EFFECTS OF EXERCISE INTERVENTION ON SERUM LEPTIN, CELLULAR IMMUNE FUNCTION, BODY MASS INDEX AND EXERCISE ABILITY IN PATIENTS WITH OBESITY

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ABSTRACT

Objective: *To investigate the influence of exercise on serum leptin, cellular immune function, body mass index and exercise capacity in obese patients.*

Methods: *Eighty obese patients admitted to the endocrinology department in our hospital from November 2017 to June 2018 were enrolled. They were equally and randomly divided into an exercise-intervention group (activity treatment) and a basic-intervention group (medication treatment). Serum leptin, visfatin, and resistin levels, as well as body weight, body mass index (BMI), cellular immune function, and time-to-exhaustion times were compared pre- and post-intervention between the two groups.*

Results: *Serum leptin and resistin levels in both the exercise- and basic-treatment groups were significantly lower than pre-treatment levels, and both group dylinin levels were significantly higher post-treatment compared to pre-treatment. Exercise-treatment levels of leptin and resistin were significantly lower than those in the basic-treatment group, and dyslipidin levels were significantly higher after exercise treatment compared to basic treatment. Both groups showed significantly lower body weights after their treatments, but weight reduction in the exercise-treatment group was significantly higher than in the basic-treatment group. BMI values for both groups was significantly lower after their treatments, but BMI reduction in the exercise-treatment group was significantly more than in the basic-treatment group. Post-treatment index values for both the thymus and spleen in the two groups were significantly higher than pre-treatment values, and both indices were significantly higher in the exercise-treatment group compared to the basic-treatment group. Time-to-exhaustion, a measure of exercise capacity, increased significantly in both groups after treatment, but this measure was significantly longer in the exercise-treatment group compared to the basic-treatment group.*

Conclusion: *Exercise treatment can effectively regulate the levels of serum adipokines (leptin, dyslipidin, and resistin), improve cellular immune function, significantly reduce an obese patient's BMI, and prolong their time-to-exhaustion.*

Keywords: *Exercise intervention, obesity, cellular immune function, serum leptin, body mass index, exercise capacity.*

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Introduction

Obesity involves the pathological metabolism of proteins, fats, carbohydrates and other substances in the human body, and is a complex metabolic disorder syndrome(1). It is a high-risk factor for both diabetes and for cardiovascular diseases, and as a common non-communicable disease, it severely threatens human life and health in society(2). Obesity can occur in any age group, but its incidence in younger groups has increased significantly in recent years. At present, the pathogenesis of obesity is not clear. It is recognized to be the result of multiple genetic and environmental interactions, with specific genetic and immune system factors important for its occurrence(3). The core clinical features of obesity are abnormal lipid metabolism, hypertension and diabetes, insulin resistance or impaired glucose tolerance, with insulin resistance being the main cause(4). Insulin's main role is in maintaining the body's metabolism of glucose and lipids, and insulin resistance refers to a pathophysiological state where the body's response to insulin is reduced(5). Exercise can improve the body's sensitivity of insulin, and is an effective method to treat obesity(6), with clinical studies demonstrating that a combination of diet and exercise is curative, without toxic side effects, and has a low rebound rate(7). We therefore used an exercise intervention in obese patients to determine any changes in serum leptin level, cellular immune function, body mass index, and exercise capacity. These reference values should help to prevent and to treat obesity in the future.

Materials and methods

General patient information

Eighty (80) obese patients admitted to the endocrinology department of our hospital from November 2017 to June 2018 were enrolled in the study.

The inclusion criteria for all patients were as follows:

- They met the diagnostic criteria for obesity as defined in The Obesity Clinical Diagnosis and Treatment Manual;
- They had a BMI ≥25.0; they were 18-58 years old;
- They had normal-to-high levels of low-density lipoprotein cholesterol (LDL-C), triglycerides (TG), total cholesterol (TC);
- They had relatively low levels of high-density lipoprotein cholesterol (HDL-C);
- They had obesity-related hyperthyroidism;
- They gave informed consent;
- They received approval from the hospital ethics committee.

The exclusion criteria for all patients were as follows:

- Those with endocrine or metabolic diseases;
- Those with movement disorders;
- Those with long-term use of hormones, sleeping pills or other psychotropic drugs;
- Serious heart, brain, liver, and kidney dysfunction;
- Those with clinical uterine bleeding, amenorrhea, infertility, and perimenopausal syndrome;
- Those with diabetic ketoacidosis;
- Those with hypertension or cardiovascular diseases;
- Those who were pregnant or lactating.

According to the random number table method, the patients were equally divided into an exercise-intervention group and a basic-intervention group, and their general characteristics are presented in Table 1. In the exercise-intervention group (23 males and 17 females), the average age was 47.99±7.49 years, the average BMI was 77.50±15.99 kg/m2, and the mean disease duration was 4.33±3.25 years. In the basic intervention group (21 males and 19 females), average age was 46.88±8.56 years, average BMI was 77.49±15.52 kg/m^2, mean disease duration was 4.68±3.02 years. There were no significant differences (P>0.05) for these data between the two groups.

Groups	Gender (male/female)	Mean age (years)	BMI (kg/m^2)	Mean disease course (years)
Exercise intervention	23/17	47.99±7.49	77.50±15.99	4.33±3.25
Basic intervention	21/19	46.88±8.56	77.49±15.52	4.68±3.02
χ^2/t	1.268	0.230	0.003	0.619
P	0.530	0.794	0.998	0.499

Table 1: Comparison of general patient data between the two groups (mean ± SD).

Methods

Patients in the exercise-intervention group had their daily energy requirements determined, and were given health advice and exercise programmes tailored to their specific conditions. For each patient, daily physical exertion was gradually increased, and then maintained, to 50%-70% of maximum oxygen consumption during 30-60 min of aerobic exercise, with a recommended daily physical exertion value of >350 kcal. Each patient wore motion monitoring equipment to record calories burned by the exercises in real time, and recordings were reset automatically at midnight each day. Patients were required to transmit the exercise data via the internet weekly. Medium-intensity sports were recommended (e.g., jogging, brisk walking, swimming, and dancing) depending on patients' hobbies and physical health, and with telephone guidance and supervision. Obese patients in the basic-intervention group were prescribed individualized drugs to reduce blood pressure, lower blood sugar, and lower blood lipids according to their specific needs, and were strictly supervised for compliance.

Observation indicators

- Fasting blood samples were used to determine serum leptin, visfatin and resistin levels by immunoassay.
- All patients wore their same clothes for each body weight measurement, using the same scale, at the same time of day. The BMI was calculated by dividing patient weight (kg) by patient height (cm).

Statistical methods

Data processing was performed using the SPSS 23.0 software package. Data were expressed as means ± standard deviations. Paired-sample t-tests were used to compare data before and after interventions. Independent-sample t-tests were used for comparisons between groups. The χ^2 test was used for enumeration data comparisons. Differences with a P value <0.05 were considered statistically significant.

Results

Comparison of serum leptin, adiponectin and resistin levels in the two groups

After the interventions (see Table 2), serum leptin and resistin levels in both groups were significantly lower than before the interventions (P<0.05), and in both groups, dylinin levels were significantly higher than before the treatment (P<0.05).

Between groups, the after-treatment levels of serum leptin and resistin in the exercise-intervention group were significantly lower than those of the basic-intervention group (P<0.05), and the after-treatment level of dyslipidin was significantly higher than that of the basic-intervention group (P<0.05).

Groups	Time	Leptin (μg/dL)	Resistin (μg/dL)	Adiponectin (μg/dL)
Exercise intervention	Before intervention	13.11±4.31	12.11±6.31	8.11±3.31
	After intervention	7.81±0.81$^{*\#}$	7.01±4.21$^{*\#}$	13.91±2.91$^{*\#}$
Basic intervention	Before intervention	12.11±5.11	12.61±3.81	9.11±5.11
	After intervention	8.61±5.11*	8.61±3.11*	12.41±3.51*

Table 2: Comparisons of serum leptin, adiponectin and resistin levels in the two groups (mean ± SD).
Note: *P<0.05, compared to before treatment; $^{\#}$P<0.05, compared to the basic-intervention group after treatment.

Comparison of body weight and BMI function between the two groups

After the interventions (Figure 1), both group body-weights were significantly lower than before the interventions (P<0.05), and exercise-intervention group body weight was significantly lower than that of the basic-treatment group (P<0.05). For BMI measures, the two groups were also significantly lower after the interventions (P<0.05), and BMI values of the exercise-intervention group was significantly lower than those of the basic-treatment group (P<0.05).

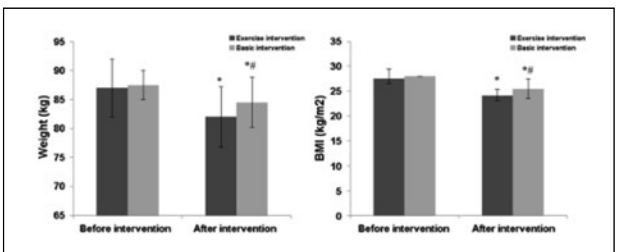

Figure 1: Comparison of mean body weight, and mean BMI, between groups.
Note: *P<0.05, compared to before treatment in the same group; $^{\#}$P<0.05, compared to the basic intervention group after treatment.

Comparison of cellular immune function between the two groups

The thymus and spleen indices of the two groups after treatment (Table 3) were significantly higher than those before treatment (P<0.05), and both of these indices in the exercise-intervention group were significantly higher than those of the basic-treatment group (P<0.05).

Groups	Time	Thymus index (g/kg)	Spleen index (g/kg)
Exercise intervention	Before intervention	2.28±0.30	1.11±0.31
	After intervention	3.73±0.35$^{*\#}$	1.98±0.32$^{*\#}$
Basic intervention	Before intervention	2.32±0.26	1.02±0.29
	After intervention	2.83±0.29*	1.32±0.22*

Table 3: Comparisons of cellular immune function between the two groups (mean ± SD).
Note: *P<0.05, compared to before treatment; $^{\#}$P<0.05, compared to the basic-intervention group after treatment.

Comparison of exhaustive exercise time between the two groups

After the interventions, the time-to-exhaustion in the two groups (Table 4) was significantly longer than that before treatment (P<0.05), and the time-to-exhaustion in the exercise intervention group was significantly longer than that of the basic-intervention group (P<0.05).

Groups	n	Time	Time to exhaustion (min)
Exercise intervention	40	Before intervention	59.73±6.89
		After intervention	77.60±5.45$^{*\#}$
Basic intervention	40	Before intervention	58.62±6.93
		After intervention	67.34±4.95*

Table 4: Comparisons of time-to-exhaustion between the two groups (mean ± SD).
Note: *P<0.05, compared to before treatment; $^{\#}$P<0.05, compared to the basic intervention group.

Discussion

Obesity has become a public health problem that endangers human life and health in the 21st century. According to a 2005 World Health Organization report, 160 million adults were overweight, and 400 million adults were obese. In 2015, overweight adults increased to 2.3 billion, and adult obesity exceeded 700 million[8]. Exercise promotes fat breakdown, and increases energy consumption: an effective method for preventing and treating obesity. Moderate and low-intensity exercise is known to play an important role in improving blood sugar levels, insulin levels, lowering blood lipid levels, and the risk of cardiovascular disease; effectively preventing ischemic heart disease, myocardial infarction, and congestive heart failure[9]. Therefore, for obesity, it is particularly important to explore healthy and effective weight-loss methods. Clinical studies have shown that eight weeks of aerobic exercise can significantly reduce body weight in obese patients, restore their systolic blood pressure to normal, and improve their exercise capacity.

Adipose tissue not only has important endocrine functions, but also serves as an energy storage centre, and can secrete a variety of hormones (e.g., leptin, adiponectin, and resistin), cytokines, vasoactive substances, and lipids[10]. These adipokines can effectively regulate insulin, glycolipid metabolism, and energy balance to maintain homeostasis in the body[11]. The results of this study demonstrate that serum leptin and resistin levels in the exercise-intervention group were significantly reduced compared to the basic intervention group ($P<0.05$), and that the level of dyslipidin was significantly higher than in the basic-intervention group ($P<0.05$). We interpret these findings to mean that serum leptin, dyslipidin and resistin are involved in the development of obesity, and an exercise intervention can effectively improve the level of these adipokines.

Clinical studies have shown that most obese patients have unhealthy eating habits, and the standard three-meals-a-day eating structure is unreasonable. In addition, obese patients are overweight, sluggish, lazy, and their calorie consumption is significantly reduced. Fat accumulates in the body, and leads to an constant increase in body weight[12], and weight is an important factor for measuring body size and judging fatness. Combining weight and height, the BMI is widely used as an effective benchmark for measuring world obesity levels, and it is positively correlated with body density, which can indirectly estimate the level of body fat[13]. The present results demonstrate that both interventions significantly reduced body weight ($P<0.05$), and exercise-induced weight loss was significantly more than that seen in the basic-treatment group ($P<0.05$). After both interventions, BMI values were significantly lower than pre-intervention ($P<0.05$), and the exercise-induced reduction in BMI was significantly more than that seen in the basic-treatment group ($P<0.05$). These results suggest that an exercise intervention in obese patients can effectively reduce their weight and BMI.

The thymus and spleen are important immune system organs, and their namesake indices directly reflect their immune functions and changes within the bod y[14]. We found that both indices were significantly higher in the exercise-treatment group compared to the basic-treatment group ($P<0.05$), suggesting that exercise intervention can effectively improve the immune system in obese patients.

Aerobic exercise has been shown to effectively reduce the BMI of obese mice, and enhance their exercise capacity through enhanced transcription and translation of γ-assisted activator factor 1α and its downstream elements[15]. Our results demonstrate that time-to-exhaustion in the exercise-treatment group was significantly longer than in the basic-intervention group ($P<0.05$), improving the exercise capacity of the obese.

In summary, we have shown that exercise can effectively regulate serum levels of adipokines, improve cellular immune function, and significantly reduce BMI values in obese patients while increasing their exercise capacity.

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