of the training protocol and again 48 hours after the final training session to assess inflammatory markers.

The participants were categorized into the following groups according to their individual characteristics (n= 11):

1- Control group (C): People in this group had 12 weeks of daily life without participating in regular exercise.

2- HIFT group (H): People in this group performed HIFT exercises for 12 weeks.

Anthropometric assessment

Participants visited the laboratory as per the predetermined schedule to assess their anthropometric measurements. Their weight was recorded 48 hours prior to the start of the program and again 48 hours after its conclusion, without shoes, using a digital scale (Kafber, Germany) with an accuracy of 100 grams. Height was measured using a tape measure accurate to 1 cm, with participants standing barefoot against a wall and maintaining a normal shoulder position. The BMI was determined using the formula: weight

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in kilograms divided by height in meters squared.

HIFT exercise protocol

For 12 weeks, the subjects underwent HIFT training according to the method presented by Feito and colleagues (8). Crossfit was used as the HIFT program. The first two sessions of the training program were used to familiarise the subjects with the common movements (squat, deadlift, press, jerk, barbell, dumbbell movement, clean movement with medicine ball, pull-up bar fix movement, kettlebell swing movement). At the beginning of the third day, each training session includes 10-15 minutes of stretching and warm-up, 10-20 minutes of training and training techniques, and 30-50 minutes of WOD (Workout of the Day), performed at a very high intensity and according to the individual's ability. The main training components were aerobic activities (running, jumping rope), bodyweight activities (Traction Barfix, Scott) and weightlifting (front squats, kettlebell twists), always performed in the form of Crossfit exercises in single, double and triple sets for time, repetitions or weight. Selected movements from Table 1 were used. The training regimen for both experimental groups comprised three stages: warm-up, main training, and cool-down. The functional training incorporated for the HIFT group was conducted in a circuit format and adhered to the overload principle throughout each session. In the first week, the protocol involved 30 minutes of training at an intensity of 40 to 50% of the maximum heart rate. In the second week, the duration increased to 40 minutes at 50 to 60% of the maximum heart rate. During the third week, participants trained for 50 minutes at an intensity of 50 to 60% of their maximum heart rate, followed by 50 minutes at 60 to 70% in the fourth week. Finally, for the last eight weeks, the training continued for 60 minutes at an intensity of 60 to 70% of the maximum heart rate.

The schedule of training sessions was 1-(one movement like M), 2-(two alternating movements as activity-rest including G, M) and 3-(three 20-minute activities with the combination of M, G, W). In this program, M is an activity with a long distance and slow speed, G is a heavy skill and W is a movement with heavy weight and low repetitions. The training program consisted of three days of training and one day of rest; the first day of WOD training consisted of one type of activity, the second day of WOD training consisted of two types of activity, the third day of WOD training consisted of three types of activity and the fourth day was a rest day. Each day, the duration of each exercise, the total number of rounds and repetitions completed for each movement, the weights used, and any modifications required to each exercise program were recorded for each participant. The training intensity was determined using the Karvonen formula (9).

The target heart rate was determined according to the following formula:

Target Heart rate= Resting Heart Rate+ {%Intensity of training* Reserve}

Reserve= Maximum Heart Rate- Resting

Table 1. Movements used in the HIFT protocol

Movements using body weight	Aerobic activity	Movements with weights
Bodyweight Squat	Run	Deadlift
Pull-up (Barfix)	Riding bike	Clean
Push-ups	Rowing	Chest Press
Dip	Skipping rope	Snatch
Swimming		Clean and Jerk
Rope climbing		Movements using medicine ball
Burpee		Kettlebell Swings
Loin Fillets		Dumbbell Movements
Sit-ups		Barbell
The types of jumps		Goblet Squat
Lunge		

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Measurement of biomarkers in blood

Fasting blood samples were collected in two stages: pre-test (48 hours before the start of the study) and post-test (48 hours after the completion of the research protocol). 7 ml of blood was collected from the brachial vein and transferred to tubes containing EDTA anticoagulant. After centrifugation (10 minutes, 3000 rpm), the plasma samples were separated and transferred to the freezer to measure the target biomarker. In this study, the levels of semaphorin E (Cat. No. SEL920Hu, Cloud-Clone Corp, USA), were measured by the ELISA method (Diagnostic Biochem, Canada).

Statistical analysis

In this study, the Kolmogorov-Smirnov test was employed to assess the normal distribution of the data. A paired t-test was used to compare pre-test and post-test changes within each group. Differences in changes between groups were analyzed using analysis of variance (ANOVA) followed by Bonferroni's post hoc test. Data are expressed as mean ± standard deviation. All analyses were carried out using SPSS version 22 software, with a significance level set at $P< 0.05$.

Ethical considerations

The Academic Center for Education, Culture, and Research of Khorasan Razavi has approved this research proposal (ethical code: IR. ACECR.JDM.REC.1402.016). Additionally, this study received approval from the committee of Tehran University of Medical Sciences and is registered with the IRCT under the registration number IRCT2024060806 2039N1.

Results

The statistical sample included 22 obese men (BMI≥ 30) in the age range of 23 to 32 years (mean age: 8.4±27.6 years; mean height: 168.4±2.6 cm; mean weight: 95.7±3.8 kg, mean BMI: 32.6±2.6 kg/m^2) and the semaphorin level before the start of the training protocol was 0.701±0.0396 and after the training was 0.533 ±0.0303. In this section of the study, the ANOVA analysis revealed a significant difference among the experimental groups ($P< 0.001$). Consequently, Bonferroni's post hoc test was employed for group comparisons. As illustrated in Chart 1, the blood levels of Sema3E were notably lower in the H groups compared to the control group ($P< 0.001$).
The main effect of Group was also significant ($P= 0.032$), suggesting differences between the three intervention groups.

The findings indicated a significant reduction in semaphorin-3E levels within the HIFT group relative to the control group. Additionally, the HIFT group demonstrated significant improvements in body composition, including decreases in body weight, BMI, and waist circumference ($P< 0.001$) (Table 2) (Figure 1).

Conclusion

The present study showed that the HIFT exercise protocol could reduce systemic inflammatory marker and cardiovascular disease risk factor in obese people by showing a synergistic effect. Therefore, due to the time and space savings of HIFT exercises on semaphorin-3E levels, these solutions can be considered in the health programme to fight obesity.

Table 2. Body weight, BMI and Sema3E in two stages of pre-test and post-test in the control group (C), the HIFT group (H group). Data are shown as mean ± standard deviation.

Variable	Group	Before	After	*P*-value
Body weight(kg)	C	94.33 (±1.82)	93.55 (±2.43)	< 0.001
	H	92.78 (±1.89)	89.19 (±2.37)	
BMI(kg/m^2)	C	33.08 (±1.34)	32.87 (±1.44)	< 0.001
	H	33.22 (±1.07)	31.85 (±1.19)	
Sema3E	C	0.701 (±0.0396)	0.723 (±0.0378)	< 0.001
	H	0.693 (±0.0481)	0.533 (± 0.0303)	

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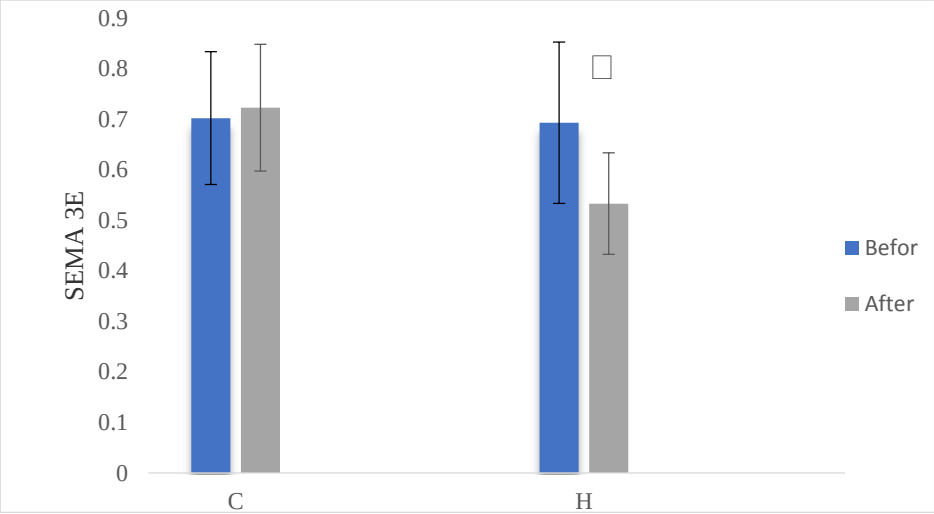

Figure 1. Changes in the level of semaphorin 3 (Sema3E) in the control group (C) and the HIFT group (H group). * compared to the control group. Data are shown as mean ± standard deviation.

This study indicates that HIFT could be an effective method for enhancing semaphorin-3E levels in obese men. Additionally, HIFT might help lower the risk of metabolic conditions, including IR and cardiovascular disease. Nevertheless, further investigation is essential to validate these findings and to establish the most effective HIFT program for increasing semaphorin-3E levels in obese individuals .

In summary, integrating HIFT into lifestyle interventions for obese men might represent an innovative strategy for improving vascular health and preventing metabolic disorders. Additional research is required to explore the long-term impacts of HIFT on semaphorin-3E levels and metabolic health among obese individuals.

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Conflict of Interest

No funding was received by a third party or institution.

Authors' contributions

All authors have taken responsibility for the complete content of this manuscript and have agreed to be accountable for all facets of the work, ensuring that any questions regarding the accuracy or integrity of any portion are properly investigated and addressed. They have also approved the version to be published.

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