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The effect of eight weeks' resistance and high-intensity interval training on neuropilin-1 levels in aged obese male rats

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Extended Abstract

Introduction

Neuropilin 1 is able to reduce the risk of atherosclerosis by increasing angiogenesis and maintaining the integrity of blood vessels, while reducing inflammation in adipose tissue. Also, neuropilin 1 is able to prevent insulin resistance associated with inflammatory conditions of obesity by increasing the absorption of fatty acids. Neuropilin 1 stimulates fatty acid uptake in adipose tissue and provides a substrate for beta-oxidation. With these interpretations, neuropilin 1 could be an important therapeutic target in the prevention of cardiovascular and metabolic diseases in the elderly. It is possible that effective therapeutic strategies in the prevention and treatment of obesity, such as physical activity and exercise training, may reduce the risk of inflammatory diseases associated with obesity by affecting neuropilin 1.
Intense exercise causes local hypoxia in active cells. Exercise stress can also alter the expression of angiogenic and inflammatory factors through other mechanisms such as increased production of free radicals, release of pro-inflammatory cytokines, disruption of cell energy charge, and shear stress in vessels. Therefore, exercise is considered a strong stimulus in regulating growth factors, but different exercise protocols can have different effects and in this regard, tissues generally respond differently to exercise. Few studies have examined the effects of exercise training on serum levels of neuropilin 1, and none of the previous studies have examined the effects of exercise training on neuropilin 1 in obese and at-risk individuals. Therefore, the present experimental study aimed to compare the effects of eight weeks of high-intensity interval training and resistance training on neuropilin 1 expression in aged obese male rats.

Method

Thirty aged male Wistar rats with an average age of 20-22 months and an initial weight of 250±20 grams were randomly divided into three equal groups: high-fat diet, high-fat diet and resistance training, and high-fat diet and high-intensity interval training. This study was conducted in two phases, including fattening (300 grams) and training phase. After one week of familiarization of the animals with the environment and normal diet, the process of changing the diet began; in such a way that for every 100 grams of the mice's weight, five grams of food were given per meal. A high-fat diet consisting of 40% fat (20% soybean oil and 20% animal fat), 13% protein, and 47% carbohydrates was prepared and all rats were fed this diet for the next 8 weeks. After the rats reached a body weight of 300 g, the training phase continued with the high-fat diet. Resistance training consisted of eight weeks of five sessions per week of climbing a one-meter ladder with 26 steps. After attaching a weight to the tail, the rats were forced to climb the ladder. In the first week, the amount of weights attached to the rats was 30% of their body weight, which gradually reached about 200% of their body weight in the final week. The exercises were performed in three sets of four repetitions. Three minutes of rest between sets and about ten seconds between repetitions were considered. The high-intensity interval training program included

swimming in a rodent pool with controlled water temperature. Swimming training was performed five sessions per week for eight weeks. The load intensity was adjusted by a weight attached to the animal's tail and in each training session individually according to body mass. The criterion for determining the amount of weight was a load between five and sixteen percent of body weight, which was obtained for each rat. Therefore, the swimming protocol used in this study ranged from low intensity (load between zero and five percent of body mass) to high intensity (load between 5 and 16 percent of body mass). Forty-eight hours after the last training session, blood was drawn at 8:00 a.m. The serum was used to measure blood marker levels. Serum levels of neuropilin 1 were measured using the ELISA method using the instructions of the animal kit manufactured by East Biopharm Company, China (Cat.No: RK03079) with a sensitivity of 0.19 pg/ml. All stages of the study were conducted in accordance with the guidelines of the National Ethics Committee with the ethics code IR.IAU.BOJNOURD.REC.1402.011 in biomedical research. One-way analysis of variance and Bonferroni post hoc test were used to test the hypotheses at a significance level of $P \leq 0.05$.

Results

The results showed that the mean of neuropilin 1 was different among the groups [$F(2,27) = 3.182$, $P = 0.035$]. The results of the Bonferroni post hoc test showed that there was a significant difference between the high-fat diet-resistance training group and the high-fat diet-high-intensity interval training group with the high-fat diet group ($P \leq 0.001$). No significant difference was found between the two training groups ($P = 0.125$). The effects of eight weeks of resistance training on the expression of neuropilin 1 in aged obese male rats are acceptable ($P \leq 0.001$). The level of neuropilin 1 in the high-fat diet-resistance training group increased compared to the high-fat diet group. The effects of eight weeks of high-intensity interval training on the levels of neuropilin 1 in aged obese male rats are acceptable ($P \leq 0.001$). The level of neuropilin 1 in the high-fat diet-high-intensity interval training group increased compared to the high-fat diet group.

Discussion and Conclusion

The respiratory exchange ratio in mice lacking the neuropilin 1 gene indicated an increase in fat consumption compared to carbohydrates during physical activity. The volume of oxygen consumed and heat production during exercise were lower in mice lacking the neuropilin 1 gene that became obese on a high-fat diet, which indicates a decrease in fat catabolism in these mice, and perhaps this decrease in fat consumption caused the accumulation of lipid-based calories. In addition, improved angiogenesis is one of the important adaptations in response to aerobic exercise, indicating the importance of remodeling the extracellular matrix of skeletal muscle for achieving improved aerobic capacity after endurance exercise. According to gene expression profiling, several factors have a regulatory effect on the extracellular environment and facilitate vascular remodeling following exercise. Changes in vascular endothelial growth factor and its receptors, such as neuropilin-1, following exercise confirm this.

One of the reasons for the increase in serum neuropilin 1 levels in the present study is the improvement in body composition following eight weeks of exercise training. In the present study, regular exercise was effective in reducing body weight and preventing obesity by increasing energy expenditure. There is a significant relationship between changes in neuropilin 1 following aerobic exercise and changes in body weight and body fat percentage. Therefore, this hypothesis is strengthened that obesity modulation plays a role in the increase in serum neuropilin 1 levels after eight weeks of exercise training. In addition, aerobic exercise increases fat oxidation by affecting some hormones affecting lipid metabolism such as epinephrine, norepinephrine, growth hormone, and cortisol, and by increasing the recall and use of free fatty acids, it reduces body fat mass.

The results showed that the exercise activities in the present study were able to exert their protective effects through changes in serum levels of neuropilin-1. Exercise training is able to increase neuroplein-1 levels compared to the control group, indicating the benefits of such exercises in the aging and obesity process. Of course, no significant differences were found between the two exercise groups. Therefore, it can be recommended that this type of exercise be used to prevent risks and age-related obesity in at-risk groups such as the elderly. Full confirmation of these results requires further research by examining other signaling and effector pathways as well as other factors involved in this field.

Keywords: Resistance training, High-intensity interval training, Neuropolin-1, Obesity, Aging.

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