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Article

A multivariate study on the regulation of metabolic patterns of human fat cells by aerobics exercise from the perspective of biomechanics

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Abstract: This paper explores the principle of aerobics exercise and proposes the process of aerobic exercise on energy metabolism and lipid metabolism based on this principle, breaking down fat metabolism into several parts of digestion, absorption, decomposition and synthesis to simulate the process of fat metabolism. A two-way ANOVA was used to analyze the multivariate effects of aerobics exercise on the regulation of human adipocyte metabolic patterns. The results showed that after 6 weeks of intervention, the total cholesterol level of the aerobics exercise group returned to the normal range, and compared with the pre-intervention total cholesterol level decreased by 0.391 mmol/L and there was a significant difference, with a *p* value of less than 0.05. After 12 weeks of intervention, the total cholesterol level of the aerobics exercise group and the tai chi exercise group returned to the normal range, and the total cholesterol level of the aerobics exercise group compared with the pre-intervention total cholesterol level decreased by 0.676 mmol/L and the total cholesterol level decreased by 0.676 mmol/L. level decreased by 0.676 mmol/L, again with a significant difference. After aerobics exercise, the changes of adipocytokines of serum leptin and resistin were lower than those of the control group, and the changes of cytokines were 7.889 μg/dl and 6.948 μg/dl, respectively, which showed that the effect of aerobics exercise on the metabolism of adipocytes in the human body was more obvious. After the intervention of aerobic exercise lasting 12 weeks, it can effectively alleviate the cell morphological changes caused by high total cholesterol, and play a preventive role in the cell damage induced by high total cholesterol.

Keywords: adipose metabolism; regulatory effect; lipocalin; aerobic exercise; aerobics; two-way ANOVA

1. Introduction

With the rapid development of modern economy, science and technology, people's material life is more and more demanding, the masses of people's demand for spiritual life is increasing day by day, especially pay great attention to the health of the body. Aerobics as a new fashion and with the vigorous development of China's sports and development, and in the enhancement of people's physical fitness to build a socialist spiritual civilization has shown its important role and status. Aerobics, regardless of the form of division, has different styles and characteristics, can reflect the temperament and spirit of the times and can achieve the cultivation of correct body posture, the form of fitness of the body for the purpose, and has to enhance the respiratory system, the blood circulation system, as well as to promote the metabolism of fat and so on play an important role [1–4].

Through aerobics exercise, the human body can improve energy consumption, prompting fat cells to break down fat, thus reducing fat storage. In addition, aerobics exercise can also improve the body's oxygen intake, accelerate the metabolic rate, and further promote fat metabolism. Aerobics can increase energy consumption, thus reducing fat storage. When people perform aerobics exercises, muscles need to consume energy to maintain the exercise. Energy mainly comes from fat and carbohydrates, and in low-intensity aerobic exercise, fat is the main source of energy. Through sustained aerobic exercise, the decomposition and utilization of fat can be accelerated, thus reducing fat storage [5–8].

Yang [9] systematically introduced aerobics and investigated the effect of aerobics training on lipid reduction and obesity treatment. The investigation concluded that aerobics training is beneficial for fat reduction and obesity treatment, but the effect is not overnight. Zang [10] examined the effect of aerobics training on obesity. Based on experimental data, it was emphasized that aerobics training is not only beneficial to obesity treatment, but also has the function of cultivating self-awareness of exercise and shaping the body shape, which is welcomed by most students. Ding [11] comprehensively introduced the sport of aerobics, indicating that practicing aerobics not only improves obesity and body shape, but also enhances cardiorespiratory fitness and prevents cardiovascular diseases. Jin [12] aimed to investigate the effect of aerobic exercise on body shape of obese college students. By launching a comparative experiment on 60 obese college students. The results pointed out that aerobic exercise has a positive effect on reducing body weight and BMI. Therefore, college students should increase aerobic training to improve their physical fitness. Zhu et al. [13] aimed to examine the effect of aerobic exercise on the physical health of obese college students, and the results indicated that aerobic exercise is beneficial to enhance the physical fitness of obese college students through the testing of college students' body fat percentage, body weight and other indicators. Haiying and Lirong [14] explored the effects of aerobic exercise on obesity and lipid metabolism in adolescents. A comparative experiment was conducted on 40 adolescents. The results indicated that aerobic exercise helps to reduce obesity in adolescents. Wang [15] examined the effects of aerobic exercise on weight loss and related biochemical indices in athletes. Based on the questionnaire survey of 20 athletes, the collection and mathematical statistics were utilized to study the athletes' body size and fitness, blood indexes and other related data. The results showed that aerobic exercise can improve athletes' shape, body mass and biochemical indicators.

The aim of the Tian [16] was to explore the modulatory effects of physical activity on lipid metabolism in adolescents. Based on a comparative experiment of 80 obese youths. And BMI, CT and other indexes before and after the intervention were compared. The results emphasized that physical exercise can effectively improve the shape of adolescents. Beqa [17] aimed to determine the effect of planned kinesiological activities on the reduction of overweight. Using 20 females as subjects, the results revealed that Kangoo jumping with high intensity music is beneficial in reducing the amount of fat. Marandi [18] aimed to discuss the effects of light and moderate aerobic intensity on body composition and lipids in obese/overweight women. After a comparative experiment, it was shown that both light and moderate aerobic exercise improved body composition and blood lipids in obese/overweight women. Afriani [19] states that a proper exercise program is beneficial in reducing fat levels and body weight in overweight people. Surveillance-based aerobic exercise programs have shown that increases in aerobic fitness and body mass index do not always change significantly, as muscle mass increases with decreases in fat mass. Adrien and Felix [20] investigated the effects of aerobic exercise on blood lipids over a short period of time and launched an eight-week experiment. The results showed that aerobic exercise was beneficial in reducing body markers such as triglycerides and total cholesterol. Hagag [21] aimed to assess the effect of aerobic training on metabolic parameters and cardiorespiratory health parameters in obese women. Based on the experimental research approach, the experiment was carried out on 60 women. The results indicated that aerobic training is an effective way to improve lipids and cardiovascular health and can be used as a preventive measure against cardiovascular diseases due to obesity.

This paper defines aerobics exercise, which belongs to the category of aerobic exercise, and analyzes its energy metabolism as well as lipid metabolism processes using aerobic exercise as an entry point. It is proposed that through aerobic training in the intensity of the increase, there is a long time fat consumption function. The main constituents of fat are explored, and the metabolic pathways of fat are discussed in relation to the causes of fat formation. Summarize the effect of aerobic exercise on the production of the three elements based on the characteristics of the formation of blood lipids, leptin and lipocalin. Designing research experiments, using two-factor ANOVA, the results of the effects of aerobics exercise on human morphological indexes, fat metabolism indexes, and serum adipocytes were analyzed by means of an intervention control.

2. Research on the regulation of human fat cell metabolic patterns by aerobics exercise

2.1. Aerobics

2.1.1. Definition of aerobic exercise

Aerobics exercise belongs to aerobic exercise, and aerobic exercise refers to physical exercise in which the human body is supplied with sufficient oxygen [22]. That is, during exercise, the body inhales oxygen equal to the demand and reaches a physiological equilibrium. Its exercise duration is long (about 30 min or more), and the intensity of exercise is at a moderate or upper-middle level (60% to 80% of the maximum heart rate value).

2.1.2. Energy metabolism in aerobic exercise

Fat is the main fuel at quiet and low intensity, energy production is a key part of exercise capacity, the energy produced is first used by the brain, in comparison the energy required for muscle contraction is much greater, therefore, the total amount of energy required for aerobic exercise is extremely high, and the body needs to satisfy this demand not only by increasing its energy reserves, but also by increasing the efficiency of energy utilization. In aerobic exercise, greater utilization of energy stored in fat leads to changes in body composition, and in order for this transformation to occur, changes in the endocrine system are the body is able to produce energy more efficiently.

Aerobic exercise causes changes in the energy system to occur for two reasons, firstly, the body produces adaptation by storing more energy substances; second, the body increases its ability to utilize energy substances through enzyme activity and physiological adaptations at the cellular level. The adaptation of energy storage is the ability of aerobic exercise to produce adaptations in the storage of energy substances (primarily glycogen), and aerobic training also causes an increase in intramuscular triglycerides. Elevated levels of available energy substances can prolong the duration of exercise. Depending on the intensity of the exercise, an increase in pre-existing fatty acids has a direct effect on glycogen stores. Lactic acid, which is the inflection point of the body's energy-supplying substances from fats to carbohydrates, also represents the inflection point of the body from aerobic to anaerobic energy supply, which begins to increase as a result of the shift in the energy-supplying system. This is because aerobic training allows people to function by burning fat for long periods of time while increasing in intensity.

2.1.3. Aerobic exercise and lipid metabolism

Typically, the total blood volume in an adult's body is about 5 L, and there are about 5 g of glucose in 5 L of total blood volume. Carbohydrate intake from food, hepatic glycogenolysis (breakdown of liver glucose), and gluconeogenesis all help maintain blood glucose levels. When blood glucose falls below normal levels, the alpha cells of the pancreas secrete glucagon. Glucagon is a carbohydrate mobilizing hormone which promotes gluconeogenesis and hepatic glycolysis in the liver, thus returning blood glucose levels to normal, and when blood glucose falls below normal, the pancreas secretes insulin. During training, aerobic training endurance decreases as blood glucose decreases.

At rest and during exercise, the liver produces glucose to ensure that blood glucose concentrations reach 100 mg/dL (5.5 mmol/L), blood glucose provides approximately only 30% of the total energy required by the working muscles, with the rest of the required carbohydrate energy coming from stored myoglycogen, During prolonged high-intensity exercise, blood glucose concentrations eventually drop below normal levels, due to the fact that the contracting skeletal muscles are continuously consuming blood glucose, while liver glycogen stores continue to diminish.

Later in the exercise period, the levels of myoglycogen involved in exercise drop, which causes these muscles to become more and more dependent on blood glucose as their source of carbohydrates. If carbohydrates are not consumed, then hypoglycemia (< 45 mg/dL, 2.5 mmol/L) can easily occur after hepatic and myoglycogen depletion, which ultimately affects performance and contributes to central nervous system fatigue after prolonged exercise.

2.2. Adipocyte metabolism

2.2.1. Fat metabolic pathways

Lipid metabolism involves more reactions in the normal functioning of the organism, and for obese individuals, fat is an important cause of overweight body weight, so the metabolism of fat is generally discussed in studies [23]. Fat mainly consists of three fatty acid triglycerides, and fat is traditionally regarded as an energy saving tissue, while fat is also involved in other metabolisms in the endocrine body, such as the metabolic balance of glycolipids. The metabolic process of fat mainly covers digestion, absorption, catabolism and synthesis.

2.2.2. Effect of aerobic exercise on blood lipids

Human plasma contains a large number of lipids such as triglycerides (TG), phospholipids (PL), cholesterol (TC) and free fatty acids (FFA), which are collectively referred to as lipids. Since lipids have an insoluble nature, these lipids in the human body are collectively referred to as hemolipoproteins. Lipid content in the human body has a normal range, more than this range, the human body's metabolism will be disrupted, many of the diseases will follow, daily life in the common obesity, atherosclerosis and other diseases is the human body lipid content exceeded the standard caused by. The human body to carry out appropriate aerobic exercise can promote the body's metabolism, accelerate the decomposition of fat, and at the same time reduce the amount of LDL-C in the body, reduce the emergence of lipid-related diseases [24].

2.2.3. Effect of aerobic exercise on leptin

Leptin is short for ob protein in the body, a hormone that, like lipids, needs to result with carrier proteins in the body in order to exist, and is mainly composed of white adipose tissue. In the human body, leptin can transmit the information of fat changes in the human body to the brain, so that the brain to make a timely response. With the stimulation of leptin information, the brain will respond quickly, in order to maintain the balance of the body's fat content, the brain will control the body's energy intake, accelerate the consumption of energy, the study found that appropriate aerobic exercise can be very good to improve the function of leptin in the body, so that the regulation of fat in the body to reach a higher level, as far as possible to reduce the emergence of obesity. Research has found that the leptin content in the body of athletes is relatively low compared to the general population.

2.2.4. Effect of aerobic exercise on lipocalin

Adipocytokines are circulating hormones that are secreted by adipose tissue and it is a hot topic in medical research nowadays. Lipocalins, which increase in size and decrease in secretion as adipocytes increase in size, are also known as Aerp30, GBPZs. they are endogenous biologically active peptides or proteins that are secreted by mature cells.

3. Experimental design and analysis of results

3.1. Subjects and methods of study

3.1.1. Subject of the study

ZZ Fitness Club aerobics exercise for weight loss women (20 people), tai chi exercise for weight loss women (20 people) general obese women (20 people) were selected as experimental subjects.

(1) Inclusion criteria: Age 45–55 years old, by asking the subjects about past medical history and basic health status, finally selected healthy, no heart disease, hypertension, diabetes, liver disease and other past medical history, no history of regular exercise and smoking history, before the experiment did not take hormones or weight-loss drugs for the experimental subjects. The selection criteria for obesity: BMI ≥ 24kg/m^2, waist circumference ≥ 80 cm, all subjects were informed of the content of the experiment and the matters that should be noted during the experiment, and agreed to participate in the experiment.

(2) Grouping of experimental subjects.

The 60 experimental subjects were divided into 3 groups: 40 women from ZZ Fitness Club for exercise and weight loss were randomly divided into two groups: Aerobics exercise group (S) and tai chi group (A), and 20 ordinary obese women were placed in the control group (C).

3.1.2. Research methodology

(1) Mathematical and statistical methods.

Two-factor ANOVA was applied to the obtained data using SPSS 16.0 software under Windows 97. Paired *t*-test was used to compare the data before and after the experiment, and independent samples *t*-test was used to compare between groups. Two-factor ANOVA was applied and multiple comparisons were processed. Normality and variance chi-square tests were performed on the measured results. All statistical tests were performed using two-sided tests. The measured values of each index were expressed as mean ± standard deviation ($x \pm S$), and the significance level was taken as $p < 0.05$, and the very significant level was taken as $p < 0.01$.

(2) Experimental method.

Based on the existing theories and experimental needs, the design was proposed. Under natural conditions, the intervention is implemented purposely and step by step for the weight loss subjects, and the test of each relevant index is conducted before and after the experiment.

The intervention content of this experiment is to learn the fitness value of calisthenics, the basic pace of calisthenics, the provision of the national mass calisthenics level one complete set of movements, and the special strength training of calisthenics. The class assignment of the control group was the same as that of the experimental group, with a total of 54 class hours in 18 weeks, 3 classes per week, 45 min each time. Among them, the control group of students according to the routine Taijiquan physical education and health course content. The students in the experimental group and the control group were pre-tested before the experiment, and the students in the experimental group and the control group were post-tested after the experiment. The students in the experimental group were subjected to the aerobics exercise program intervention, which lasted for 18 weeks. Before and after the implementation of the intervention program, the students in the experimental group and the control group were tested for various indicators.

3.2. The effect of aerobics exercise on human morphological indicators

Table 1 shows the changes in body morphology indexes of middle-aged obese women before and after the experiment, as seen in **Table 1**, there was no significant difference in the data measured in each group before the experiment, $p > 0.05$. Compared with the preexperiment, there was no change in the height of all subjects after the experiment. The weight, BMI, waist circumference, hip circumference, WHR, upper arm, scapula, abdomen and other indexes of each group decreased compared with the pre-experiment, with significant difference, $p < 0.01$. Among them, the data of upper arm and scapula in group A decreased, but the difference was not significant, and the decrease of body weight, BMI and abdominal skinfold thickness in group (S) was more obvious, with highly significant difference, and the data of these three groups after the experiment were 57.16, 22.84 and 62.54, $p < 0.01$.

Comparison between experimental groups: There was no significant difference in the relevant data between the groups before the experiment, $p > 0.05$. There was no difference in body weight, BMI and abdominal skinfold thickness between Group C and Group A after the experiment, and there was no significant difference in waist circumference, hip circumference, WHR, upper arm and scapular area compared with the three experimental groups. Weight, BMI and abdominal skinfold thickness decreased more in group (S) compared to groups C and A. There was a significant difference, $p < 0.05$.

Table 1. Changes in the physical shape of women in mid-aged obese women.

Index		**(C) group**		**(A) group**		**(S) group**	
		Pre experiment	**Post experiment**	**Pre experiment**	**Post experiment**	**Pre experiment**	**Post experiment**
BMI	Height (m)	1.64 ± 0.03	1.63 ± 0.02	1.60 ± 0.06	1.60 ± 0.05	1.61 ± 0.06	1.62 ± 0.05
	Weight (kg)	73.86 ± 6.45	70.55 ± 5.24	72.94 ± 6.15	61.25 ± 6.18*	73.02 ± 6.51	**57.16 ± 5.85**#**
	BMI	28.26 ± 2.15	27.48 ± 2.18	28.15 ± 2.49	23.48 ± 2.46*	28.16 ± 2.99	**22.84 ± 2.86**#**
WHR	Waistline (cm)	87.69 ± 6.45	87.51 ± 5.97	86.48 ± 6.15	72.45 ± 5.15*	86.98 ± 6.12	70.65 ± 6.05*
	Hip Circumference (cm)	93.45 ± 3.48	90.64 ± 4.21	93.45 ± 3.78	89.15 ± 3.48*	94.26 ± 3.45	88.15 ± 2.69*
	WHR	0.81 ± 0.08	0.80 ± 0.05	0.84 ± 0.04	0.77 ± 0.02*	0.84 ± 0.05	0.75 ± 0.04*
Thickness of plenated (mm)	Upper Arm Circumference	29.15 ± 2.36	28.63 ± 1.25*	29.24 ± 2.36	27.15 ± 1.98	29.15 ± 2.45	25.39 ± 1.85*
	Scapula	32.48 ± 3.26	30.63 ± 1.05	30.36 ± 3.25	29.15 ± 1.96	31.48 ± 3.15	28.45 ± 1.58*
	Abdomen	72.36 ± 4.96	68.48 ± 3.74	7.23 ± 4.96	65.15 ± 2.59*	72.36 ± 4.12	**62.54 ± 3.15**#**

Note: * indicates that $p < 0.05$ is significant difference between all groups after the experiment and before the experiment; ** indicates $p < 0.01$ is extremely significant difference. # means that after the experiment, S group compared with C and A group, $p < 0.05$, there is A significant difference; ## means $p < 0.01$, there is a very significant difference.

3.3. The effect of bodybuilding exercises on indicators of fat metabolism

3.3.1. Serum Triglycerides (TG)

Triglycerides (TG) are the most abundant lipids in the human body. Currently, triglyceride levels can be categorized into four levels: Normal level < 1.69 mmol/L, critical high level 1.69–2.25 mmol/L, high level 2.26–5.63 mmol/L, and very high level ≥ 5.64 mmol/L. Triglycerides that exceed the normal level will jeopardize the health of the body, such as: Accumulation under the skin will cause obesity, accumulation around the blood vessel wall will cause arteriosclerosis, accumulation around the heart will lead to cardiac hypertrophy, and fatty liver will form. For example, accumulation of triglycerides under the skin will lead to obesity, accumulation of triglycerides on the walls of blood vessels will lead to atherosclerosis, accumulation of triglycerides around the heart will lead to cardiac hypertrophy, and accumulation of triglycerides in the liver will lead to the formation of fatty liver.

Figure 1 shows the trend of triglyceride changes in the three groups during the 12-week intervention process. Before the intervention, the triglyceride (TG) levels of the aerobics exercise group, tai chi exercise group and control group were 1.425 mmol/L, 1.648 mmol/L, and 1.398 mmol/L, respectively, which were all within the normal range. After 6 weeks of intervention, triglyceride (TG) levels in the aerobics exercise group were reduced by 0.11 mmol/L but the difference was not significant ($p > 0.05$), and triglyceride (TG) in the tai chi exercise group was reduced by 0.223 mmol/L but the difference was not significant ($p > 0.05$) when compared with the pre-intervention period. After 12 weeks of intervention, triglyceride (TG) levels in the aerobics exercise group were reduced by 0.366 mmol/L and there was a highly significant difference compared with the pre-intervention ($p < 0.01$), and there was a significant difference compared with the 6 weeks of intervention ($p < 0.05$). After 12 weeks of intervention, triglycerides (TG) in the tai chi exercise group decreased by 0.352 mmol/L and there was a highly significant difference compared with the pre-intervention period ($p < 0.01$), and there was a highly significant difference compared with 6 weeks of intervention ($p < 0.01$). Throughout the intervention, the triglyceride (TG) level decreased slightly more in the aerobics exercise group than in the tai chi exercise group.

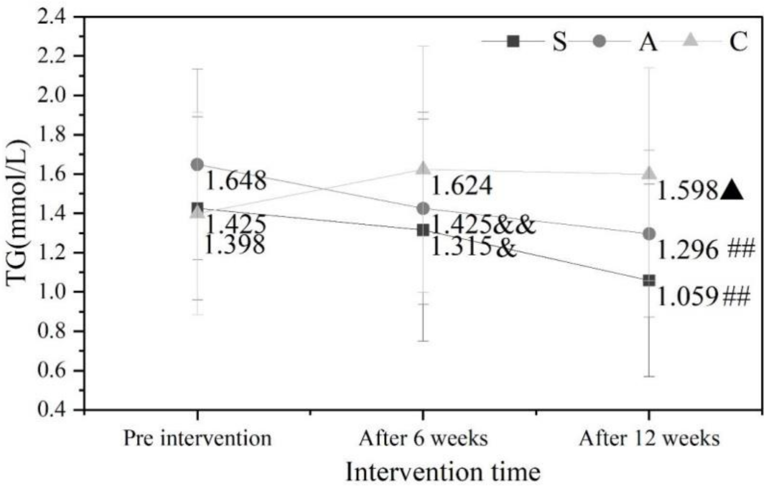

Figure 1. The trend of the three ester changes.

The before and after 6 weeks, ※ means $p < 0.05$, ※※ means $p < 0.01$. Before intervention and after 12 weeks, # means $p < 0.05$, ## means $p < 0.01$. The comparison between 6 weeks of intervention and 12 weeks of intervention, & means $p < 0.05$, && means $p < 0.01$.

Before intervention, 6 weeks and 12 weeks after intervention, the aerobics exercise group was compared with the Tai chi exercise group. ● means $p < 0.05$, ●● means $p < 0.01$. Comparison between the aerobics exercise group and the control group, ▲ means $p < 0.05$, ▲▲ means $p < 0.01$. Comparing Taijiquan exercise group with control group, ◆ means $p < 0.05$, ◆◆ means $p < 0.01$.

3.3.2. Total serum cholesterol (TC)

Total cholesterol (TC) refers to the total amount of cholesterol contained in all lipids within the blood [25]. The amount of total cholesterol in the body generally depends on genetics and lifestyle. The normal range of total cholesterol is generally 2.1–5.2 mmol/L (90–200 mg/dl). High total cholesterol levels are an important cause of certain diseases, such as coronary heart disease, which is caused by high total cholesterol levels. Atherosclerosis is also closely related to total cholesterol level, the higher the total cholesterol level, the more likely to lead to atherosclerosis.

Figure 2 shows the trend of serum total cholesterol changes in each group before, 6 weeks and 12 weeks after the intervention. The total cholesterol levels of the three groups of people before the intervention were higher than the normal range. After 6 weeks of intervention, the total cholesterol level of the aerobics exercise group returned to the normal range, and compared with the pre-intervention total cholesterol (TC) level decreased by 0.391 mmol/L and there was a significant difference ($p < 0.05$), while in the tai chi exercise group the total cholesterol (TC) level decreased by 0.387 mmol/L compared with the pre-intervention total cholesterol (TC) level and there was a significant difference ($p < 0.05$). After 12 weeks of intervention, the total cholesterol levels of both aerobics and tai chi exercise groups returned to the normal range, and the total cholesterol (TC) level of the aerobics exercise group decreased by 0.676 mmol/L with a highly significant difference ($p < 0.01$) compared with the pre-intervention period, and there was a significant difference ($p < 0.05$) compared with that of the 6-week intervention period. The total cholesterol (TC) level in the tai chi exercise group decreased by 0.65 mmol/L and there was a highly significant difference ($p < 0.01$) when compared with the pre-intervention period, and there was a highly significant difference ($p < 0.01$) when compared with the 6-week intervention period. Overall, it seems that the decrease in total cholesterol level in the aerobics exercise group was greater than the decrease in total cholesterol (TC) level in the tai chi exercise group. It indicates that aerobics exercise improved total cholesterol levels slightly better than tai chi exercise.

There was no significant difference in total cholesterol (TC) levels among the aerobics exercise group, tai chi exercise group, and control group before and after 6 weeks of intervention ($p > 0.05$). After 12 weeks of intervention, the total cholesterol (TC) level of the aerobics exercise group was significantly lower than that of the control group, and there was a significant difference ($p < 0.05$), which was statistically significant.

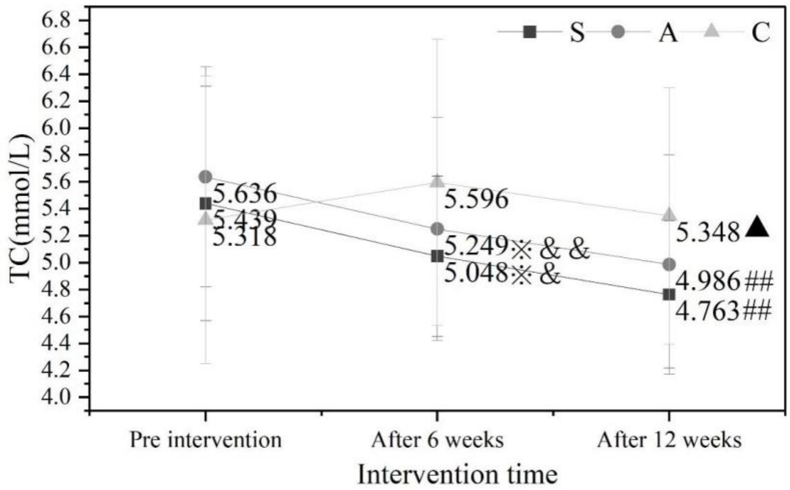

Figure 2. Serum total cholesterol changes.

3.3.3. Serum high-density lipoprotein cholesterol (HDL-C)

High-density lipoprotein (HDL) cholesterol (HDL-C) is generally understood to be the "good" cholesterol, the cholesterol that fights against atherosclerosis, because HDL cholesterol is able to reduce the risk of coronary heart disease. In general, HDL-C is 1.16–1.42 mmol/L in Chinese adult males and 1.29–1.55 mmol/L in females. The reference range of HDL-C for commonly used biochemical reagents is 0.91–2.17 mmol/L. HDL-C can be used as a predictor of coronary heart disease risk.

Figure 3 shows the trend of serum high-density lipoprotein cholesterol (HDL-C) levels in each group before, 6 weeks and after 12 weeks of intervention. After 6 weeks of intervention, the high-density lipoprotein cholesterol (HDL-C) level in the aerobics exercise group was almost unchanged compared with the pre-intervention period. In the tai chi exercise group, the high-density lipoprotein cholesterol (HDL-C) level increased by 0.107 mmol/L compared with the pre-intervention period and was significantly different ($p < 0.05$). At the end of 12 weeks of intervention, the high-density lipoprotein cholesterol (HDL-C) level in the aerobics exercise group increased by 0.114 mmol/L compared with the pre-intervention period with a highly significant difference ($p < 0.01$). There was a highly significant difference ($p < 0.01$) in HDL-C in the aerobics exercise group comparing 12 weeks of intervention with 6 weeks of intervention.

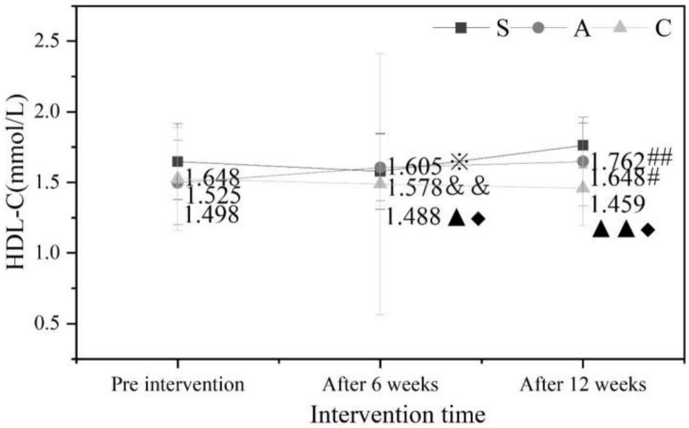

Figure 3. Serum HDL cholesterol changes.

3.3.4. Total cholesterol to HDL cholesterol ratio

Low total cholesterol and high HDL is good for health. The total cholesterol to HDL ratio (TC/HDL-C) is ideally < 4.5 for men and < 3.5 for women. The lower the general total cholesterol to HDL ratio (TC/HDL-C), the healthier the cardiovascular system.

Figure 4 shows the trend of TC/HDL-C changes in the population before and after the intervention, after 6 weeks of intervention, after 12 weeks of intervention, the TC/HDL-C value of the aerobics exercise group compared with the pre-intervention, a decrease of 0.58 and there is a highly significant difference ($p < 0.01$), and compared with the intervention of 6 weeks, a decrease of 0.25 there is a highly significant difference ($p < 0.01$).

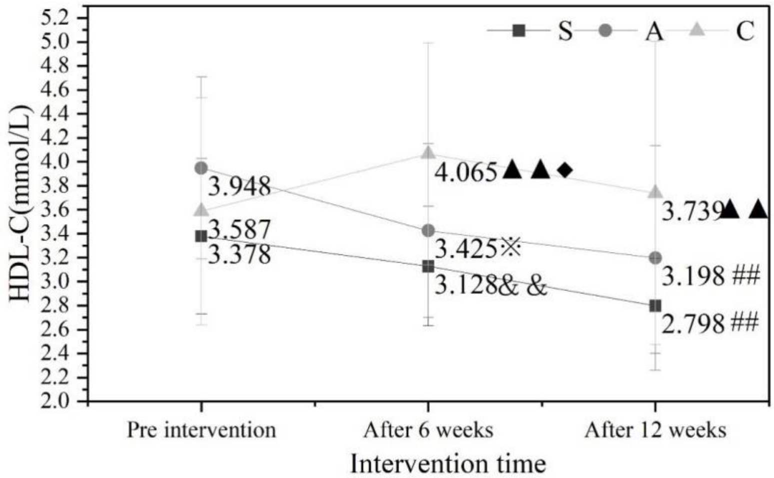

Figure 4. TC/HDL-C trends.

3.3.5. Serum low-density lipoprotein cholesterol (LDL-C)

LDL-C: Lipoproteins are the form of cholesterol found in the blood. LDL-C is generally understood to be the "bad" cholesterol because elevated levels of LDL-C increase the risk of cardiovascular disease, and high levels of LDL-C are responsible for several conditions including hypercholesterolemia, hypertriglyceridemia, and mixed hyperlipidemia. General dyslipidemia in China divides LDL-C into 3 different levels: ≦ 3.12 mmol/L is the appropriate range, 3.13–3.59 mmol/L is borderline elevated, and ≧ 3.6 mmol/L is elevated.

Figure 5 shows the trend of serum LDL cholesterol changes in the population before and after the intervention, and before the intervention, the LDL cholesterol (LDL-C) levels of the three groups exceeded the normal range. After 6 weeks of intervention, the LDL-C level in the aerobics exercise group decreased by 0.538 mmol/L compared with the pre-intervention period, and there was a significant difference ($p < 0.05$), and the LDL-C level in the tai chi exercise group decreased by 0.382 mmol/L compared with the pre-intervention period and there was a significant difference ($p < 0.05$), and after 12 weeks of intervention, the serum LDL-C level of the three groups exceeded the normal range. After 12 weeks, the LDL-C levels in both the aerobics exercise group and the tai chi exercise group returned to the normal range, while the control group had a tendency to increase, and the LDL-C levels in the aerobics exercise group decreased by 0.778 mmol/L compared with the pre-intervention period, and decreased by 0.538 mmol/L compared with the 6-week period of the intervention, and both of them had a highly significant differences ($p < 0.01$).

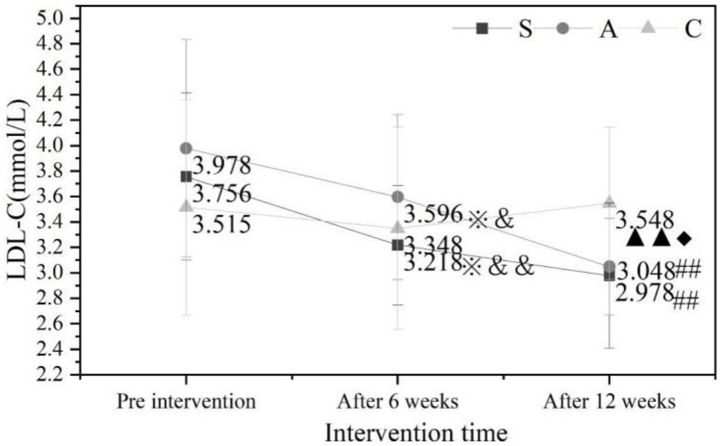

Figure 5. Serum LDL-C cholesterol changes.

3.4. Effects of aerobic exercise on cell morphology

Table 2 shows the changes of serum adipocytokines in the three groups before and after intervention, the serum bilipokines of group S were significantly higher than those of group C (1 ± 2.929 ± 3.569) μg/dl, while serum leptin (7.889 ± 0.264) μg/dl and resistin (6.948 ± 4.168) μg/dl were significantly lower than those of the control group (8.536 ± 4.958) μg/dl and resistin (7.626 ± 2.948) μg/dl, the difference was statistically significant ($p < 0.05$). After the intervention group in group S, the serum leptin and bilipoin decreased compared with those before intervention, and the resistin increased compared with those before intervention, and the calisthenics exercise intervention group decreased significantly after 12 weeks ($p < 0.01$).

Table 2. The changes in serum fat cell factors before and after intervention.

Group	**Leptin (μg/dl)**	**Residin (μg/dl)**	**Ligin (mg/dl)**
S Group			
Preintervention	13.154 ± 4.265	12.265 ± 6.248	8.065 ± 3.215
Intervention for 6 weeks	8.065 ± 4.165 [a]	8.348 ± 2.895 [a]	11.685 ± 3.269 [a]
Intervention 12 weeks	7.889 ± 0.264 [a]	6.948 ± 4.168 [ab]	13.848 ± 2.869 [ab]
F Value	6.487	5.658	4.965
p Value	< 0.01	< 0.01	< 0.01
A Group			
Preintervention	12.069 ± 5.065	12.548 ± 3.745	9.064 ± 5.066
Intervention for 6 weeks	10.598 ± 3.088	8.815 ± 3.485 [a]	10.348 ± 3.548
Intervention 12 weeks	8.515 ± 5.065	8.536 ± 3.048 [a]	12.348 ± 3.496 [a]
F Value	2.856	3.187	2.856
p Value	> 0.05	> 0.05	> 0.05

Table 2. (*Continued*).

Group	Leptin (μg/dl)	Residin (μg/dl)	Ligin (mg/dl)
C Group			
Preintervention	12.099 ± 4.099	12.388 ± 3.698	9.066 ± 4.987
Intervention for 6 weeks	10.599 ± 3.155	7.985 ± 2.955	11.298 ± 2.987
Intervention 12 weeks	8.536 ± 4.958	7.626 ± 2.948	12.929 ± 3.569
F Value	3.265	2.987	2.966
p Value	> 0.05	> 0.05	> 0.05

Note: [a] Compared with before intervention, $p < 0.05$, [b] Compared with the intervention in March, $p < 0.05$.

As an effective way to prevent and cure chronic metabolic diseases, aerobic exercise has been recognized as an effective way to prevent and cure high cholesterol. The above studies found that aerobic exercise can affect cholesterol through the regulation of blood leptin, while alleviating inflammation, promoting the body to increase the rate of cholesterol clearance, and then directly or indirectly achieve the effect of reducing cholesterol. This study found that during the 12-week intervention experiment, aerobic exercise intervention could effectively alleviate the increase in cholesterol caused by diet, confirming previous studies. However, compared with other drug intervention methods, there are individual differences in the intervention effect of aerobic exercise, which suggests that it is necessary to pay attention to the exercise effect in the process of preventing and treating cardiomyocytes induced by aerobic exercise. Different intensity and forms of exercise have different effects on cholesterol. Larger intensity exercise and short-term acute exercise will also lead to the increase of cholesterol, which will aggravate the occurrence of injury.

According to the HE staining of cells observed by light microscope, aerobic exercise intervention can effectively alleviate the cell morphological damage caused by diet in the 12-week intervention experiment. Cardiomyocytes in the aerobic exercise group were arranged more neatly and the cell space was relatively reduced, but there was inflammation in some cells, which may be caused by the failure to fully recover after the last exercise or the accumulation of exercise effects. This study confirmed that long-term aerobics exercise intervention can reduce the level of cholesterol and alleviate the morphological damage of heart cells induced by high cholesterol. However, there are individual differences, and it is necessary to pay attention to the intensity of exercise and avoid acute exercise or greater intensity exercise.

4. Conclusion

This paper analyzes the principles of aerobics exercise, and combs the relationship between aerobic exercise and energy metabolism as well as lipid metabolism. It proposes a fat metabolism process pathway, covering digestion, absorption, catabolism and synthesis, and explores the effects of aerobic exercise on blood lipids, leptin and lipocalin. Designed research experiments to study and analyze the effects of aerobics exercise on human morphology indexes, fat metabolism indexes, and serum fat. After the intervention of aerobics exercise, the human morphological indexes of body weight, BMI and abdominal skinfold thickness decreased more significantly and had highly significant differences, and the data of these three groups after the experiment were 57.16, 22.84 and 62.54, respectively, $p < 0.01$. Trends in triglyceride changes in the three groups of subjects were analyzed, and after 6 weeks of intervention, triglyceride (TG) levels in the aerobics exercise group were reduced by 0.11 mmol/L compared with the pre-intervention period. After 12 weeks of intervention, the triglyceride (TG) level in the aerobics exercise group decreased by 0.366 mmol/L compared with that before intervention and there was a highly significant difference, with a *p*-value of less than 0.01. Throughout the course of the intervention, the triglyceride (TG) level in the aerobics exercise group decreased by a slightly larger amount than that in the tai chi exercise group. Comparative analysis of changes in serum adipocytokines before and after the intervention, group S serum lipocalin was 13.848 ± 2.869 μg/dl, which was significantly lower than that of group C. After the intervention of group S, serum leptin and lipocalin were lower than that before the intervention, and resistin was elevated compared to the pre-intervention period, and the reduction was more significant in the aerobics exercise intervention group after 12 weeks.

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