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Effects of Exercise Intervention on Aerobic Capacity and Metabolic Indexes of Obese Adolescents from the Perspective of Computer Application



Abstract: - T The effects of 4-week aerobic training prescription intervention on aerobic capacity, body composition, blood lipid and C-reactive protein (CRP) in obese adolescents were analyzed by digital technology and computer software. The subjects were obese patients, aged 13-18 years old, 40 adolescents with body fat ratio >30%, including 20 males and 20 females. Body shape, fasting blood glucose, blood lipid, blood insulin and serum hs-CRP were measured before and after the intervention, and the data were divided by statistical analysis. Conclusion: Abdominal fat accumulation in obese adolescents is excessive, serum hs-CRP level is increased, waist circumference is significantly correlated with hs-CRP level, lipid metabolism disorders (TC, HDL-C, LDL-C) and insulin resistance are closely related to the increase of hs-CRP level, which may be a comprehensive risk factor for cardiovascular and other pathological changes in obese patients. 4 weeks of aerobic exercise can effectively reduce the body fat percentage of obese adolescents, improve waist circumference and hip circumference, improve lipid metabolism, significantly reduce the fasting insulin and hs-CRP levels of obese adolescents, and will play a positive role in preventing and reducing the occurrence and development of cardiovascular diseases in obese adolescents.

Keywords: Computer aided analysis, Obese adolescents, Blood lipids, Body composition, Insulin resistance, Hypersensitivity C-reaction

I. INTRODUCTION

AI big data statistics show that the incidence of global adolescent obesity is increasing year by year, mainly due to poor lifestyle (such as over-nutrition, lack of physical activity, etc.) ^[1]. Early-onset obesity increases the incidence of adult obesity and obesity-related diseases (such as cardiovascular disease, diabetes, insulin resistance) and affects exercise capacity and quality of life ^[2].

Computer aided software, statistical analysis of global data, concluded that obesity is a mild systemic inflammatory disease ^[3,4], is a major risk factor for chronic diseases such as hypertension, hyperlipidemia, arteriosclerosis, coronary artery disease ^[5,6]. Fat cells secrete large amounts of tumor necrosis factor. TNF-A and IL-6 stimulate the liver to produce highly sensitive C-reactive protein (HS-CRP) ^[7]. Epidemiological studies confirm that hs-CRP is considered the strongest inflammatory marker of future cardiovascular events ^[8], and individuals with high CRP levels are 2-3 times more likely to develop cardiovascular disease than individuals with low levels ^[9]. Exercise intervention is the preferred method for the prevention and treatment of obesity, and only a single aerobic training mode is emphasized in the exercise prescription design. In recent years, it has been found that resistance training plays an irreplaceable role in the growth and development of teenagers' physical quality. There are few reports on exercise prescription design for obese adolescents by combining different methods. The purpose of this study was to observe the effects of 8-week exercise prescription intervention on aerobic capacity, body composition, blood lipids and G-reactive protein (CRP) in obese adolescents, and to provide evidence for the physical health of obese adolescents.

II. RESEARCH OBJECT AND METHOD

A. Research Object

Subjects are obese 13-18 years old who voluntarily participate in total closed exercise to lose weight. There are 40 adolescents (body fat rate >30%), including 20 males and 20 females. Medical history investigation: No acute and chronic infection in the past two weeks, and after physical examination and exercise load test. Except for endocrine system diseases and cardiovascular insufficiency. Before the experiment and the subject's home, sign the informed consent form.

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B. Research Method

Under the background of technical muscle application, the body size, fasting blood glucose, blood lipid, blood insulin and serum hs-CRP before and after the intervention were measured by instruments, and the data before and after the detection were analyzed by computer software statistical analysis method. The statistical data provided the basis for the conclusion of this study.

III. OPERATION STEPS

Exercise plan. After the camp, the subjects were given 4-week closed nutritional intervention and exercise intervention. The dietitian arranges meals according to the basic metabolic rate. According to the health status of the subjects according to the results of exercise load test, determine the exercise intensity, target heart rate (THR) quiet heart rate (RHR)+heart rate reserve (maximum heart rate - RHR)>X20% - 40%, and formulate personalized exercise prescription.

Sports mode: adopt indoor and outdoor diversified sports such as swimming, walking, jogging, aerobics and ball games; Exercise 6 days a week, and carry out 2 hours of aerobic exercise in the morning and afternoon, 15 to 20 minutes of preparation activities before exercise, and 10 minutes of finishing activities after exercise. Arrange 2-3 short breaks during exercise. All sports are guided by full-time coaches, and medical supervision is carried out by professionals to monitor the intensity of sports in real time.

C. Use Computer Aided Software and Instruments to Measure the Main Indicators

1) *Body shape index measurement*: First, confirm that you have the correct template for your paper size. This template has been tailored for output on the US-letter paper size. If you are using A4-sized paper, please close this template and download the file for A4 paper format called "CPS_A4_format".

2) *Exercise load test*: After recording the 9-lead quiet ECG, the subjects carried out the exercise test of 4 km/h, 6 km/h and 8 km/h incremental load on the treadmill. After each level of load lasted for 4 minutes, the I-lead ECG was recorded immediately after the load. If the ECG is obviously abnormal or reaches 85% of the expected maximum heart rate or the subject cannot continue to exercise subjectively, the exercise load test shall be terminated, and the ECG in the recovery period of 1 min after exercise shall be recorded after the experiment. Monitor the exercise heart rate with POLAR table during the exercise load. The recording of quiet and exercise ECG provides the basis for the formulation of exercise prescription and ensures the safety and effectiveness of exercise weight loss.

3) *Determination of blood biochemical indexes*: Collect 5 ml of elbow static in the fasting state on the next day of the camp and the morning before the camp. Pulse blood, standing at room temperature for 30 min, centrifuging at 3000 r/min for 10 min, and then extracting the serum. Use the oxidase method of automatic biochemical analyzer to measure four items of blood lipids, namely glycerol triacetate (TG), total cholesterol (TC), high-density lipoprotein cholesterol (HDL-C) and low density. Degrees lipoprotein cholesterol (LDL-C); Determination of fasting blood glucose by glucose oxidase method (GLU); Insulin (FINS) was measured by radioimmunoassay; Immunoturbidimetry Determination of hypersensitive C-reactive protein (hs-CRP). Insulin resistance index (HOMA-IR)=(fasting blood glucose x fasting insulin)/22.5.

4) *Computer statistical analysis*: SPSS 180 statistical software package for statistical analysis and quantitative data the mean is expressed by standard deviation (x soil SD), and the paired t Test, P<0.05 means statistically significant, P<0.01 means significant very significant. Pearson correlation coefficient was used for linear correlation analysis.

IV. ANALYSIS OF RESEARCH RESULTS

A. Changes of Body Shape and Body Composition of Obese Adolescents before and after Exercise

Table 1 shows that after 4 weeks of aerobic exercise intervention, the weight and BMI of obese adolescents, body fat rate and fat weight decreased significantly (P<0.01). Male the average fat weight of obese adolescents decreased by 10.4%, and that of women decreased by 6. 5% 86%, poor the difference was very significant (P<0.01). Both boys and girls have increased lean weight trend, but the difference was not statistically significant (P>0.05), and there was no gender difference. Motion after the intervention, the waist circumference and hip circumference of the subjects were significantly reduced, and the waist circumference of the male was lower than that of the female High sex (P<0 01).

1) *Changes of blood biochemical indexes in obese adolescents before and after exercise:* It can be seen from Table 2 that after 4-week low-intensity aerobic exercise intervention, male and female obese subjects The content of serum hs-CRP decreased by 38.9% and 28.8% (P<0.01). The levels of DL-C and TG in TC workers of obese adolescents of both sexes decreased significantly (P<0.01), HDL-C also showed a downward trend, and HDL/LDL increased significantly, with very significant statistical significance (P<0.01). Fasting blood insulin level and HOMA-IR index decreased significantly, and the difference before and after intervention was very significant, while the fasting blood glucose level did not change significantly before and after intervention (P>0.05).

Table 1: Change of Morphological Indices and Body Composition of Obese Adolescent before and after 4-Week Exercise

Target	boy(n=20)		girl(n=20)	
	Before intervention	After intervention	Before intervention	After intervention
TC/(mmol/L)	4.51 ± 1.18	3.29 ± 0.57**	4.37 ± 0.95	3.75 ± 0.60**
LDL-C/(mmol/L)	2.80 ± 0.80	2.03 ± 0.41**	2.84 ± 0.76	2.15 ± 0.67**
HDL-C/(mmol/L)	1.00 ± 0.18	0.88 ± 0.14**	1.03 ± 0.21	0.91 ± 0.19**
TG/(mmol/L)	1.16 ± 0.56	0.60 ± 0.30**	0.82 ± 0.46	0.61 ± 0.33**
GLU/(mmol/L)	5.05 ± 2.42	4.61 ± 0.45	4.49 ± 0.73	4.63 ± 0.25
FINS/(pmol/L)	112.5 ± 65.1	69.93 ± 27.08**	97.14 ± 50.79	70.21 ± 35.80**
HOMA-IR/(MIU/mL)	3.81 ± 2.88	2.06 ± 0.83**	2.83 ± 1.68	2.09 ± 1.10**
Hs-CRP	6.07 ± 3.46	3.71 ± 2.43**	6.43 ± 3.49	4.58 ± 3.08**

2) *Relationship between hs-CRP and body composition, blood lipid and insulin resistance of subjects before exercise intervention:* The data analysis showed that before exercise intervention, serum hs-CRP was positively correlated with BMI, Body fat percentage and waist circumference, with a correlation coefficient of 0.493, 0.521 and 0.647 (P < 0.01) were negatively correlated with HDL-C, and the correlation coefficient was 1.349 (P < 0.05) was positively correlated with GLU and HOMA-IR (P < 0.05)

Changes in Body Shape and Body Composition of Obese Adolescents after Exercise

The latest research shows that the degree of obesity in adolescents is independently related to coronary heart disease [10]. The excessive increase of body fat in adolescents is mainly centripetal, and abdominal visceral fat directly or indirectly damages the cardiovascular system [11]. Waist circumference is a practical index to evaluate the abdominal fat content of adolescents, and is an important risk factor of cardiovascular disease in adolescents [12]. The study confirmed that the abdominal visceral fat content of adolescents and children with high waist circumference was 2 to 3 times higher than that of normal weight adolescents after stratified by BMI classification criteria. The risk of hypertension, changes in vascular morphology, early myocardial and coronary artery damage in adolescents with this size was significantly higher than those with low waist circumference [13]. The average waist circumference of male and female adolescents in this study was 101.3 cm and 82.68 cm, which is significantly higher than the cut-off point of the 90th percentile of waist circumference of Chinese adolescents aged 7-18 (male: 78.6-83.0 cm; Female: 74.0-76.1 cm), indicating that the risk factors of cardiovascular disease in the subjects of this study are seriously increased. After 4 weeks of exercise intervention, the waist circumference of male and female subjects decreased by 6.5% respectively 2 cm and 58 cm, indicating that the low-intensity and long-term aerobic exercise can selectively mobilize the body fat, giving priority to the mobilization of abdominal adipose tissue, and the subcutaneous fat utilization of buttocks and thighs is slightly slower than the abdominal fat map. Therefore, exercise intervention can effectively reduce abdominal fat, improve central body fat distribution and reduce the risk of cardiovascular disease in obese adolescents.

Body composition includes body fat (FM) and lean body weight. Due to the characteristics of adolescent development, there are gender differences in body composition of adolescents. The skin fold thickness and body

fat rate of adolescent women are greater than those of men. The body fat of women is mainly accumulated under the buttocks, while the body fat of men is mainly distributed under the viscera and trunk. In this experiment, after four weeks of aerobic exercise, the body weight, BMI and body fat rate of obese adolescents of men and women are significantly decreased, with the body fat rate decreasing more than that of men. Sex weight and body fat rate decreased significantly compared with women, and lean weight increased. G. C. Henderson et al [14]. believed that the lipid metabolism of men was higher than that of women during exercise and 3h after exercise, which may be the reason for the faster weight and fat loss of men than women. However, some studies have shown that the reason why men lose weight faster than women in the process of exercise intervention is that the fat loss of men and women is similar, but the lean weight loss of men is more obvious. The results of this study show that after 4 weeks of exercise intervention, the lean weight of obese adolescents in both men and women tends to increase.

1) *Changes of lipid metabolism and insulin level in obese adolescents after exercise intervention:* Adolescent dyslipidemia is a risk factor of adult cardiovascular disease [15]. It has been confirmed that obese adolescents have different degrees of dyslipidemia, mainly manifested by elevated TG, TC, LDL-C and decreased HDL-C. There are 4 items of blood lipids (TC, TG, HDL-C and LDL-C) are within the normal range, but there are one or more types of lipoprotein abnormalities in the sub-subjects, of which 30% are LDL-C levels higher than the normal value, and 20% are HDL-C levels lower than the normal value, the abnormal rate of TC level is 17.5%. After 4 weeks of low-intensity aerobic exercise, the subjects the blood lipid level of patients was significantly improved, and the number of people with LDL-C level higher than normal decreased to 2.5%, serum TC level of all subjects returned to normal, HDL-C/LDL-C ratio the value of HDL-C increased significantly, but the level of HDL-C in the subjects did not change significantly, which may be related to the low exercise intensity or short exercise intervention time.

Some research results show that the exercise intensity is higher than after continuous exercise for more than 12 weeks HRmax aerobic exercise can significantly improve HDL-C level, suggesting that regular low-intensity and long-term exercise intervention for more than 4 weeks may have a more significant effect on improving blood lipids. Other studies reported that there were differences in FITTS, HOMA-IR and p-cell function index between obese adolescents and normal weight adolescents [16], fasting blood insulin was significantly higher, and there was insulin resistance. After four weeks of exercise intervention, the fasting insulin and insulin resistance in serum of obese adolescents were significantly reduced, and insulin sensitivity was strengthened, suggesting that exercise intervention can effectively reduce blood sugar and insulin levels, significantly improve glucose and lipid metabolism and IR, thus reducing the risk of cardiovascular disease and diabetes.

2) *Effect of exercise intervention on hs-CRP in obese adolescents:* C-reactive protein is a sensitive acute phase reactive protein synthesized by the liver, which normally exists in human serum in trace form. When the body has acute CRP levels were significantly increased in inflammation, trauma and infarction. CRP, especially hs-CRP, is considered to be the most sensitive inflammatory marker of cardiovascular disease [17]. According to the guidelines of the American Heart Association, serum hs-CRP <1.0 mg/L, 1.0-3.0 mg/L >3.0mg/L represents the low, medium and high levels of relative risk of cardiovascular disease hs-CRP >3 the age of 0 m L was associated with an increase in the incidence of cardiovascular events, M. Roivainen's study showed that the relative risk of coronary heart disease events in the population with CRP in the highest quartile increased more than three times (RR: 3.56) [18]. Recent research found that every unit of increase in CRP after logarithmic conversion increased the risk of coronary heart disease by 29%. A large number of studies have confirmed that the concentration of circulating hs-CRP in adult obese patients is significantly higher than that in normal weight patients, and is closely related to BMI. The results of the study on the changes of serum CRP level in adolescent obese patients are not consistent. Most studies believe that serum CRP in obese adolescents is increased. Other studies have shown that there is no significant difference in serum CRP between overweight and obese adolescents compared with normal subjects. In this study, the mean value of basic level of hs-CRP in obese male and female adolescents was 6 At the age of 07 m, 6.43 mg/L, about 75% of the subjects had significantly abnormal serum hs-CRP (higher than 3 mg/L), belonging to the high-risk group of cardiovascular disease risk stratification, suggesting that obese adolescents were at high risk of cardiovascular disease.

The blood CRP level can decrease in proportion with the change of weight loss and fat content. There are different reports on the effect of aerobic exercise on CRP. F. Mattusch et al. showed that nine-month high-intensity endurance training can reduce plasma CRP level, suggesting that regular exercise has anti-inflammatory effect; Another study reported that 34 obese postmenopausal women with low calorie diet and exercise for 6 months improved their maximum oxygen uptake by 6% and CRP decreased [19], while the weight loss of the low calorie diet control group was similar to that of the experimental group, and CRP did not change, indicating

that exercise was more effective than BMI in reducing chronic inflammation. Ran Feng studied 80 middle-aged and elderly obese patients, and found that aerobic exercise with equal load in 12 weeks can reduce body composition and serum CRP level, while P. C. Wong et al. The research results of 12 weeks of intervention with resistance and aerobic exercise twice a week and 1 hour each time for obese adolescents showed that exercise can effectively improve the aerobic fitness of obese adolescents yes, but there is no improvement in the CRP level of obese patients beyond the high-risk cut-off point, which may be related to the short intervention time. In this study, after 4 weeks of low-intensity aerobic exercise for a long time the level of serum hs-CRP in adolescents was significantly lower than that before exercise intervention 1kg body weight, hs-CRP decreased by 0.3 mg/L, but after exercise intervention, the mean value of hs-CRF level is still higher than the high-risk cut-off point of 3-year-old L, suggesting that 4-week low-intensity aerobic exercise can effectively reduce the level of hs-CRF in obese adolescents, while the level of hs-CRF in obese patients may require longer exercise intervention or further reduction of body fat content to return to normal. In this experiment, hs-CRP was significantly reduced after only 4 weeks of low-intensity exercise, demonstrating that short-term low-intensity and long-term exercise intervention can improve the level of hs-CRP in obese adolescents. The improvement of hs-CRP level after exercise intervention may be the result of the superimposed effect of exercise and weight loss. Previous studies have confirmed that exercise or physical fitness may directly affect the level of hs-CRP without considering the change of body weight. The reduction of hs-CRP, a marker of inflammatory response after exercise intervention, indicates that the risk of cardiovascular disease in obese adolescents after exercise and weight loss is reduced.

3) *Correlation between 4 hs-CRP and body composition, blood lipids and insulin:* Pearson correlation analysis showed that serum hs-CRP in obese adolescents the basic level was positively correlated with BMI, body fat percentage and waist circumference, with the significance of $P < 0.001$, this is related to M Tomaszewski et al. have similar results. S. Lim et al among the many influencing factors such as BMI, waist circumference, waist to hip ratio and body fat ratio, the correlation between body fat ratio and CRP level is the highest in subjects. The increase of body fat ratio will lead to the aggravation of inflammatory reaction, suggesting that the increase of total body fat content and abdominal fat is the main factor for the aggravation of inflammatory level and the increase of cardiovascular disease incidence in obese patients. The research results of A. T. Timoteo et al. show that CRP and anthropometric index the standard BMI and WC were significantly correlated with all risk indicators of metabolic syndrome, especially in patients with cardiopathy. In terms of lipid metabolism, the results of this study showed that the subjects' hs-CRP and HDL-C were negatively correlated, suggesting that the increased level of inflammation was related to lipid disorders, while the increased level of inflammation might further promote lipid deposition and metabolic abnormalities, inhibit the activity of lipoprotein acetate, and reduce HDL-C level, thus starting the process of coronary atherosclerosis and reducing cardiovascular function. In addition, the results of this experiment show that hs-CRP has a positive correlation with HOMA-IR. Adipocyte factors participate in the formation of HOMA-II under inflammatory conditions. Insulin resistance can increase the secretion and synthesis of IL, -6 and TNF- α , while IL-1 β and TNF- α act on the liver to regulate the increase of CRP synthesis. The increase of CRP level can reduce insulin sensitivity by inhibiting the activity of insulin receptor tyrosine kinase [20].

V. CONCLUSION

Under the background of computer application technology, intervention experiment, instrument test and computer-aided software statistical analysis were used to draw the following conclusions: there was no statistical significance between the two groups before the test ($P > 0.05$). After the test, FG RHR, systolic blood pressure and serum CRP were decreased compared with those before the test ($P > 0.05$ or $P < 0.01$), VO₂max and lean body mass (LBM) were increased ($P < 0.01$ or $P < 0.01$), and CG index had no statistical significance (all $P > 0.05$). RHR, systolic blood pressure and CRP in FG group were lower than those in CG group ($P < 0.05$), VO₂ was higher than those in CG group ($P < 0.01$).

Serum hs-CRP levels increased in obese adolescents with excessive accumulation of abdominal fat. Waist circumference was significantly correlated with hs-CRP levels. Lipid metabolism disorders (TC, HDL-C, LDL-C), insulin resistance and other factors are closely related to hs-CRP levels, which may be a comprehensive risk factor for cardiovascular and other pathological changes in obese patients. 4 weeks of aerobic exercise can effectively reduce the body fat percentage of obese adolescents, improve waist circumference, hip circumference and other body types, improve fat metabolism, significantly reduce fasting insulin and hs-CRP levels, and will play a positive role in preventing and reducing the occurrence and development of cardiovascular diseases in obese adolescents.

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